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(54) **SACROILIAC JOINT IMPLANT SYSTEM**

(75) Inventors: **Edward Jeffrey Donner**, Fort Collins, CO (US); **Christopher Thomas Donner**, Fort Collins, CO (US)

(73) Assignee: **JCBD, LLC**, Fort Collins, CO (US)

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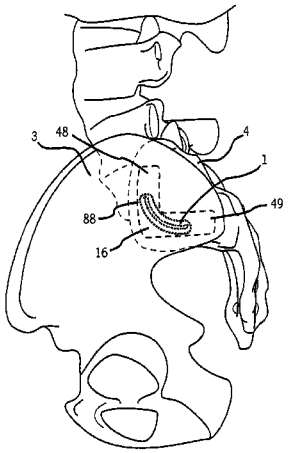
Primary Examiner — Lynnsy Summitt

(74) *Attorney, Agent, or Firm* — Polsinelli PC; Joshua J. Pranckun; Samuel Wade Johnson

(57) **ABSTRACT**

Accordingly, a broad object of the invention can be to provide an inventive implant to facilitate stabilization while allowing an amount of motion of a sacroiliac joint. Embodiments of the sacroiliac joint implant can provide an elongate body, which can further include at least one fixation member, or a pair of fixation members which extend a distance outward from the longitudinal axis of the implant body adapted for non-transverse placement between the articular surfaces of the sacroiliac joint, and as to certain embodiments can further provide a third fixation member and additionally a fourth fixation member each adapted to extend a distance outward from the elongate body into the bone of the sacrum or the ilium.

35 Claims, 39 Drawing Sheets



Related U.S. Application Data

which is a continuation-in-part of application No. 13/236,411, filed on Sep. 19, 2011, now Pat. No. 9,017,407, which is a continuation-in-part of application No. 12/998,712, filed as application No. PCT/US2011/000070 on Jan. 13, 2011, now Pat. No. 8,979,928.

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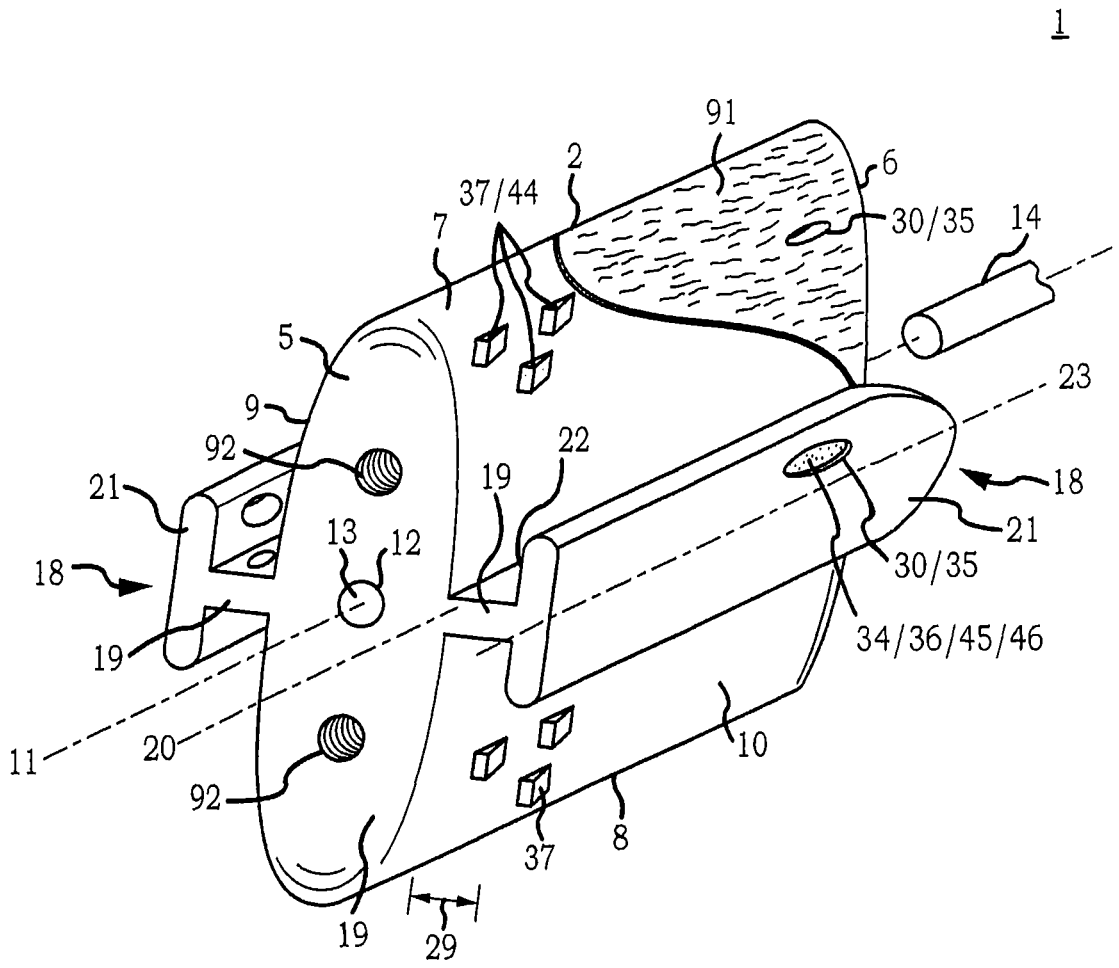
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FIG. 1

