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(54) SYSTEM AND METHOD FOR FUSION CAGE IMPLANTATION

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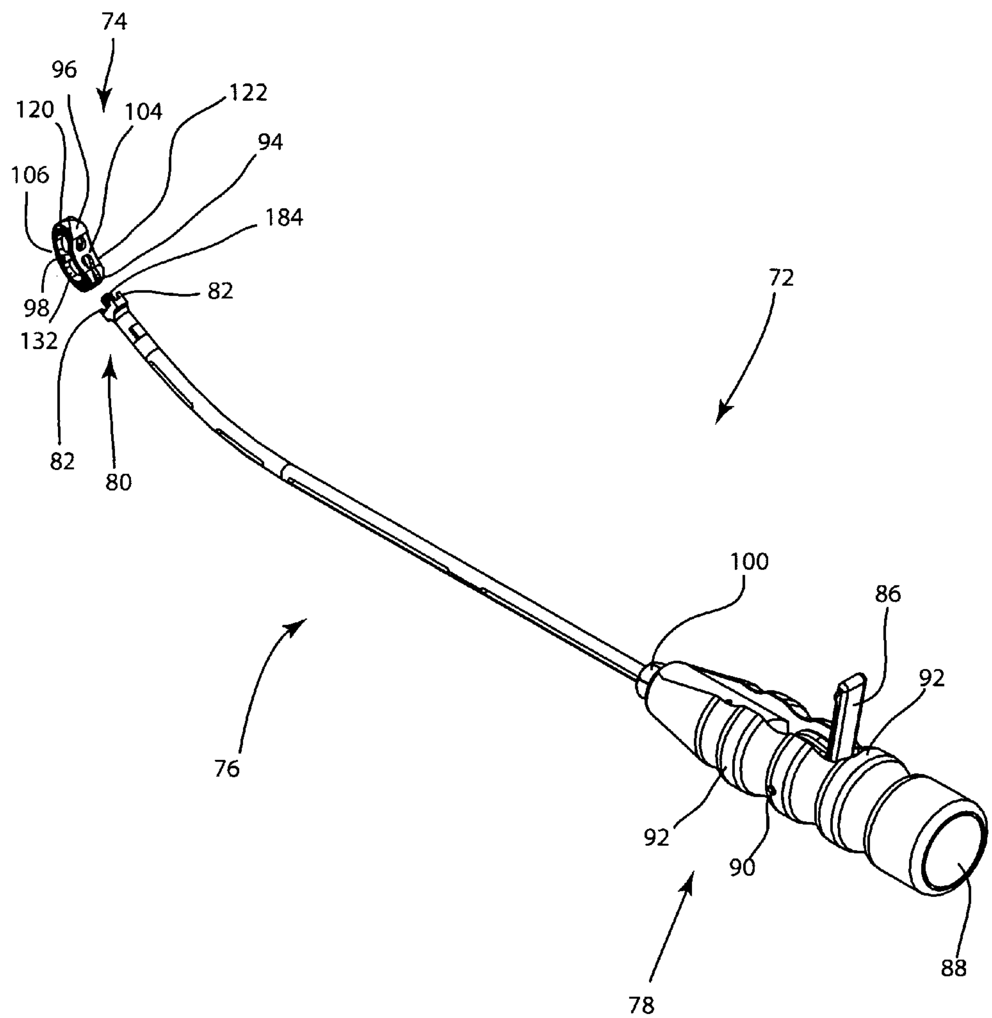
(57) ABSTRACT

A system and method facilitate insertion of a fusion implant into the intervertebral space of a spine. The fusion implant may have a first bone engaging surface and a second bone engaging surface. An attachment interface on an insertion tool allows the implant to be releasably secured to the insertion tool, so that the insertion tool may be detached from the implant without requiring a threaded coupling. The implant may be positioned in two different orientations with respect to the insertion tool to permit usage of two different techniques to insert the implant into the intervertebral space. A recessed support member in the implant creates gaps between bone facing surfaces and the vertebral bodies such that bone graft material may occupy the gaps. The implant includes embedded radiographic markers which facilitate radiographic detection of the orientation of the implant through the surrounding tissue.