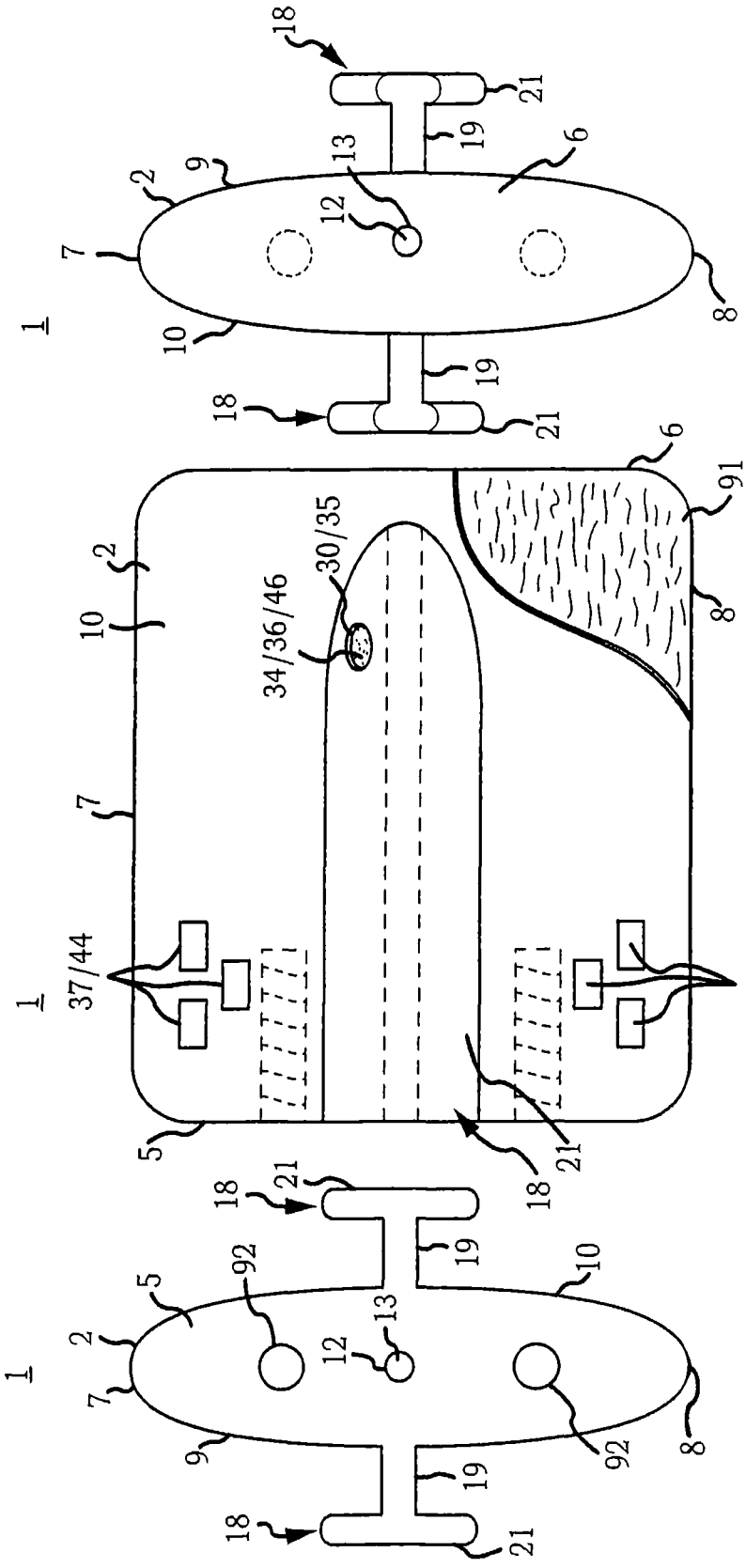

FIG.2

FIG.3

FIG.4

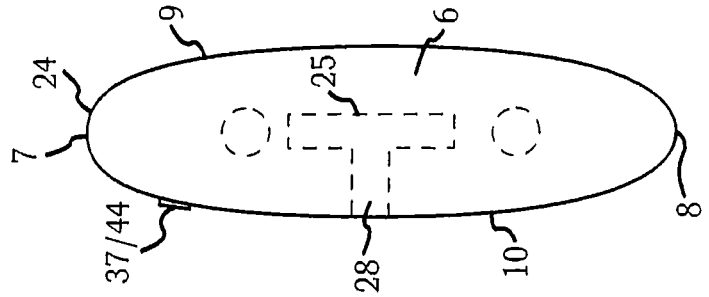

FIG.7

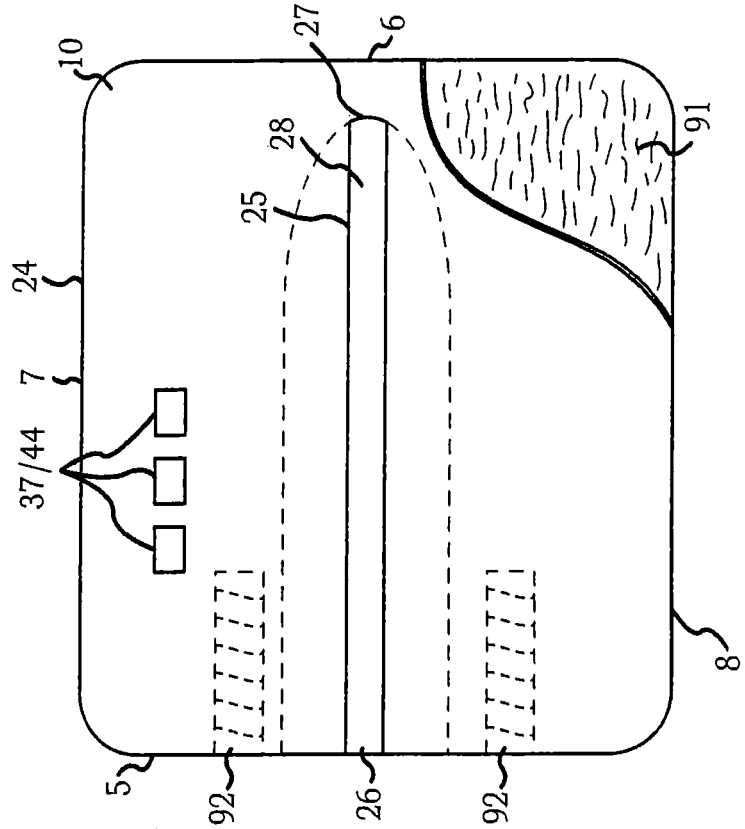

FIG.6

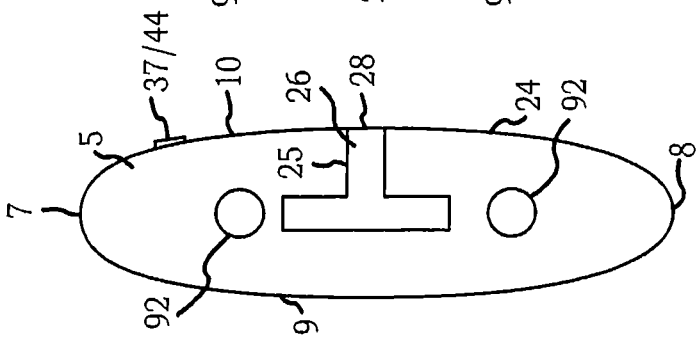

FIG.5

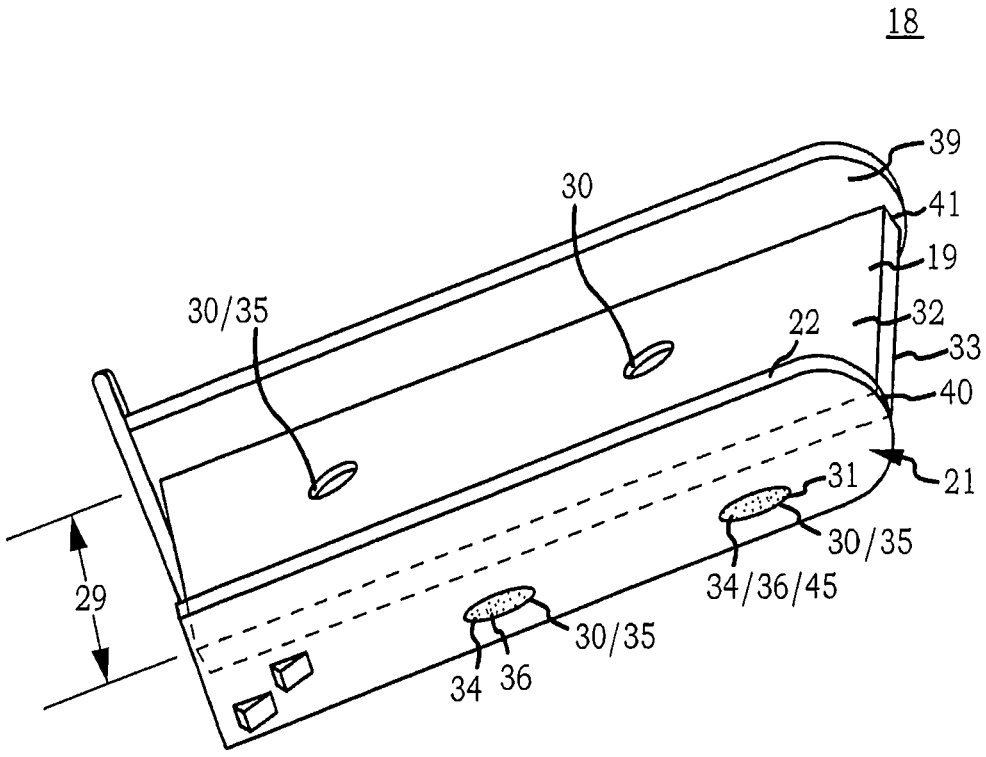

FIG.8

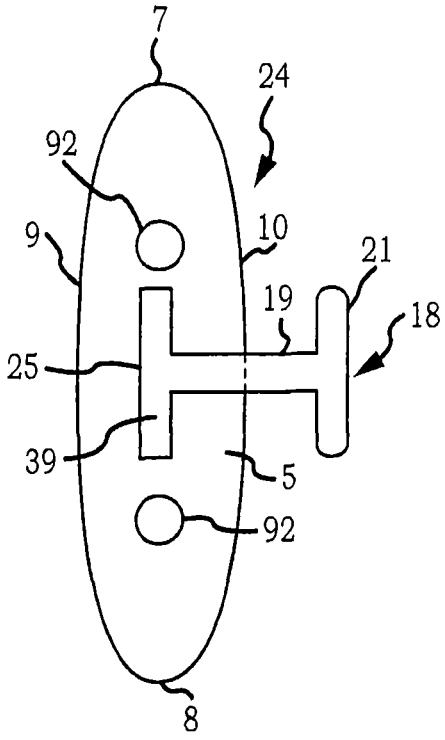

FIG.9

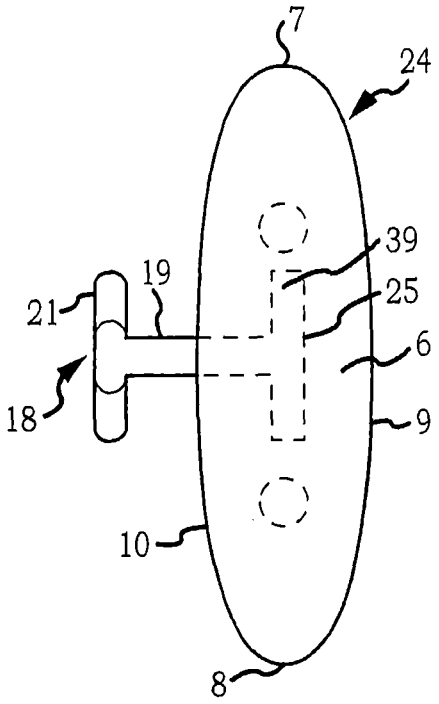

FIG.10

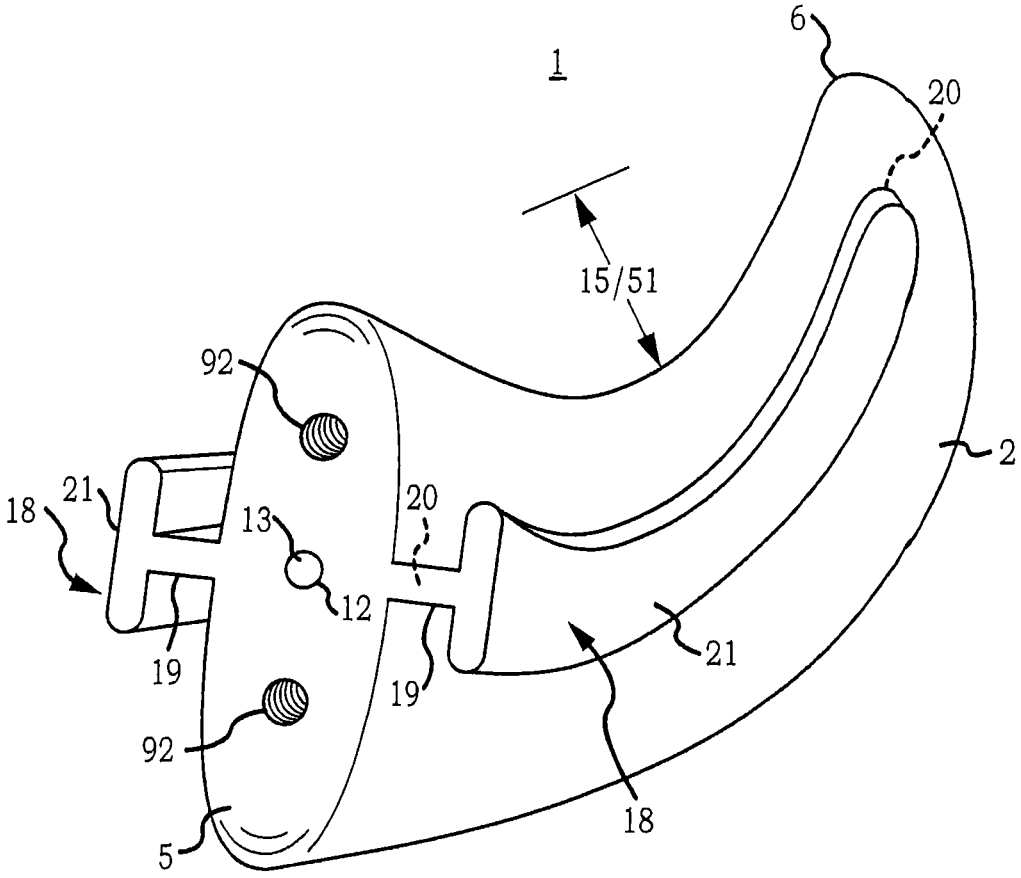

FIG. 11

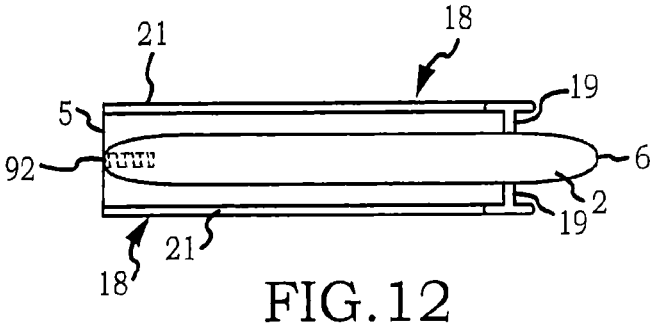

FIG. 12

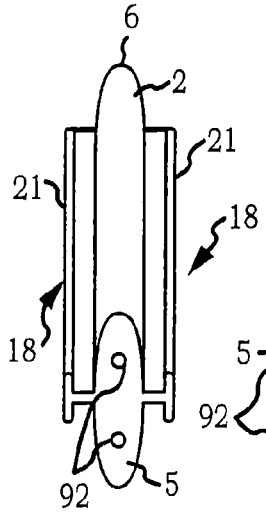

FIG. 13

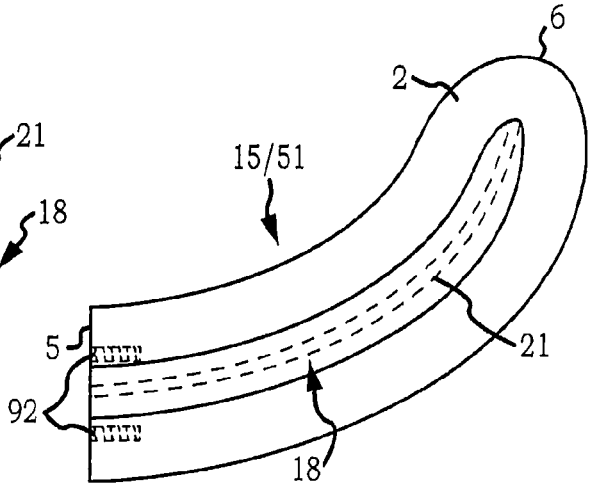

FIG. 14

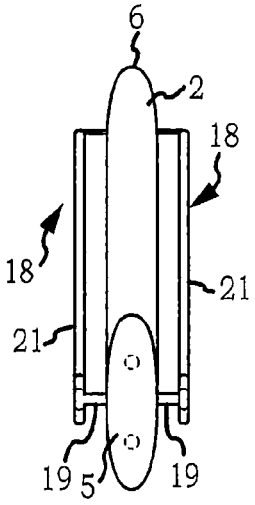

FIG. 15