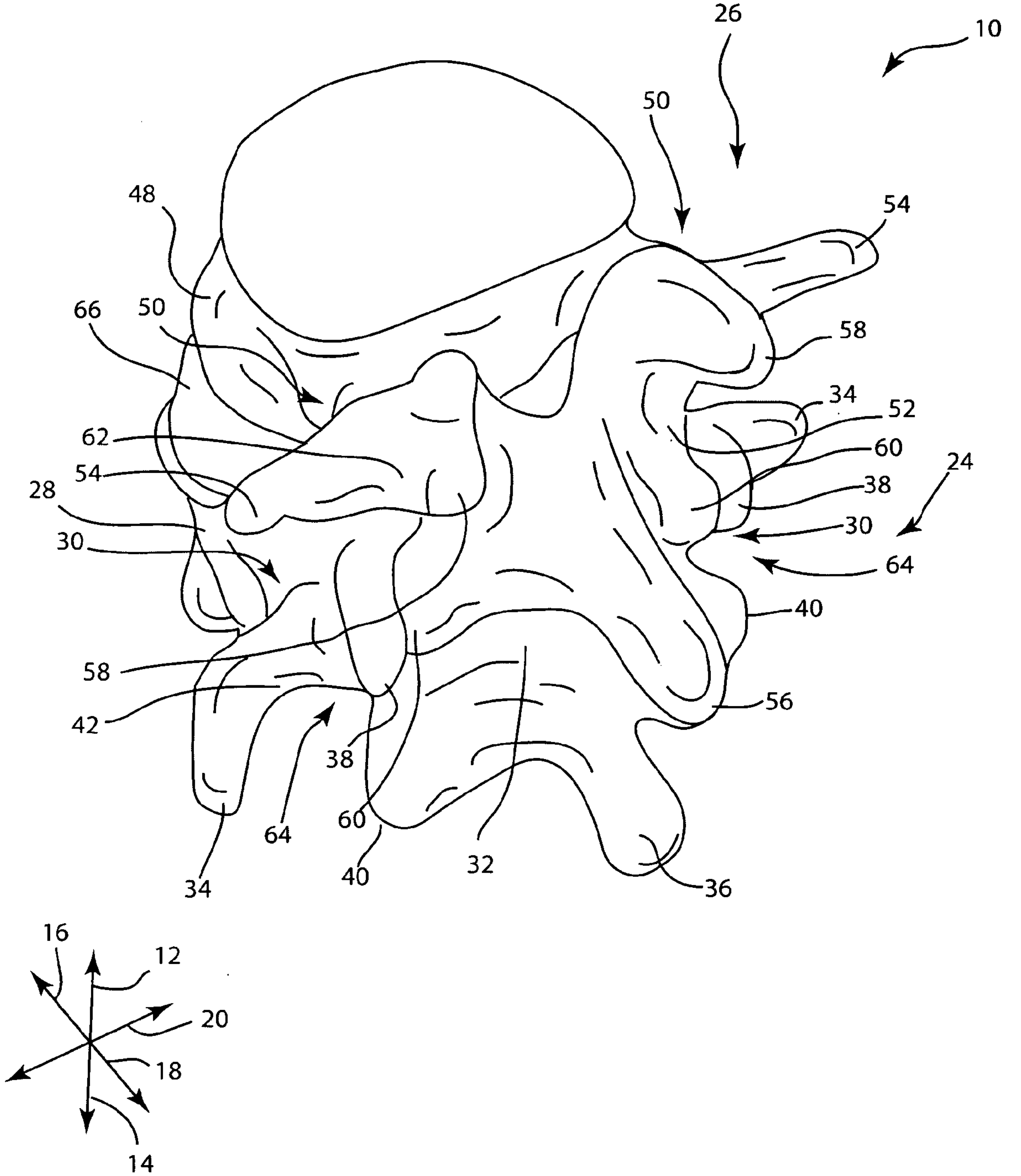

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Fig. 1

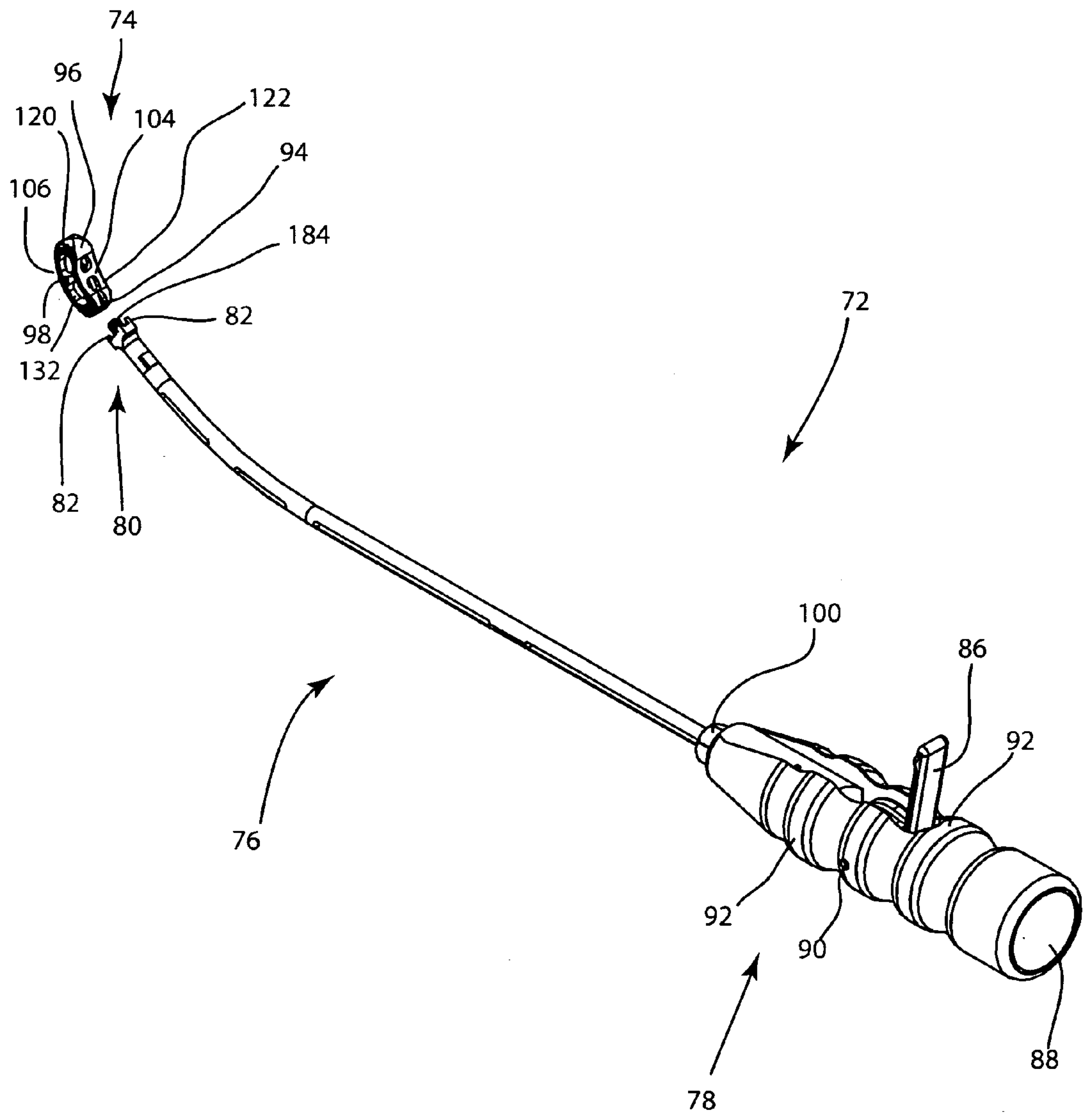
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Fig. 2

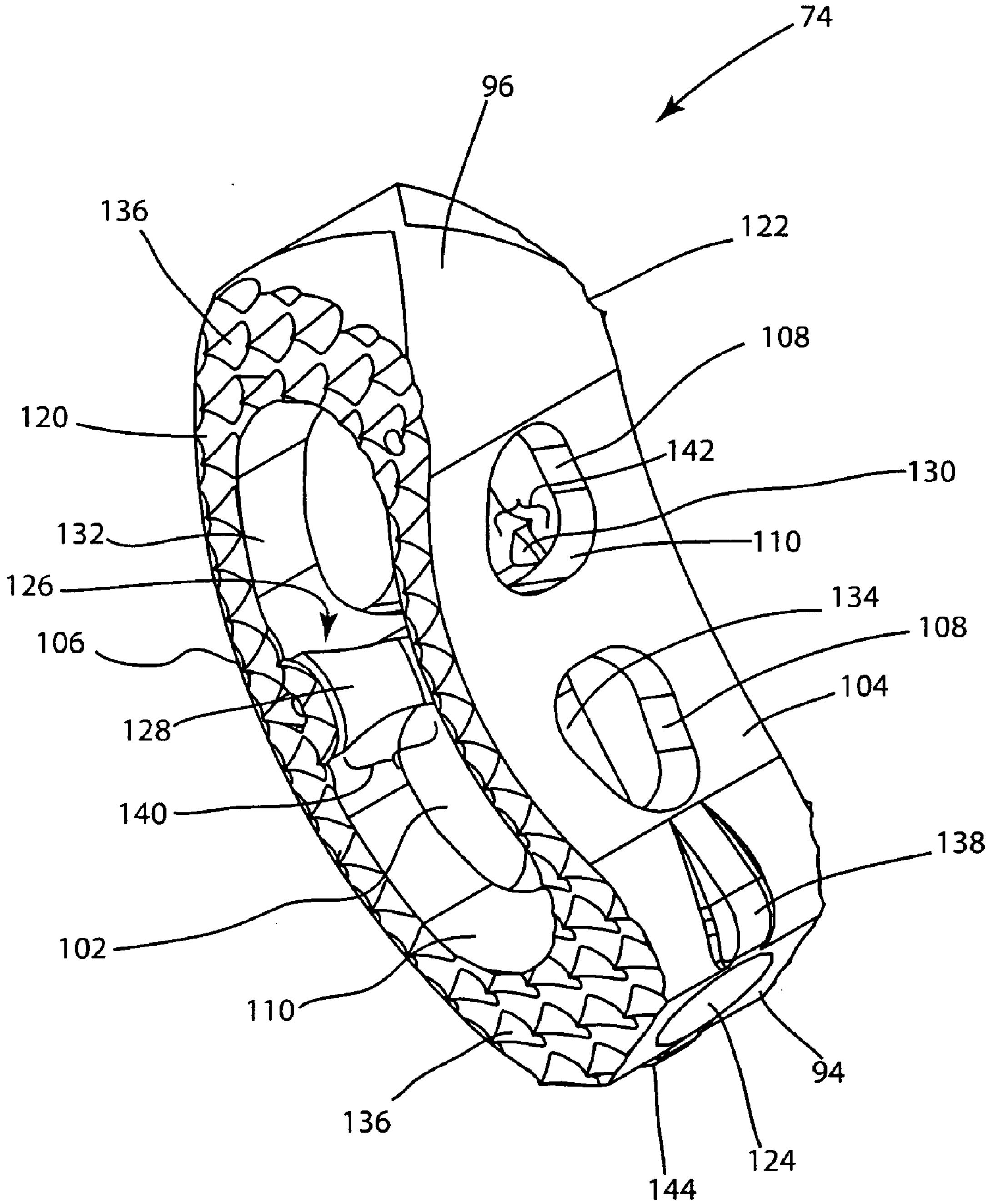
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Fig. 3

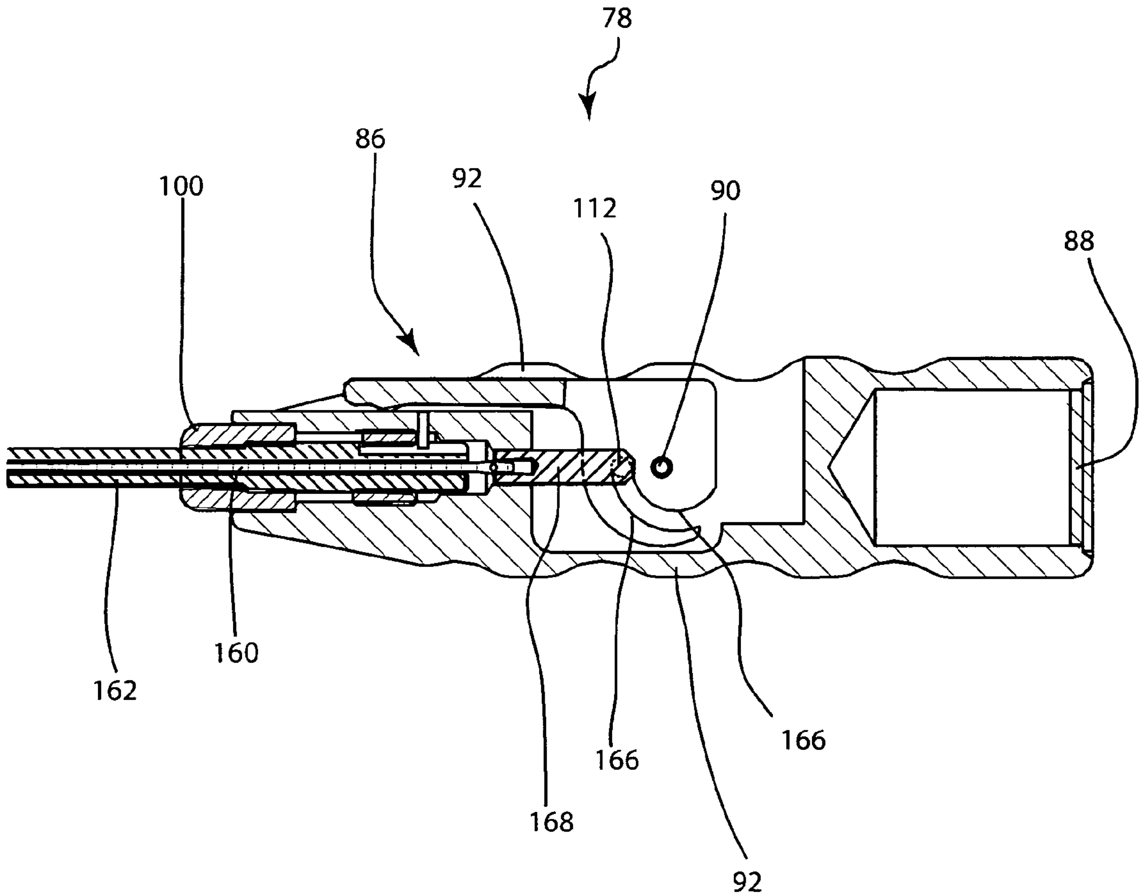

Fig. 4

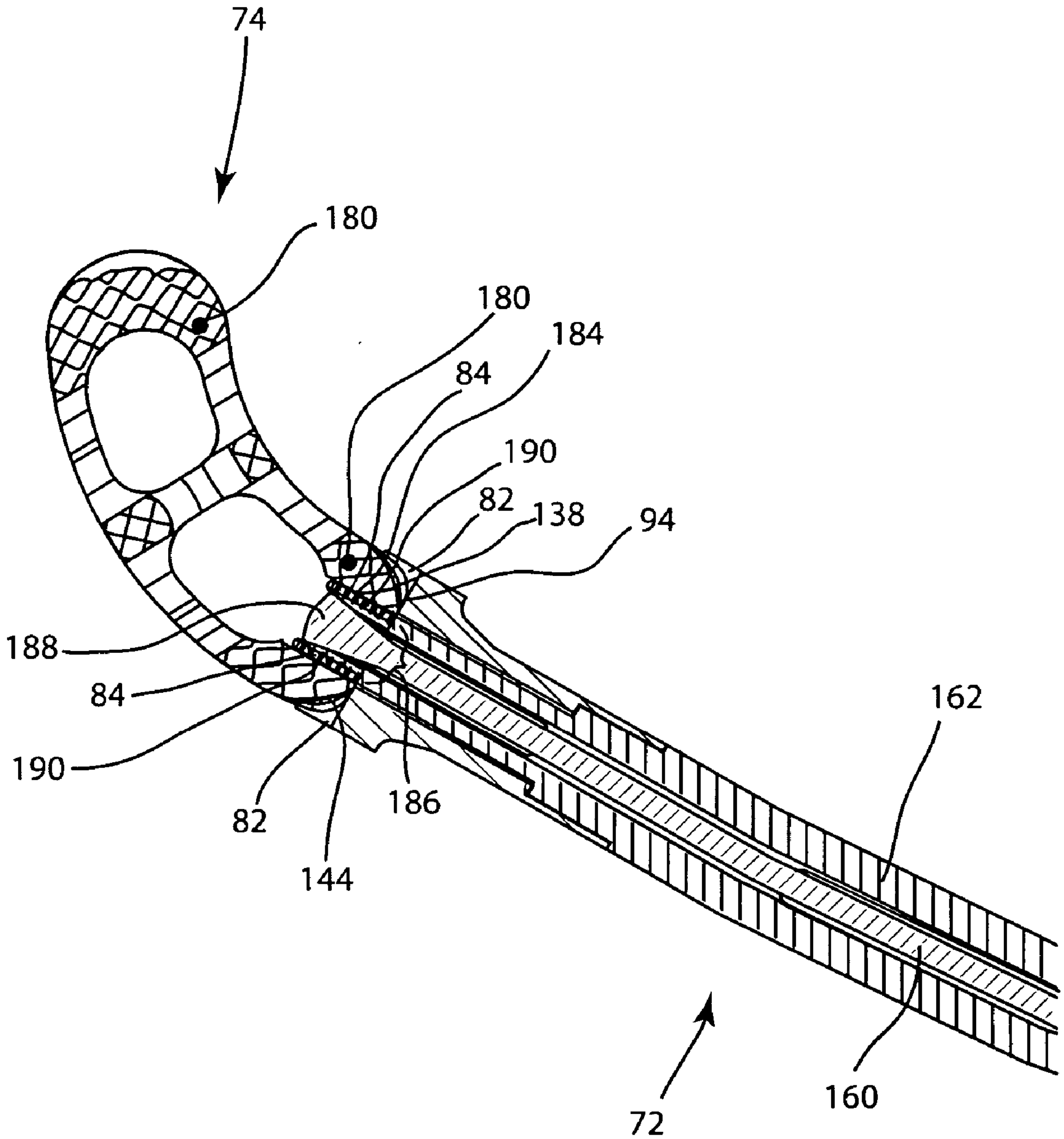

Fig. 5

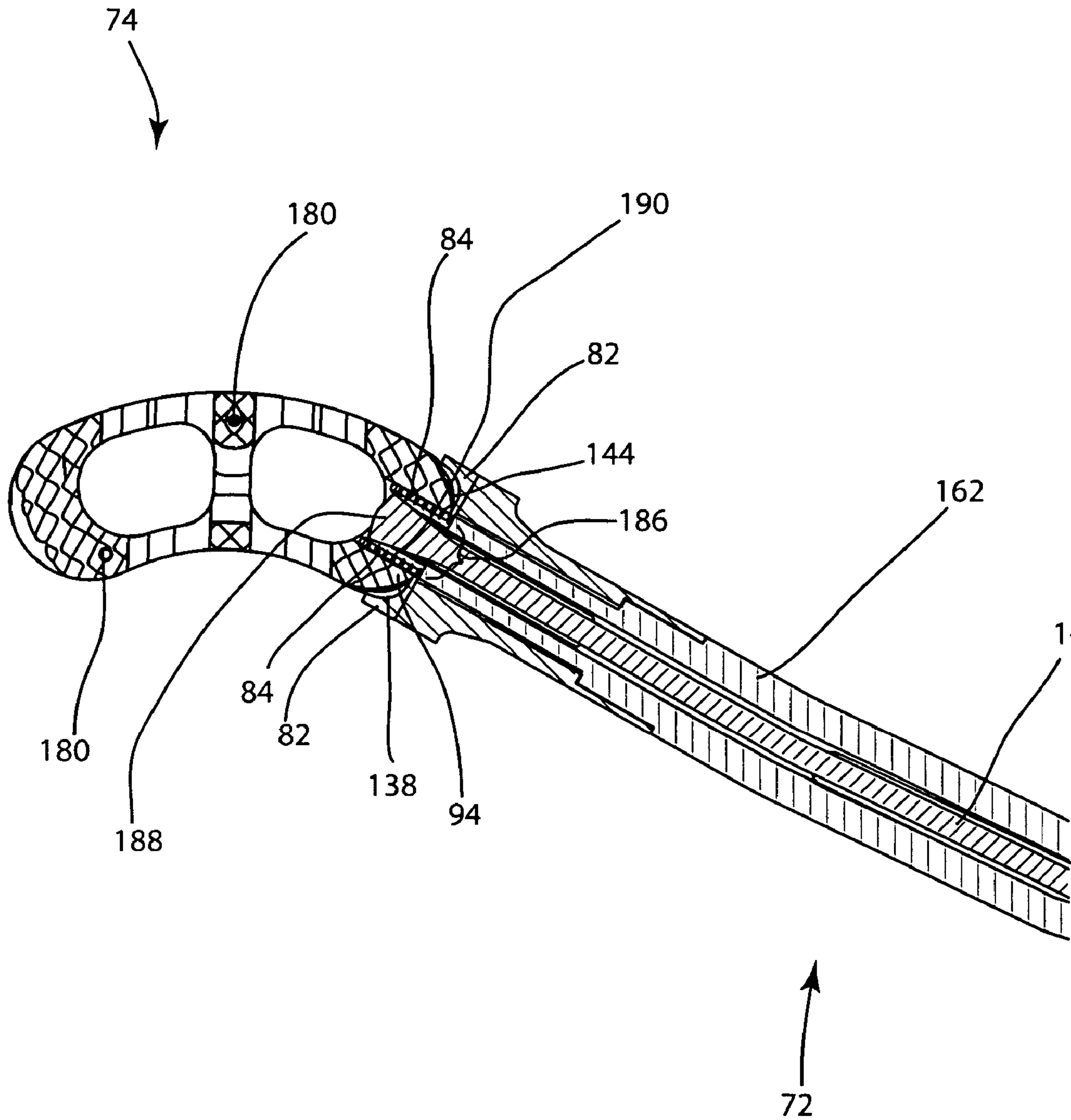

Fig. 6

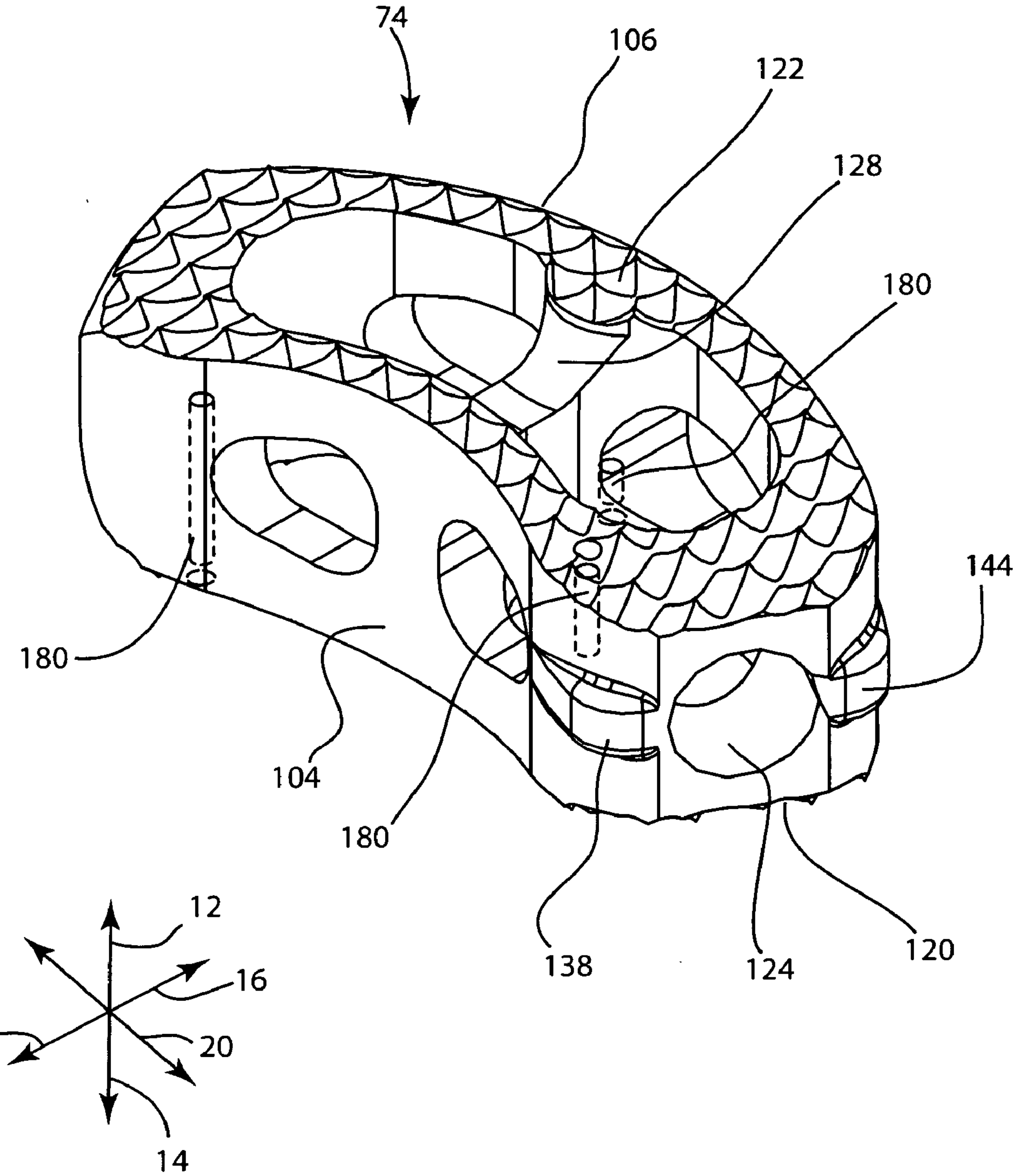

Fig. 7

SYSTEM AND METHOD FOR FUSION CAGE IMPLANTATION

BACKGROUND OF THE INVENTION

[0001] 1.The Field of the Invention

[0002] The present invention relates generally to orthopedic devices, and, more specifically, to surgical devices and methods for fusing adjacent vertebrae.

[0003] 2.The Relevant Technology

[0004] The spinal column is made up of thirty-three vertebrae separated by cushioning discs. Disease and trauma can damage these discs, creating instability that leads to loss of function and excruciating pain. Spinal fusion implants provide a successful surgical outcome by replacing the damaged disc and restoring the spacing between the vertebrae, eliminating the instability and removing the pressure on neurological elements that cause pain. The fusion is accomplished by providing an implant which recreates the natural intervertebral spacing and which has an internal cavity with outwardly extending openings. The internal cavity is commonly filled with osteogenic substances, such as autogenous bone graft or bone allograft, to cause the rapid growth of a bony column through the openings of the implant.

[0005] A variety of insertion tools exist for inserting fusion cage implants. Typically, the implantation tool is designed to fit a particular implant. Many implant tools currently in use require threading the implant on to the tool, inserting the implant, and then unscrewing the inserter to remove it from the patient. Cross-threading and/or stripping of threads may occur during this process, which can result in difficulty disengaging and removing the insertion tool. It would therefore be an improvement to provide a fusion implant insertion system that would include a system for releasably securing the implant to the insertion tool, so that disengaging the insertion tool from the implant would be simplified.