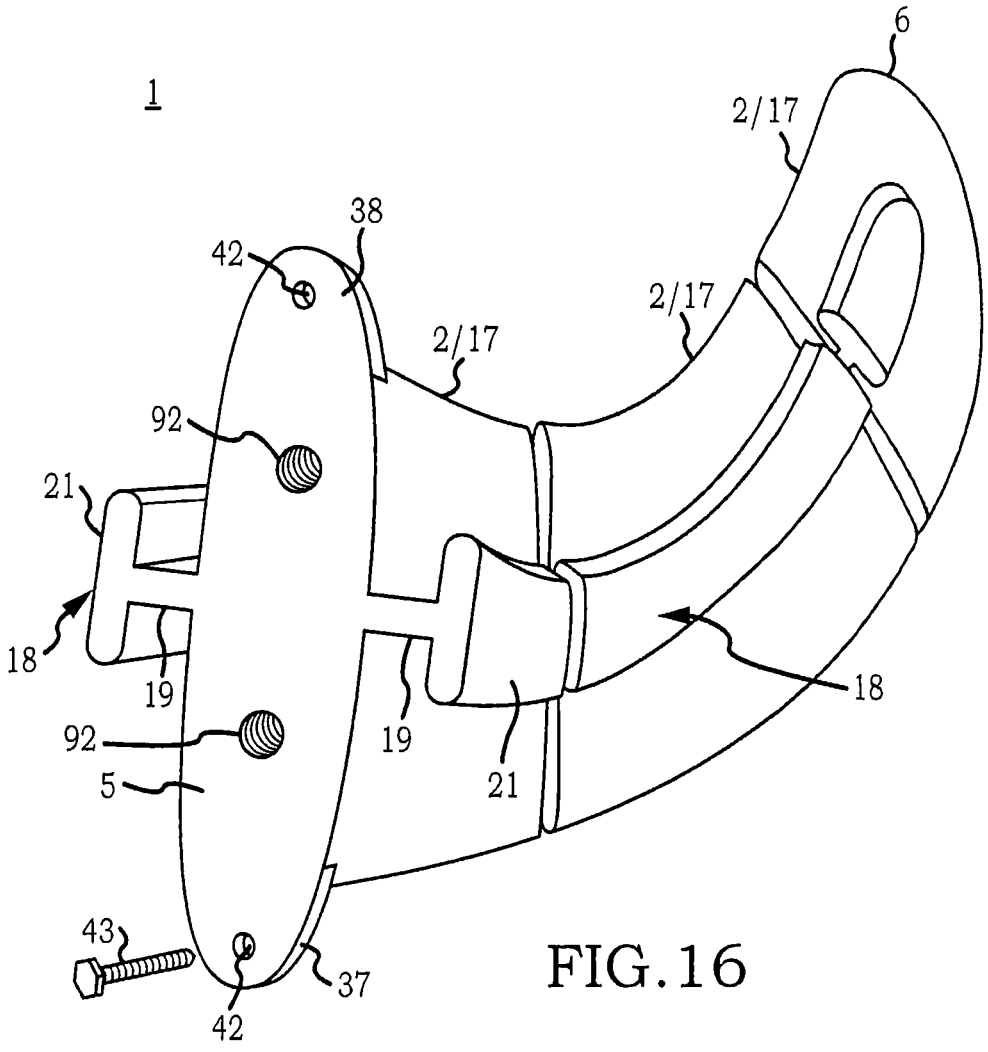

FIG. 16

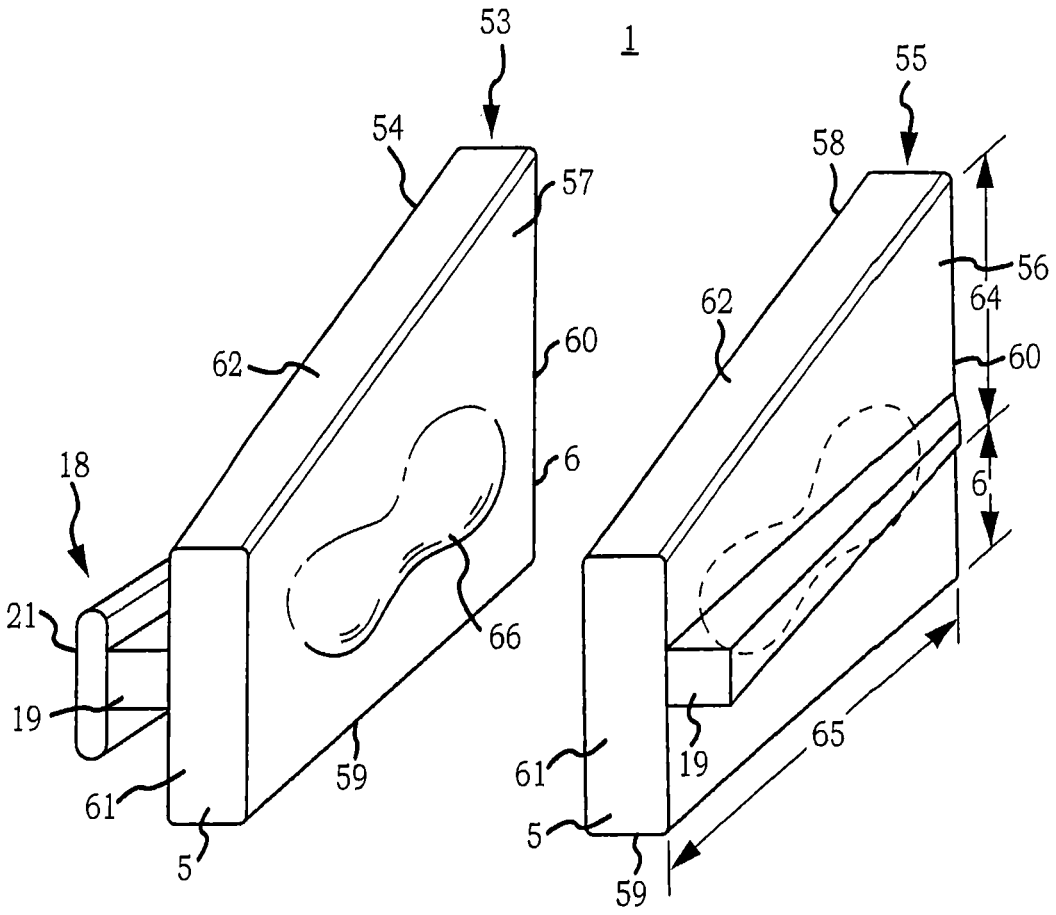

FIG. 17

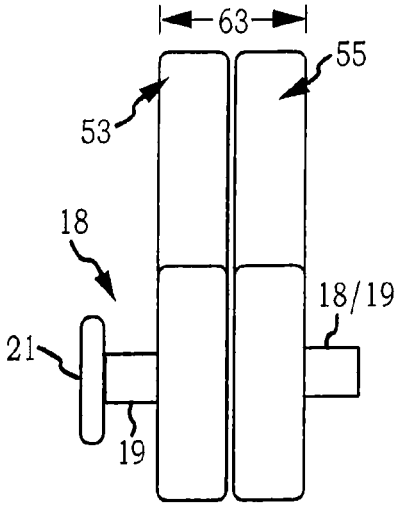

FIG.18

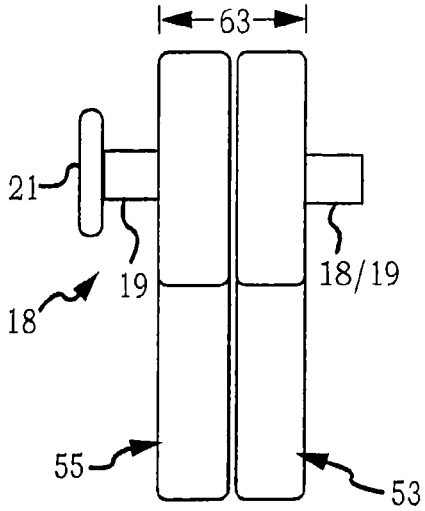

FIG.19

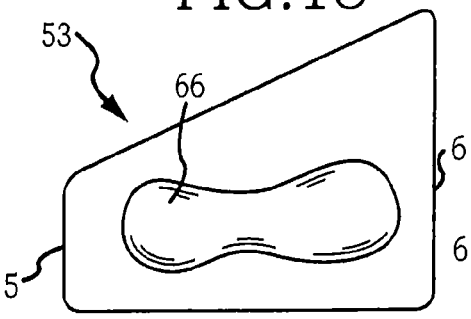

FIG.20

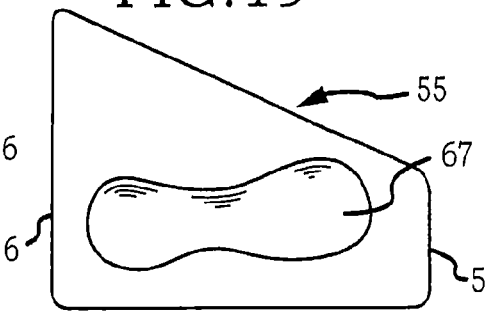

FIG.21

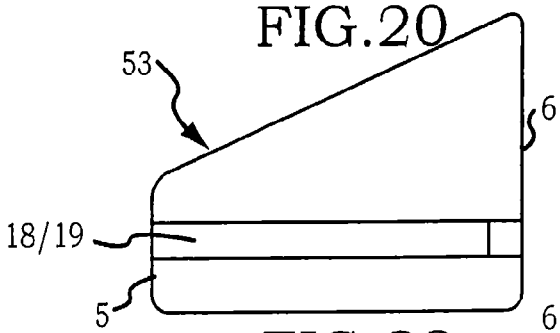