[0006] Fusion implants known in the art are held by their associated insertion tool in one position, requiring the use of one technique for insertion. Because some clinical situations require insertion of a fusion cage implant using a different approach, it would be desirable to be able to position the implant on the insertion tool in alternative positions. It would therefore be an improvement to provide a fusion implant insertion system in which the implant can be secured on the insertion tool in more than one configuration, so that an alternate technique for insertion may be employed for the same implant.

[0007] One challenge associated with spinal fusion cage implants is determining if the implant has been successfully positioned in the intervertebral space. Implants known in the art have markers which can be detected through tissue. However, correct alignment of the markers may be difficult to verify without checking the relative positioning of the markers from multiple viewpoints. It would therefore be an improvement to provide a fusion implant that is easier to check for proper alignment with the spinal column.

[0008] A key factor in successful spinal fusion via fusion cage implantation is the spreading and fusion of bone graft material through the implant. Known implants typically have openings to allow insertion of the bone graft material, and an interior space to hold the material. It would therefore be an improvement to provide a fusion implant that permits more comprehensive bone formation within the implant.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Various embodiments of the present invention will now be discussed with reference to the appended drawings. It is appreciated that these drawings depict only typical embodiments of the invention and are therefore not to be considered limiting of its scope.

[0010] FIG. **1** is a perspective view illustrating a portion of the spine.

[0011] FIG. **2** is a perspective view of one embodiment of a fusion implant and an insertion tool.

[0012] FIG. **3** is an enlarged perspective view of the fusion implant shown in FIG. **2**.

[0013] FIG. **4** is a cross sectional side view of the handle of the insertion tool shown in FIG. **2**.

[0014] FIG. **5** is an enlarged cross sectional side view of the distal end of the insertion tool shown in FIG. **2** attached to the fusion implant shown in FIG. **2**.

[0015] FIG. **6** is an enlarged cross sectional side view of the distal end of the insertion tool shown in FIG. **2** attached to the fusion implant shown in FIG. **2**, showing an alternative placement of the fusion implant on the insertion tool.

[0016] FIG. **7** is an enlarged perspective view of the fusion implant shown in FIG. **2**, showing the reverse side of the fusion implant from FIG. **3**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] The present invention relates to orthopedic devices and related implantation instruments and methods. Although the examples provided herein relate to a fusion cage, the systems and methods described herein may be readily adapted for a wide variety of implants and procedures. Accordingly, the scope of the present invention is not intended to be limited by the examples discussed herein, but only by the appended claims.

[0018] Referring to FIG. **1**, a perspective view illustrates a portion of a spine **10**. FIG. **1** illustrates only the bony structures; accordingly, ligaments, cartilage, and other soft tissues are omitted for clarity. The spine **10** has a cephalad direction **12**, a caudal direction **14**, an anterior direction **16**, a posterior direction **18**, and a medial/lateral axis **20**, all of which are oriented as shown by the arrows bearing the same reference numerals. In this application, "left" and "right" are used with reference to a posterior view, i.e., a view from behind the spine **10**. "Medial" refers to a position or orientation toward a sagittal plane (i.e., plane of symmetry that separates left and right sides from each other) of the spine **10**, and "lateral" refers to a position or orientation relatively further from the sagittal plane.

[0019] As shown, the portion of the spine **10** illustrated in FIG. **1** includes a first vertebra **24**, which may be the L**5** (Fifth Lumbar) vertebra of a patient, and a second vertebra **26**, which may be the L**4** (Fourth Lumbar) vertebra of the patient. The systems and methods may be applicable to any vertebra or vertebrae of the spine **10** and/or the sacrum (not shown). In this application, the term "vertebra" may be broadly interpreted to include the sacrum.

[0020] As shown, the first vertebra **24** has a body **28** with a generally disc-like shape and two pedicles **30** that extend posteriorly from the body **28**. A posterior arch, or lamina **32**, extends between the posterior ends of the pedicles **30** to couple the pedicles **30** together. The first vertebra **24** also has a pair of transverse processes **34** that extend laterally from the pedicles **30** generally along the medial/lateral axis **20**, and a spinous process **36** that extends from the lamina **32** along the posterior direction **18**.

[0021] The first vertebra **24** also has a pair of superior facets **38**, which are positioned toward the top of the first vertebra **24** and face generally medially. Additionally, the first vertebra **24** has inferior facets **40**, which are positioned toward the bottom of the first vertebra **24** and face generally laterally. Each of the pedicles **30** of the first vertebra **24** has a saddle point **42**, which is positioned generally at the center of the juncture of each superior facet **38** with the adjacent transverse process **34**.

[0022] Similarly, the second vertebra **26** has a body **48** from which two pedicles **50** extend posteriorly. A posterior arch, or lamina **52**, extends between the posterior ends of the pedicles **50** to couple the pedicles **50** together. The second vertebra **26** also has a pair of transverse processes **54**, each of which extends from the corresponding pedicle **50** generally along the medial/lateral axis **20**, and a spinous process **56** that extends from the lamina **52** along the posterior direction **18**.

[0023] The second vertebra **26** also has a pair of superior facets **58**, which are positioned toward the top of the second vertebra **26** and face generally inward. Additionally, the second vertebra **26** has inferior facets **60**, which are positioned toward the bottom of the second vertebra **26** and face generally outward. Each of the pedicles **60** of the second vertebra **26** has a saddle point **62**, which is positioned generally at the center of the juncture of each superior facet **58** with the adjacent transverse process **54**.

[0024] The superior facets **38** of the first vertebra **24** articulate (i.e., slide and/or press) with the inferior facets **60** of the second vertebra **26** to limit relative motion between the first and second vertebrae **24**, **26**. Thus, the combination of each superior facet **38** with the adjacent inferior facet **60** provides a facet joint **64**. The first and second vertebrae **24**, **26** thus define two facet joints **64** that span the distance between the first and second vertebrae **24**, **26**. The inferior facets **40** of the first vertebra **40** and the superior facets **58** of the second vertebra **26** are part of other facet joints that control motion between the first and second vertebrae **24**, **26** and adjacent vertebrae (not shown) and/or the sacrum (also not shown). The vertebrae **24**, **26** are separated from each other by an intervertebral disc **66**.

[0025] Referring to FIG. **2**, a perspective view illustrates one embodiment of an implant **74**, which may be termed a fusion cage, and an insertion tool **72**. The implant **74** is designed for placement between bones and/or pieces of bone to facilitate fusing of the bone matter together. More precisely, the implant **74** of FIG. **2** is designed to be inserted between the vertebral bodies **28**, **48** of the first and second vertebrae **24**, **26**, respectively, after removal of at least part of the intervertebral disc **66**.

[0026] In the embodiment depicted in FIG. **2**, the implant **74** has a generally arcuate shape with squared, box-like edges. The implant **74** has an outer wall **98** with a first bone engaging surface **120** and a second bone engaging surface **122**, which extend between a first end **94** and a second end **96**. Each of the bone engaging surfaces **120**, **122** is shaped to abut one of the vertebral bodies **28**, **48** of the vertebrae **24**, **26**, respectively. A first opening **132** on the first bone engaging surface **120** and a second opening **134** on the second bone engaging surface **122** communicate with a hollow interior space **102** encircled by the outer wall **98**. A first support surface **104** and a second support surface **106** extend between the first end **94** and the second end **96**. The outer wall **98** includes the first support surface **104** and the second support surface **106**, which also extend between the edges of the first bone engaging surface **120** and the second bone engaging surface **122**, thus forming a generally rectangular cross sectional shape. The first support surface **104** and second support surface **106** have a plurality of grafting ports which extend through implant **74** so as to communicate with the hollow interior space **102**. The configuration of the implant **74** will be described in greater detail in connection with FIG. **3**.

[0027] In the embodiment depicted in FIG. **2**, the insertion tool **72** has a handle **78** at the proximal end and a stem **76** which terminates with an attachment interface **80** at the distal end. The handle **78** has a plurality of ergonomic grip rings **92** so as to make the handle **78** easy for the user to grip. As depicted in FIG. **2**, the proximal end of the handle **78** terminates in a plug **88**. A lever **86** is positioned on one side of the handle **78**. A lever pin **90** forms an axis upon which the lever **86** can rotate. At the distal end of the handle **78**, an adjustment sleeve **100** anchors the stem **76** to the handle **78**.

[0028] As depicted in FIG. **2**, the attachment interface **80** has a plurality of prongs **82** which encircle a collet **184**. In this embodiment, the distal end of the stem **76** is slightly curved to facilitate the correct positioning of the implant **74** with respect to the vertebral bodies **28**, **48** of the first and second vertebrae **24**, **26**, respectively. In other embodiments of this invention, the stem **76** may be straight for its entire length, or may be curved to provide a variety of configurations and overall angles.

[0029] Referring to FIG. **3**, the implant **74** has a plurality of teeth **136** on the outer wall **98** of the first and second bone engaging surfaces, **120** and **122**, respectively. The teeth **136** promote secure, substantially non-sliding abutment of the bone engaging surfaces **120**, **122**, with the vertebral bodies **28**, **48**, such that once implanted, the implant **74** substantially prevents relative motion between the first and second vertebral bodies **28**, **48**. The first bone engaging surface **120** of the outer wall **98** has a first opening **132** which communicates with the hollow interior space **102**. Similarly, the second bone engaging surface **120** of the outer wall **98** has a second opening **134** which also communicates with the hollow interior space **102**. In the embodiment depicted, the first and second openings **132**, **134** comprise about 40 to 50 percent of the surface area of each of the first and second bone engaging surfaces **120**, **122**, respectively.