FIG.22

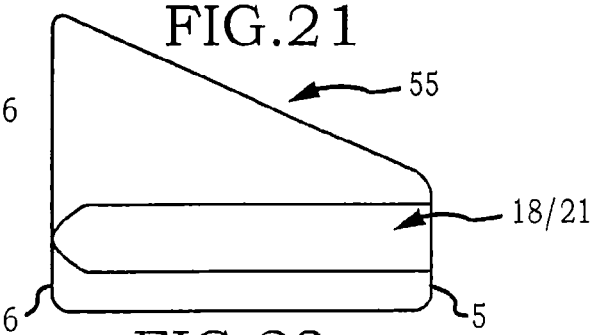

FIG.23

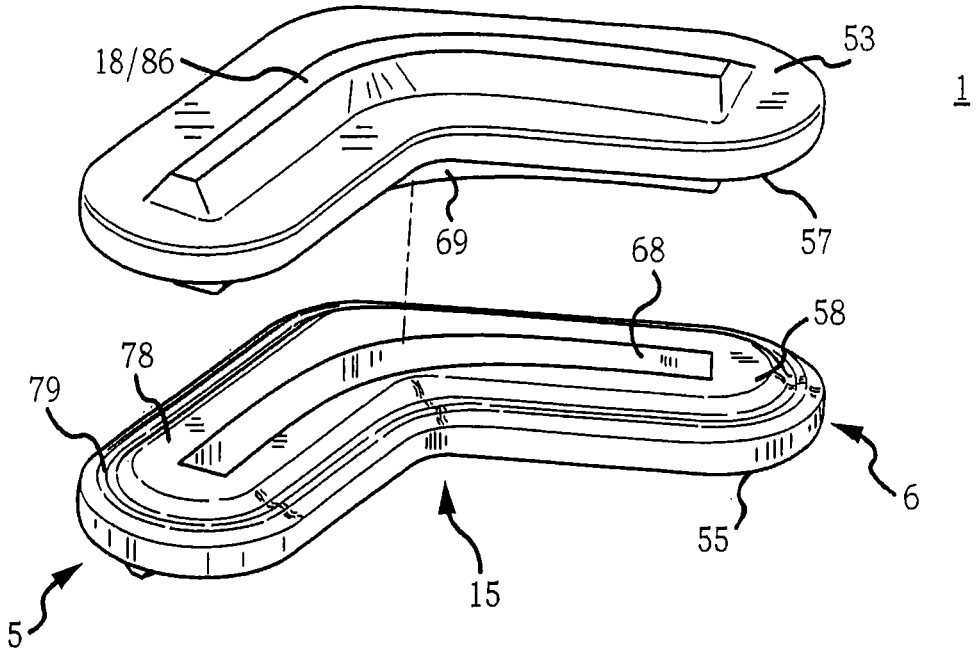

FIG.24

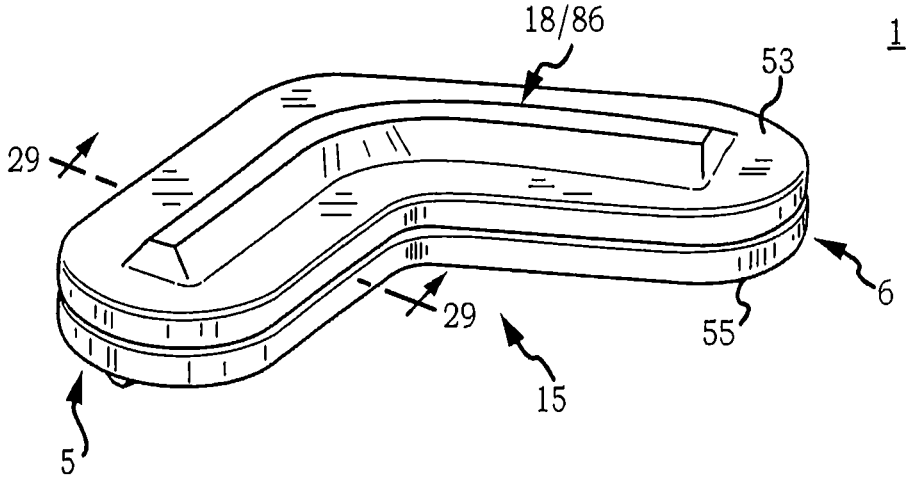

FIG.25

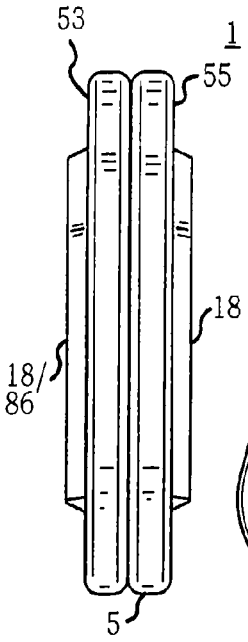

FIG.26

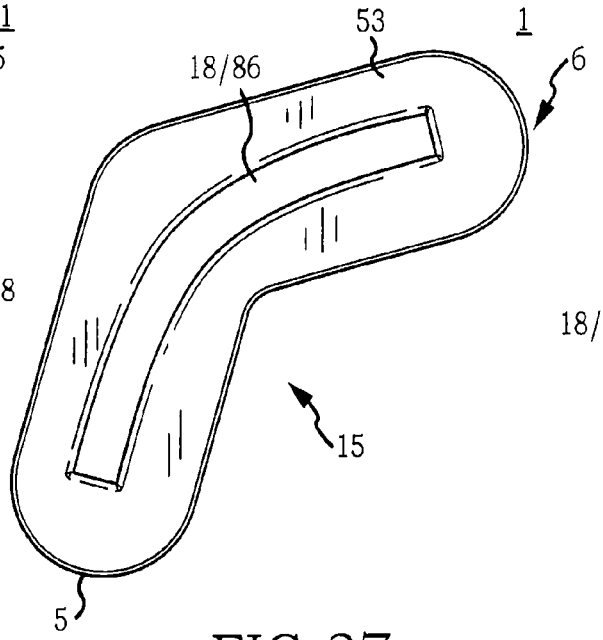

FIG.27

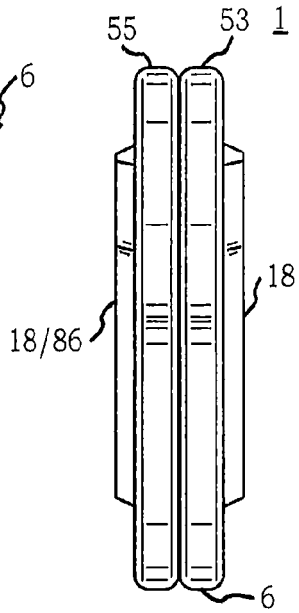

FIG.28