[0030] The outer wall **98** has an interior surface **110** that surrounds the hollow interior space **102**. The interior surface **110** makes up the interior surfaces of the first support surface **104**, the second support surface **106**, the first end **94**, and the second end **96**. The interior surface **110** is bounded by the first and second openings **132**, **134**, a plurality of grafting ports **108**, and an aperture **124** passing through the second end **96** of the implant **74**. Within the hollow interior space **102**, a support rib **126** extends from the interior surface **110**, where it extends along the first support surface **104**, to the interior surface **110**, where it extends along the second support surface **106**.

[0031] Thus, the support rib **126** spans the interior space **102**. In this application, an element that "spans" a volume crosses the volume to leave space on either side of the element. The support rib **126** is only one of many possible supporting structures that may span the interior space **102** within the scope of the present invention. Other spanning members (not shown) may extend at different angles across the interior space **102** and/or between different locations on the outer wall **98**. Such spanning members need not be integrated with the outer wall **98**, but may instead be formed separately from the outer wall **98** and subsequently attached.

[0032] The support rib **126** has a first bone facing surface **128** and a second bone facing surface **130**. The first bone facing surface **128** is recessed so as to form a first gap **140** between the first bone facing surface **128** and the vertebral body **28** or **48** to which it is adjacent after implantation. Similarly, the second bone facing surface **130** is recessed so as to form a second gap **142** between the second bone facing surface **130** and the vertebral body **28** or **48** to which it is adjacent after implantation. The first and second gaps **140**, **142** allow space for occupation of bone graft material between the vertebral bodies **28**, **48** and the bone facing surfaces **128**,**130**. Accordingly, the first and second gaps **140**, **142** permit the formation of a more complete bone column through the interior space **102**, thereby more securely integrating the implant **74** with the vertebral bodies **28**, **48**.

[0033] As depicted in FIG. **3**, an enlarged, perspective view illustrates the implant **74**. The first support surface **104** and the second support surface **106** each include two grafting ports **108**, which are positioned longitudinally along the midline of each support surface **104**, **106**. Each grafting port **108** communicates with the hollow interior space **102**, facilitating spreading of bone graft material throughout the hollow interior space **102**.

[0034] In the embodiment depicted in FIG. **3**, the aperture **124** is a round opening located in on the first end **94**. The aperture **124** is designed to fit around the collet **184** of the insertion tool **72**, allowing the implant **74** to be releasably secured to the insertion tool **72**. On the outer wall **98**, proximate the first end **94**, there is a first protrusion **138** which is located adjacent to the aperture **124**, and extends toward the first support surface **104**. The first protrusion **138** fits closely between the prongs **82** (as shown in FIG. **2**) when the implant **84** is secured to the insertion tool **72**. Similarly, on the opposite side of the aperture **124**, the outer wall **98**, proximate the first end **94**, has a second protrusion **144**. This second protrusion **144** extends from the aperture **124** toward the second support surface **106**. When the implant **74** is secured to the insertion tool **72**, the second protrusion **144** fits between the prongs **82** on the opposite side of the insertion tool **72**. The two protrusions **138**, **144** prevent the rotation of the implant **74** relative to the insertion tool **72** while the implant **74** is secured to the insertion tool **72**.

[0035] The implant **72** is only one of many embodiments included within the scope of the invention. In other embodiments (not shown), implants need not have arcuate shapes, but may be cylindrical, rectangular, or otherwise differently shaped.

[0036] Referring to FIG. **4**, a side elevation, section view illustrates the handle **78** of the insertion tool **72**. As shown, the handle **78** houses a lever **86**. Within the handle **78**, the base of the lever **86** forms a curved cam surface **166**. The cam surface **166** rotates on the axis of a lever pin **90** when the lever **86** is extended or retracted. A follower pin **112** is located within the curve of the cam surface **166**. The proximal end of a follower **168** is attached to the follower pin **112**. The distal end of the follower **168** attaches to a rod **160** which extends from the follower **168** out of the handle **78** to the distal end of the insertion tool **72**. Surrounding the rod **160** is a hollow sleeve **162** that extends along the length of the stem **76**. The adjustment sleeve **100** surrounds the proximal end of the hollow sleeve **162** to anchor the hollow sleeve **162** within the handle **78**.

[0037] In the embodiment depicted in FIG. **4**, when the lever **86** is extended away from the handle **78** such that it is generally perpendicular to the handle **78**, the cam surface **166** rotates clockwise about the pin to slide on either side of the follower pin **112**. As the cam surface **166** rotates, the follower **168** and the attached rod **160** are extended distally out of the handle **78**. The hollow sleeve **162**, which is anchored to the handle **78** by the adjustment sleeve **100**, does not extend. When the lever **86** is retracted toward the handle **78**, the cam surface **166** rotates back along the counterclockwise direction, and the follower **168** and the attached rod **160** are retracted proximally toward the handle **78**. The rotation of the cam surface **166** may be terminated by contact with the follower pin **112**, or by contact of the lever **86** with the adjoining stationary surfaces of the handle **78**.

[0038] Referring to FIG. **5**, a cross sectional side view of the releasable attachment of the implant **74** to the distal end of the insertion tool **72** is depicted. At the distal end of the insertion tool **72**, the hollow sleeve **162** widens and terminates in two set of prongs **82**. The prongs **82** are shaped so as to fit closely around the protrusions **138**, **144** on the first end **94** of the implant **74**. When viewed from a distal perspective, the four prongs form the corners of an approximate rectangle. In the center of the rectangle is a circular opening **186** at the end of the hollow sleeve **162**.

[0039] A collet **184** is anchored within the circular opening **186** of the hollow sleeve **162**. In the embodiment depicted, the collet **184** has four retention members **84** (only two of which are visible in FIG. **5**) which are arranged in a circle. The edge of each retention member **84** is adjacent to the edge of the next retention member **84**. The retention members **84** are each of an arcuate shape such that the four retention members **84** form a circle lining the circular opening **186**, when viewed from a distal perspective. The retention members **84** extend distally out of the hollow sleeve **162**, surrounded by the prongs **82**. The outer facing surfaces of the retention members **184** are scored in a pattern of ridges, creating a ridged outer surface **190**. Within the circle formed by the retention members **84**, the rod **160** terminates in a bell-shaped end **188**.

[0040] As depicted in FIGS. **2** and **5**, the implant **74** may be releasably secured to the attachment interface **80** of the insertion tool **72**. FIG. **2** depicts the implant **74** and the insertion tool **72** before attachment. During use, the lever **86** is extended from the handle **78** in the manner shown in FIG. **2**, and the bell-shaped end **188** of the rod **160** extends out of the opening formed by the retention members **84**. To releasably secure the implant **74**, the aperture **124** in the first end **94** of the implant **74** is placed over the bell-shaped end **188** of the rod **160**, and further over the four retention members **84**. Next, the lever **86** is retracted toward the handle **78**. This causes the rod **160** to be retracted proximally, along its axis, into the handle **78**. As the rod **160** is retracted, the bell-shaped end **188** of the rod **160** contacts the retention members **84** and pushes them outward, expanding them apart from each other. As the retention members **84** expand, their ridged outer surfaces **190** engage the interior of the aperture **124** of the implant **74**. As viewed in FIG. **5**, when the lever **86** is fully retracted, the prongs **82** of the insertion tool **72** fit snugly around the protrusions **138**, **144** of the implant, thus preventing rotation of the implant **74** relative to the insertion tool **72** while the implant **74** is attached to the insertion tool **72**.

[**0041**] The implant **74** may then be inserted into the space between the vertebral bodies **28**, **48** by, first, providing access to the space, and removing at least a portion of the intervertebral disc **66**. Access may be provided from the posterior direction. The vertebrae **24**, **26** may need to be distracted to temporarily widen the intervertebral space during insertion. Then, the surgeon may grasp and move the handle **78** to insert the implant **74** into the intervertebral space from an angle between the posterior direction **18** and the lateral direction **20**. The surgeon may further manipulate the handle **78** to move the implant **74** to the proper orientation, so that the second support surface **106** is oriented toward the anterior direction **16**. Such manipulation may involve striking the plug **88** with a hammer or the like to shift the implant **72** into the proper orientation between the vertebral bodies **28**, **48**.

[**0042**] Following implantation of the implant **74** between the vertebral bodies **28**, **48** of the first and second vertebrae **24**, **26**, respectively, the lever **86** is again extended perpendicularly to the handle **78**. Extending the lever **86** causes the follower **168** and the attached rod **160** to extend distally. As the rod **160** extends, the bell-shaped end **188** moves distally out of contact with the retention members **84**, allowing the retention members **84** to contract. The ridged outer surfaces **190** of the retention members **84** disengage from the interior of the aperture **124** of the implant **74**. Thus disengaged, the insertion tool **72** can be withdrawn from the patient, leaving the implant **74** in place.

[**0043**] The interaction of the collet **184** with the aperture **124** provides easy and secure engagement between the implant **74** and the insertion tool **72**. Due to this secure engagement, impact against the plug **88** may be used to position the implant **74** with little fear that the implant **74** will accidentally become disengaged from the attachment interface **80**. The engagement of the collet **184** with the aperture **124**, also enables the insertion tool **72** to be easily disengaged from the implant **74**.

[**0044**] The collet **184** and prongs **82** are only one example of an attachment interface according to the invention. According to other alternative embodiments (not shown), only two diametrically opposed retention members may be used. Such retention members may engage a round hole like the aperture **124**, a flat-sided hole, a protrusion extending from some portion of the implant, or some other feature or combination of features. A movable retention feature may even be used in combination with a static retention feature to provide gripping action or outward retention force like that of the collet **184**.

[**0045**] As shown in FIG. **6**, the implant **74** may be releasably secured to the insertion tool **72** in an alternate configuration. In comparison to FIG. **5**, in FIG. **6** the implant **74** has been turned on its longitudinal axis **180** degrees, so that the curve of the implant **74** is facing in the opposite direction. The protrusions **138**, **144** on the first end **94** of implant **74** are shaped identically, so that each of the protrusions **138**, **144** each can fit within either set of the prongs **82** on the distal end of the insertion tool **72**. Positioning the implant **74** on the insertion tool **72** as shown in FIG. **5** permits usage of a first technique to insert the implant **74** into the intervertebral space. Positioning the implant **74** on the insertion tool **72** as shown in FIG. **6** permits usage of a second technique, different from the first technique, to insert the implant **74** into the intervertebral space.

[**0046**] The first and second techniques may differ by the manner in which access to the intervertebral space is obtained, by the angle at which the insertion tool **72** is held to place the implant **74**, and/or a variety of other factors. The ability to use multiple techniques enable a surgeon to account for different morphologies of the spine and surrounding tissues, different implantation preferences, and other varying factors. The reversible engagement of the implant **74** on the insertion tool **72** enables the surgeon to select one of multiple insertion techniques without having to keep different implants or insertion tools on hand to accommodate them.

[**0047**] According to alternative embodiments (not shown), an implant may have more than two orientations with which it can be secured to the corresponding insertion tool. Such orientations may differ by any desirable angle. Indeed, a clocking feature having a multiplicity of engaging ridges and slots may be used to provide discrete, yet finely tunable control over the relative orientations of an implant and the corresponding insertion tool.

[**0048**] Referring to FIG. **7**, three markers **180** are visible in the implant **74**. In this embodiment, the markers **180** are composed of radiographic material, i.e., a material that is visible through tissue under radioscopy. A material such as tungsten may be used. Two of the markers **180** are embedded within the first bone engaging surface **120**, and terminate so their ends are slightly recessed from the first bone engaging surface **120**. A third marker **180** is similarly recessed in the second bone engaging surface **122**. The markers **180** are positioned so that when the markers **180** are detected radiographically through tissue, the orientation of the implant **74** may be verified from a single viewpoint. Proper orientation of the implant **74** may be verified by detecting alignment of any two of the markers **180** with each other when viewed from one of the anterior direction **16**, the posterior direction **18**, the lateral direction **20**, the cephalad direction **12**, and the caudal direction **14**.

[**0049**] For example, from the anterior or posterior directions **16**, **18**, the marker **180** proximate the second support surface **106** may appear to be equidistant between the markers **180** proximate the first support surface **104**. From the cephalad and caudal directions **12**, **14**, the markers **180** proximate the first support surface **104** may appear to be aligned with each other along the same lateral axis of the patient. From the lateral direction **20**, the markers **180** proximate the first support surface **104** may partially overlie each other, so that they can be distinguished from each other, yet their alignment indicates that they are on the same lateral axis of the patient.

[0050] In the alternative to the configuration of FIG. **7**, a variety of different marker configurations may be used. Although the markers **180** are generally cylindrical, in alternative embodiments, they may have different shapes, and be distributed in the corresponding implant according to a variety of spacing configurations.

[0051] The present invention may be embodied in other specific forms without departing from its spirit or essential characteristics. It is appreciated that various features of the above-described examples can be mixed and matched to form a variety of other alternatives, each of which may have a different threading system according to the invention. As such, the described embodiments are to be considered in all respects only as illustrative and not restrictive. The scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

1. An orthopedic system comprising:

an implant shaped to be inserted into an intervertebral space of a spine, the implant comprising:

an outer wall defining a hollow interior space, the outer wall having a first bone engaging surface positioned to abut a first vertebral body adjacent to the intervertebral space; and

a support rib spanning the hollow interior space, the support rib comprising a first bone facing surface that is recessed with respect to the first bone engaging surface such that, after installation of the implant in the intervertebral space, a first gap exists between the first vertebral body and the first bone facing surface.

2. The orthopedic system of claim 1, wherein the outer wall further comprises a second bone engaging surface, wherein the outer wall is sized to enable the second bone engaging surface to abut a second vertebral body adjacent to the intervertebral space simultaneously with abutment of the first bone engaging surface against the first vertebral body, such that the implant substantially prevents relative motion between the first and second vertebral bodies.

3. The orthopedic system of claim 2, wherein the support rib further comprises a second bone facing surface that is recessed with respect to the second bone engaging surface such that, after installation of the implant in the intervertebral space, a second gap exists between the second vertebral body and the second bone facing surface.

4. The orthopedic system of claim 1, wherein the implant comprises a generally arcuate shape, when viewed from a cephalad viewpoint or a caudal viewpoint.

5. The orthopedic system of claim 1, further comprising an insertion tool releasably securable to the implant to facilitate positioning of the implant in the intervertebral space.

6. The orthopedic system of claim 5, wherein the outer wall further comprises an aperture, wherein the insertion tool comprises an attachment interface comprising a first retention member and a second retention member that are movable with respect to each other between a locked configuration, in which the first and second retention members press against opposing sides of the aperture, and a released configuration in which the first and second retention members are retracted from the opposing sides.

7. The orthopedic system of claim 5, wherein the insertion tool comprises an attachment interface releasably securable to an attachment interface of the implant in a first orientation of the implant with respect to the insertion tool to permit usage of a first technique to insert the implant into the intervertebral space, and in a second orientation of the implant with respect to the insertion tool to permit usage of a second technique, different from the first technique, to insert the implant into the intervertebral space.

8. The orthopedic system of claim 1, wherein the outer wall and the support rib are components of a body of the implant, the implant further comprising:

a first marker on the body; and

a second marker on the body;

wherein each of the first and second markers is detectable through tissue, wherein the first and second markers are relatively positioned such that, after installation of the implant in the intervertebral space at a proper orientation, the first and second markers are aligned with each other when viewed from one of an anterior viewpoint, a posterior viewpoint, a lateral viewpoint, a cephalad viewpoint, and a caudal viewpoint.

9. An orthopedic system comprising:

an implant shaped to be inserted into an intervertebral space of a spine, the implant comprising an aperture; and

an insertion tool comprising an attachment interface comprising a first retention member and a second retention member that are movable with respect to each other between a locked configuration, in which the first and second retention members press against opposing sides of the aperture, and a released configuration in which the first and second retention members are retracted from the opposing sides.

10. The orthopedic system of claim 9, wherein the implant comprises a first bone engaging surface and a second bone engaging surface, wherein the first and second bone engaging surfaces are positioned to abut first and second vertebral bodies adjacent to the intervertebral space to substantially prevent relative motion between the first and second vertebral bodies.

11. The orthopedic system of claim 9, wherein the implant comprises a generally arcuate shape, when viewed from a cephalad viewpoint or a caudal viewpoint.

12. The orthopedic system of claim 9, wherein the first and second retention members are components of an expandable collet of the attachment interface.

13. The orthopedic system of claim 12, wherein the attachment interface further comprises a rod comprising an axis, wherein the rod moves along the axis to trigger expansion of the expandable collet.