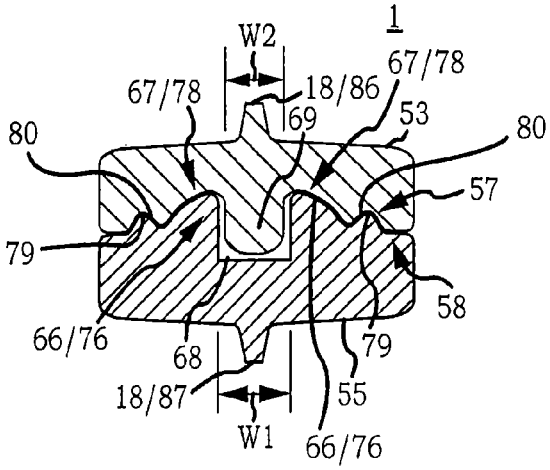

FIG.29

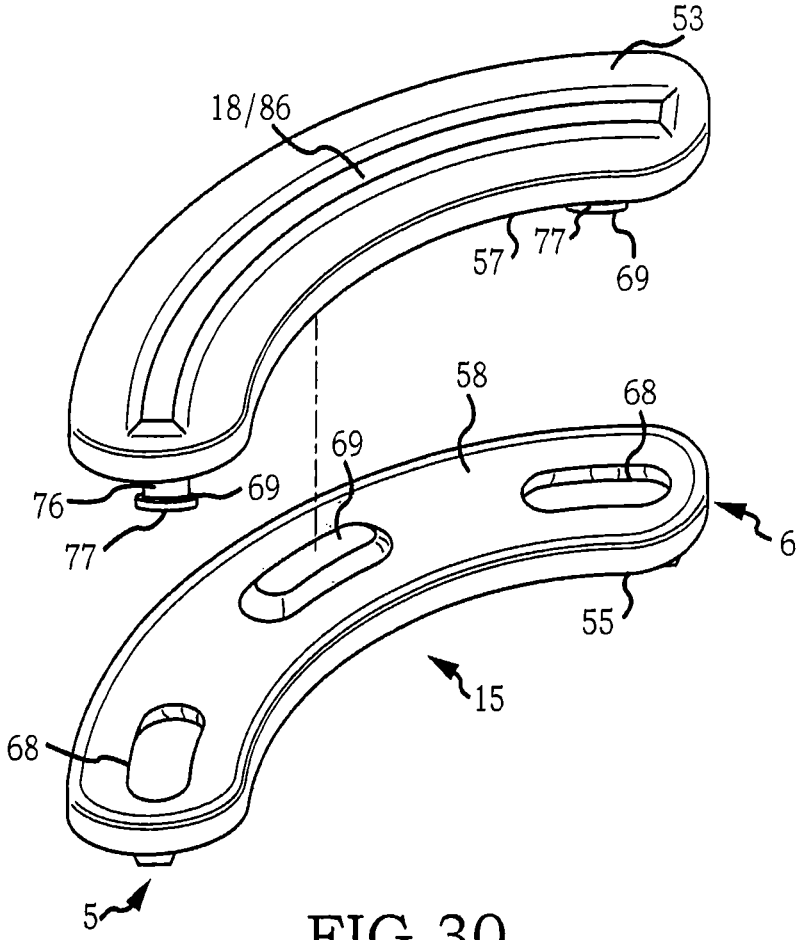

FIG.30

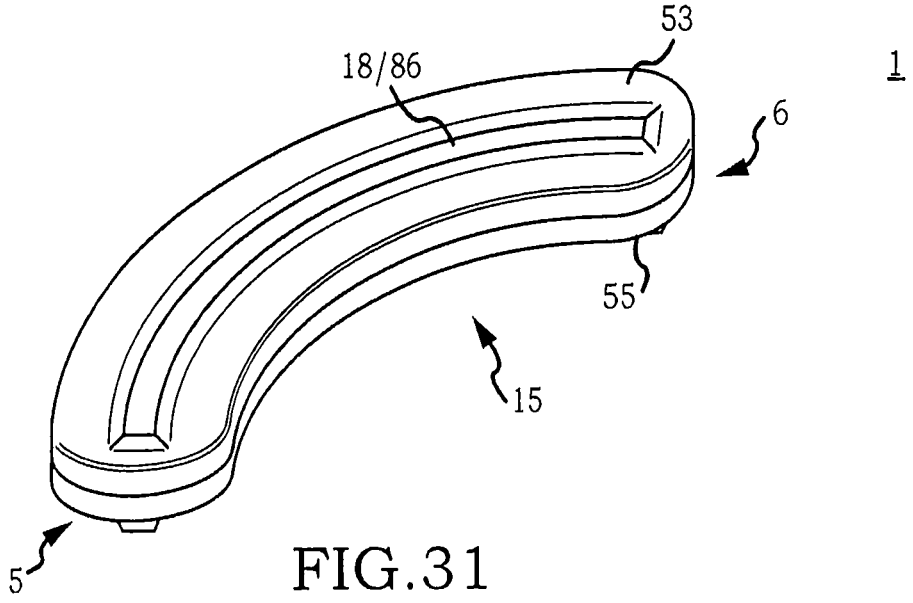

FIG.31

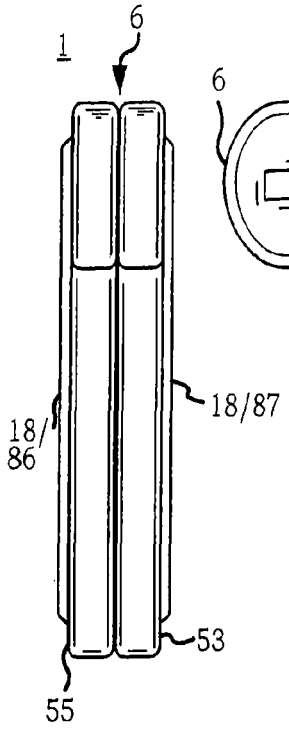

FIG.32

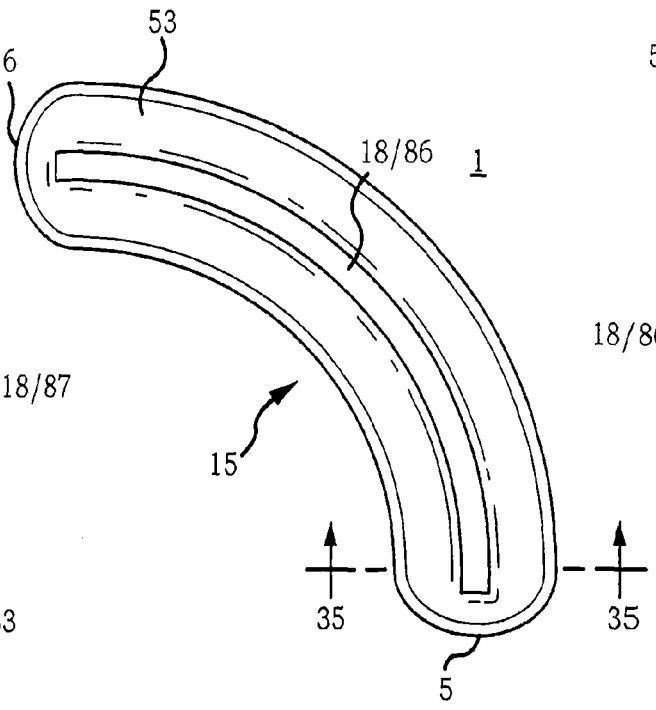

FIG.33

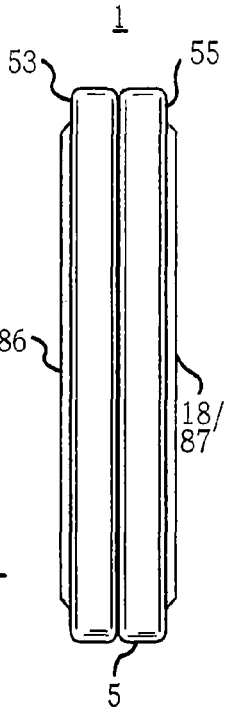

FIG.34