14. The orthopedic system of claim 13, wherein the rod comprises a tapered distal end extending through the collet such that the collet expands in response to retraction of the tapered distal end into the collet.

15. The orthopedic system of claim 9, wherein the insertion tool comprises a distal end comprising the attachment interface, and a proximal end comprising an actuation interface, wherein the attachment interface moves between the locked configuration and the released configuration in response to actuation of the actuation interface by a user.

16. The orthopedic system of claim 9, wherein the attachment interface is releasably securable to an attachment interface of the implant in a first orientation of the implant with respect to the insertion tool to permit usage of a first technique to insert the implant into the intervertebral space, and in a second orientation of the implant with respect to the insertion tool to permit usage of a second technique, different from the first technique, to insert the implant into the intervertebral space.

17. The orthopedic system of claim 9, wherein the implant comprises a body, the implant further comprising:

a first marker on the body; and

a second marker on the body;

wherein each of the first and second markers is detectable through tissue, wherein the first and second markers are relatively positioned such that, after installation of the implant in the intervertebral space at a proper orientation, the first and second markers are aligned with each other when viewed from one of an anterior viewpoint, a posterior viewpoint, a lateral viewpoint, a cephalad viewpoint, and a caudal viewpoint.

18. An orthopedic system comprising:

an implant shaped to be inserted into a body of a patient, the implant comprising an attachment interface; and

an insertion tool comprising an attachment interface releasably securable to the attachment interface of the implant in a first orientation of the implant with respect to the insertion tool to permit usage of a first technique to insert the implant into the body, and in a second orientation of the implant with respect to the insertion tool to permit usage of a second technique, different from the first technique, to insert the implant into the body.

19. The orthopedic system of claim 18, wherein the first and second orientations are separated by an angular displacement of 180°.

20. The orthopedic system of claim 18, wherein the implant comprises a generally arcuate shape, when viewed from a cephalad viewpoint or a caudal viewpoint.

21. The orthopedic system of claim 18, wherein the implant is shaped to be inserted into an intervertebral space of a spine of the body to substantially prevent relative motion of two vertebrae adjacent to the intervertebral space.

22. The orthopedic system of claim 21, wherein the first technique comprises insertion of the implant into the intervertebral space along a first posterior approach, wherein the second technique comprises insertion of the implant into the intervertebral space along a second posterior approach.

23. An orthopedic implant comprising:

a body shaped to be inserted into an intervertebral space of a spine;

a first marker on the body; and

a second marker on the body;

wherein each of the first and second markers is detectable through tissue, wherein the first and second markers are relatively positioned such that, after installation of the implant in the intervertebral space at a proper orientation, the first and second markers are aligned with each other when viewed from at least one of an anterior viewpoint, a posterior viewpoint, a lateral viewpoint, a cephalad viewpoint, and a caudal viewpoint.

24. The orthopedic implant of claim 23, wherein the body comprises a first bone engaging surface and a second bone engaging surface, wherein the first and second bone engaging surfaces are positioned to abut first and second vertebral bodies adjacent to the intervertebral space to substantially prevent relative motion between the first and second vertebral bodies.

25. The orthopedic implant of claim 23, wherein the first and second markers are radiographic.

26. The orthopedic implant of claim 25, wherein the first and second markers comprise metallic rods that are substantially radio-opaque.

27. The orthopedic implant of claim 23, wherein the first and second markers are relatively positioned such that, after installation of the implant in the intervertebral space at a proper orientation, the first and second markers are aligned with each other when viewed from a lateral viewpoint.

28. The orthopedic implant of claim 23, further comprising a third marker on the body, wherein the third marker is positioned to cooperate with the first and second markers to facilitate detection of whether the implant is at the proper orientation.

29. A method for implanting an implant in an intervertebral space of a spine, the method comprising:

inserting the implant into the intervertebral space such that a first bone engaging surface of an outer wall of the implant abuts a first vertebral body adjacent to the intervertebral space, wherein the outer wall defines a hollow interior space spanned by a support rib of the implant, the support rib comprising a first bone facing surface that is recessed with respect to the first bone engaging surface; and

inserting bone graft material into the hollow interior space such that the bone graft material occupies a first gap between the first vertebral body and the first bone facing surface.

30. The method of claim 29, wherein inserting the implant into the intervertebral space comprises abutting a second vertebral body adjacent to the intervertebral space with a second bone engaging surface of the outer wall, such that the implant substantially prevents relative motion between the first and second vertebral bodies.

31. The method of claim 30, wherein the support rib further comprises a second bone facing surface that is recessed with respect to the second bone engaging surface, the method further comprising inserting bone graft material into the hollow interior space such that the bone graft material occupies a second gap between the second vertebral body and the second bone facing surface.

32. The method of claim 29, further comprising releasably securing an insertion tool to the implant to facilitate positioning of the implant in the intervertebral space, wherein inserting the implant into the intervertebral space comprises actuating the insertion tool.

33. The method of claim 32, wherein releasably securing the insertion tool to the implant comprises:

inserting first and second retention members of the attachment interface of the insertion tool into an aperture of the outer wall; and

moving the attachment interface of the insertion tool from a released configuration, in which the first and second retention members are retracted from opposing sides of the aperture, to a locked configuration, in which the first and second retention members press against the opposing sides.

34. The method of claim 32, wherein releasably securing the insertion tool to the implant comprises releasably securing an attachment interface of the insertion tool to an attachment interface of the implant in one of a first orientation of the implant with respect to the insertion tool, and a second orientation of the implant with respect to the insertion tool, wherein inserting the implant into the intervertebral space comprises using one of a first technique to insert the implant in the first orientation, and a second technique different from the first technique to insert the implant in the second orientation.

35. The method of claim 29, wherein the outer wall and the support rib are components of a body of the implant, the implant further comprising a first marker on the body and a second marker on the body, the method further comprising:

positioning the implant at a proper orientation within the intervertebral space; and

detecting the first and second markers through tissue to verify positioning of the implant at the proper orientation by detecting alignment of the first and second markers with each other from one of an anterior viewpoint, a posterior viewpoint, a lateral viewpoint, a cephalad viewpoint, and a caudal viewpoint.

36. A method for implanting an implant in an intervertebral space of a spine, the method comprising:

inserting first and second retention members of an attachment interface of an insertion tool into an aperture of the implant;

moving the attachment interface of the insertion tool from a released configuration, in which the first and second retention members are retracted from opposing sides of the aperture, to a locked configuration, in which the first and second retention members press against the opposing sides; and

actuating the insertion tool to insert the implant into the intervertebral space.

37. The method of claim 36, wherein inserting the implant into the intervertebral space comprises abutting a first vertebral body adjacent to the intervertebral space with a first bone engaging surface of the implant, and abutting a second vertebral body adjacent to the intervertebral space with a second bone engaging surface of the implant to substantially prevent relative motion between the first and second vertebral bodies.

38. The method of claim 36, wherein the first and second retention members are components of an expandable collet of the attachment interface, wherein moving the attachment interface from the released configuration to the locked configuration comprises expanding the expandable collet.

39. The method of claim 38, wherein the attachment interface further comprises a rod comprising an axis, wherein expanding the expandable collet comprises moving the rod along the axis to trigger expansion of the expandable collet.

40. The method of claim 39, wherein the rod comprises a tapered distal end extending through the collet, wherein moving the rod along the axis comprises retracting the distal end into the collet.

41. The method of claim 36, wherein the insertion tool comprises a distal end comprising the attachment interface, and a proximal end comprising an actuation interface, the method further comprising actuating the actuation interface to trigger movement of the attachment interface from the released configuration to the locked configuration.

42. The method of claim 36, further comprising positioning the implant at one of a first orientation with respect to the insertion tool, and a second orientation with respect to the insertion tool, wherein inserting the implant into the intervertebral space comprises using one of a first technique to insert the implant in the first orientation, and a second technique different from the first technique to insert the implant in the second orientation.

43. The method of claim 36, wherein the implant comprises a body in which the aperture is formed, a first marker on the body, and a second marker on the body, the method further comprising:

positioning the implant at a proper orientation within the intervertebral space; and

detecting the first and second markers through tissue to verify positioning of the implant at the proper orientation by detecting alignment of the first and second markers with each other from one of an anterior viewpoint, a posterior viewpoint, a lateral viewpoint, a cephalad viewpoint, and a caudal viewpoint.

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