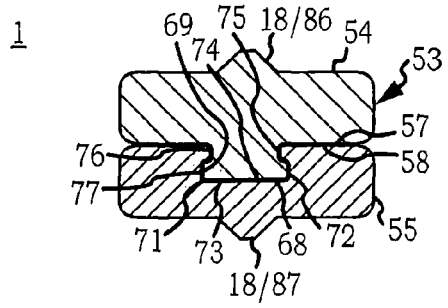

FIG.35

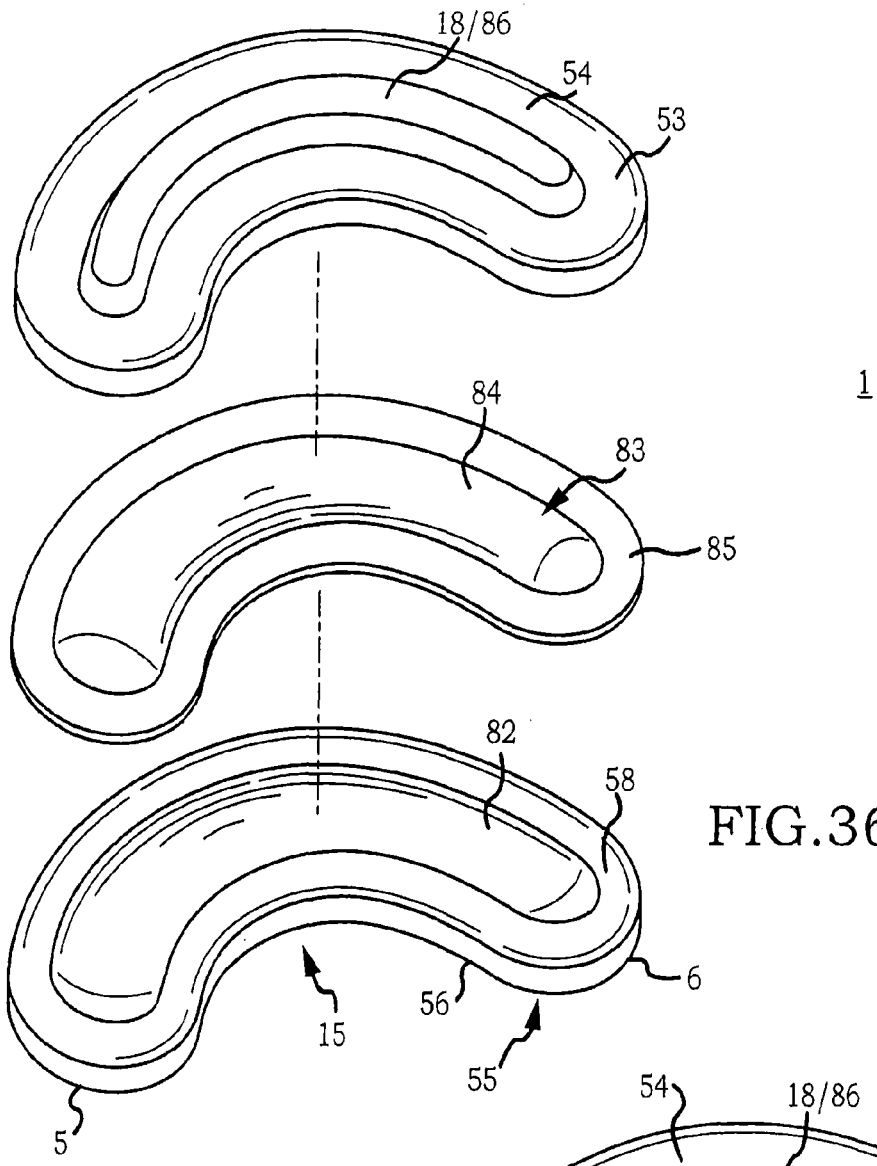

FIG.36

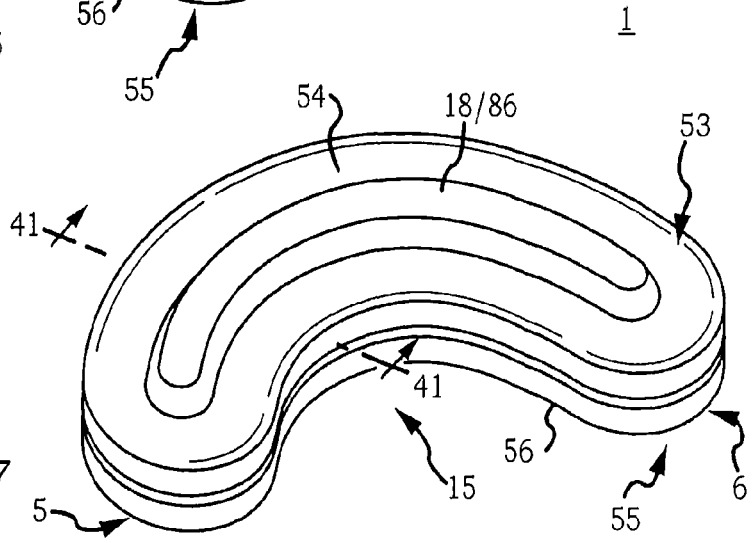

FIG.37

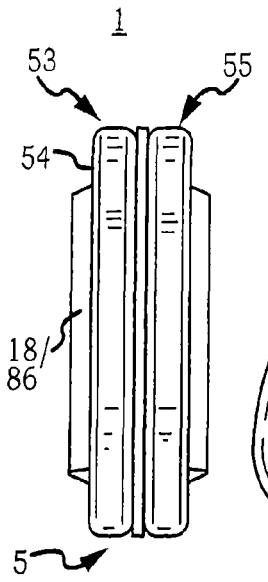

FIG.38

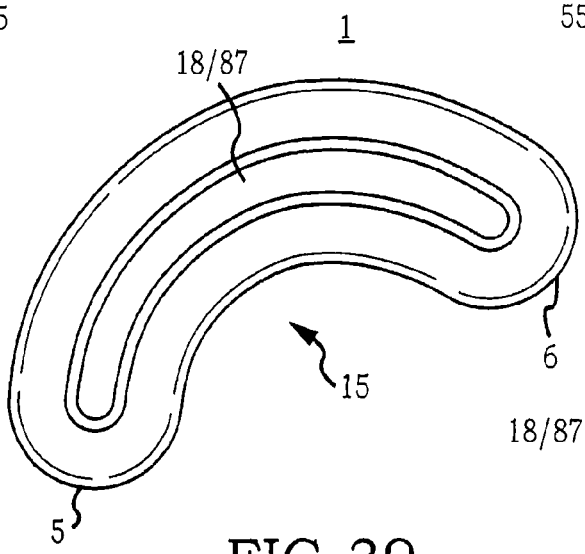

FIG.39

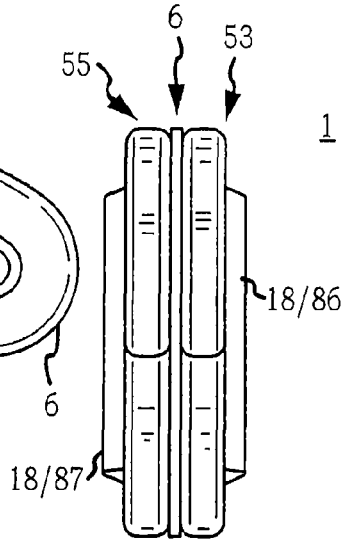

FIG.40

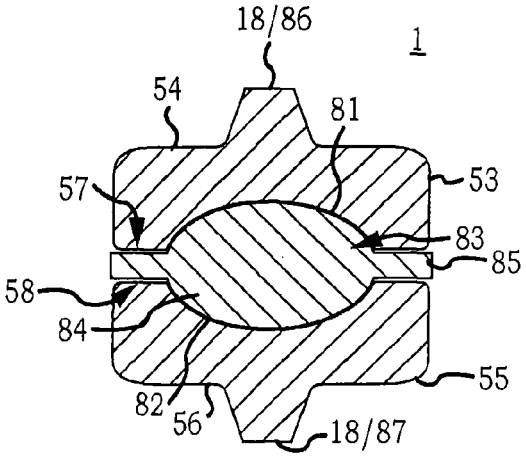

FIG.41

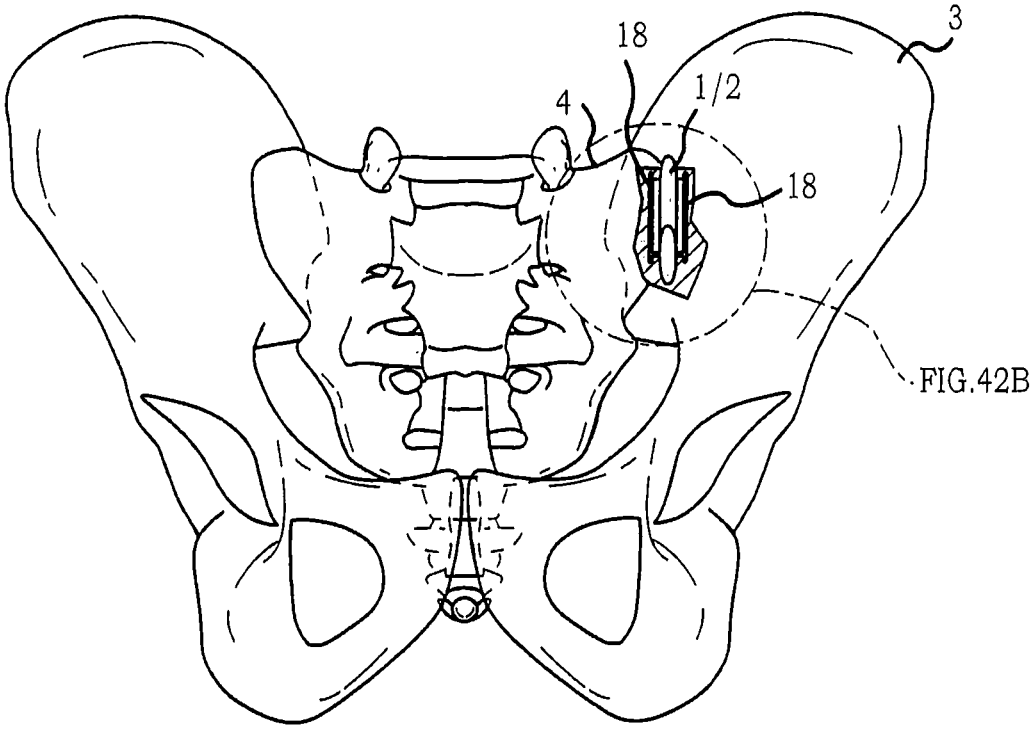

FIG.42A

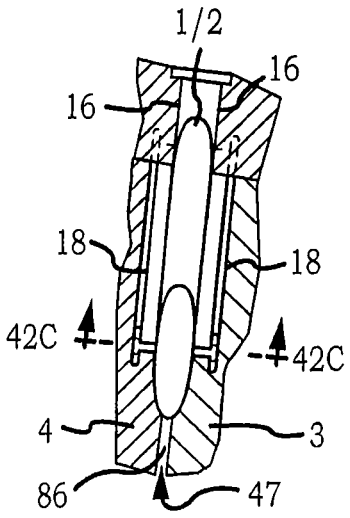

FIG.42B

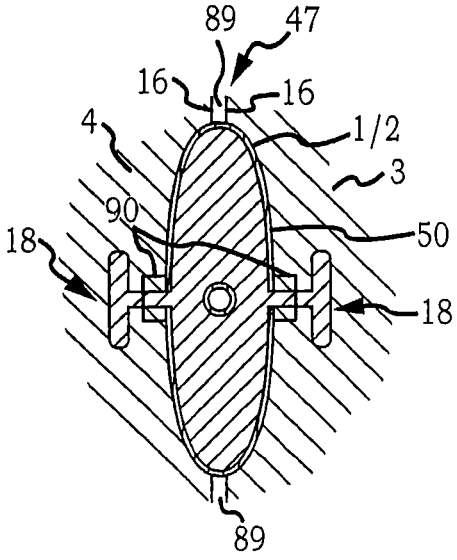

FIG.42C

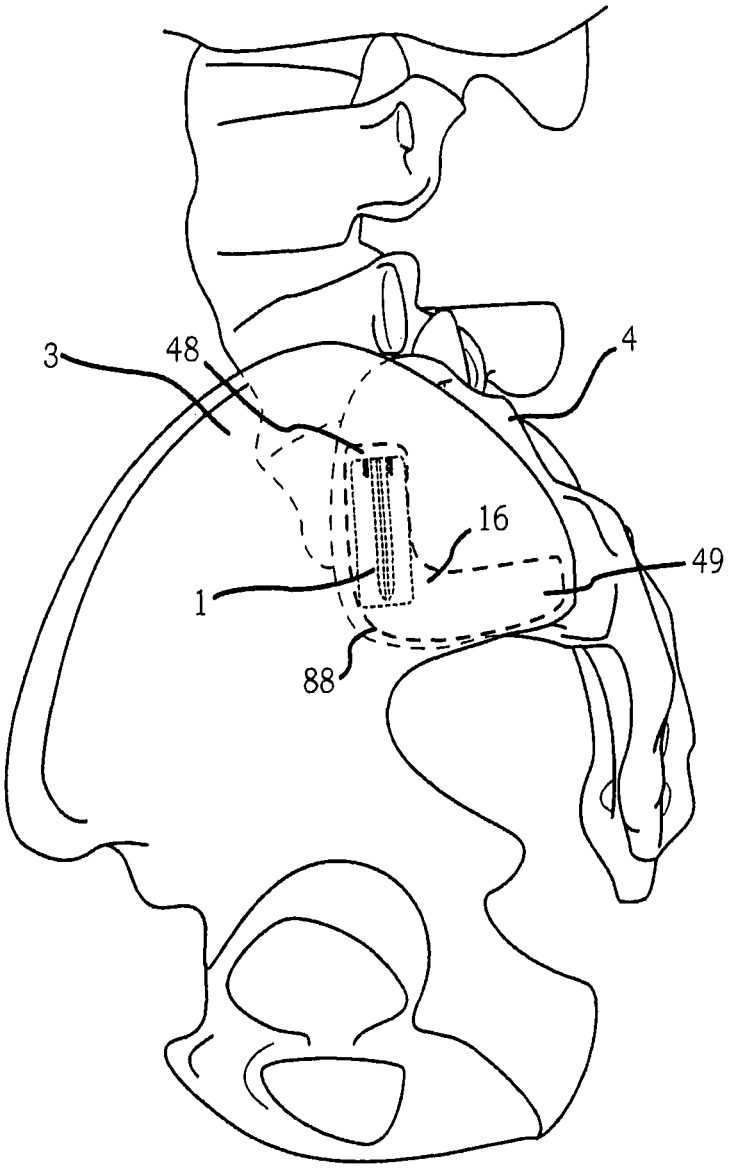

FIG.43

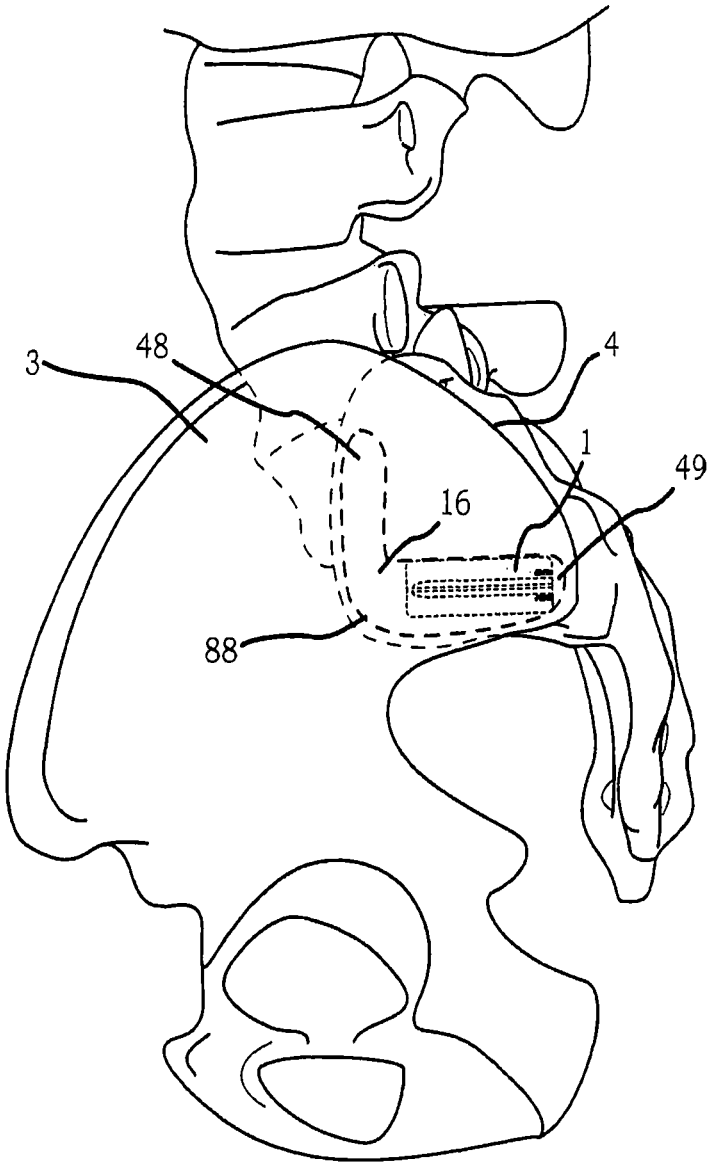

FIG.44

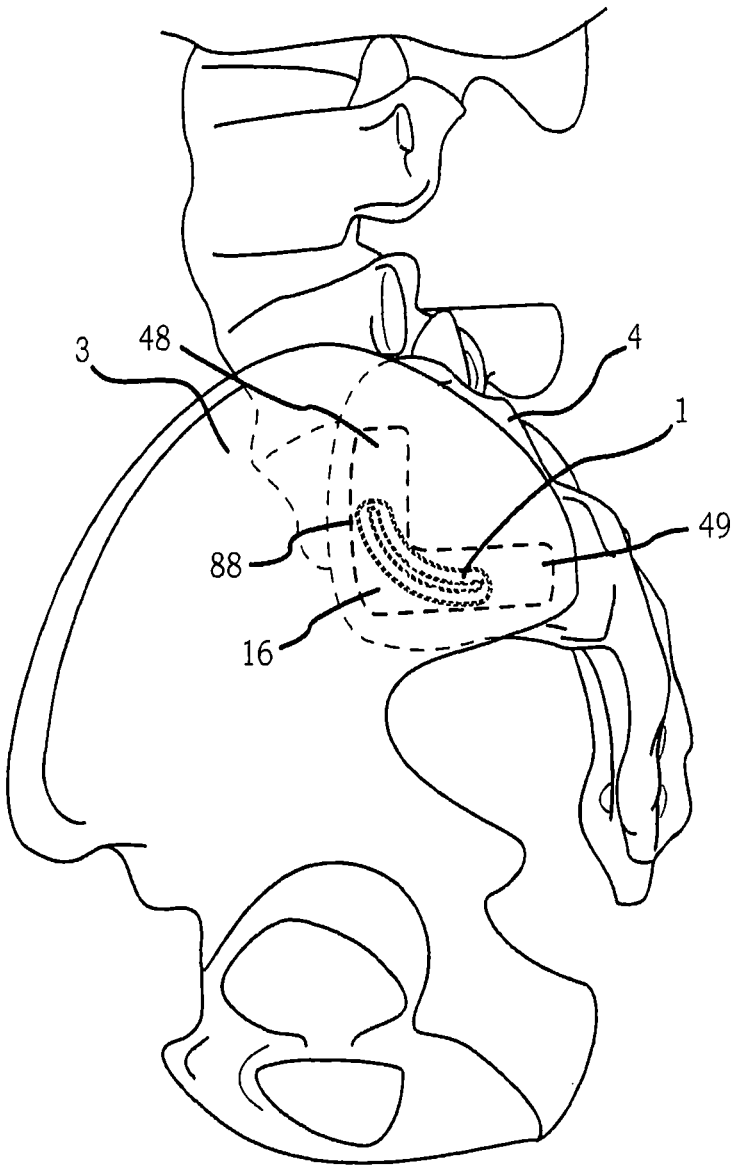

FIG.45

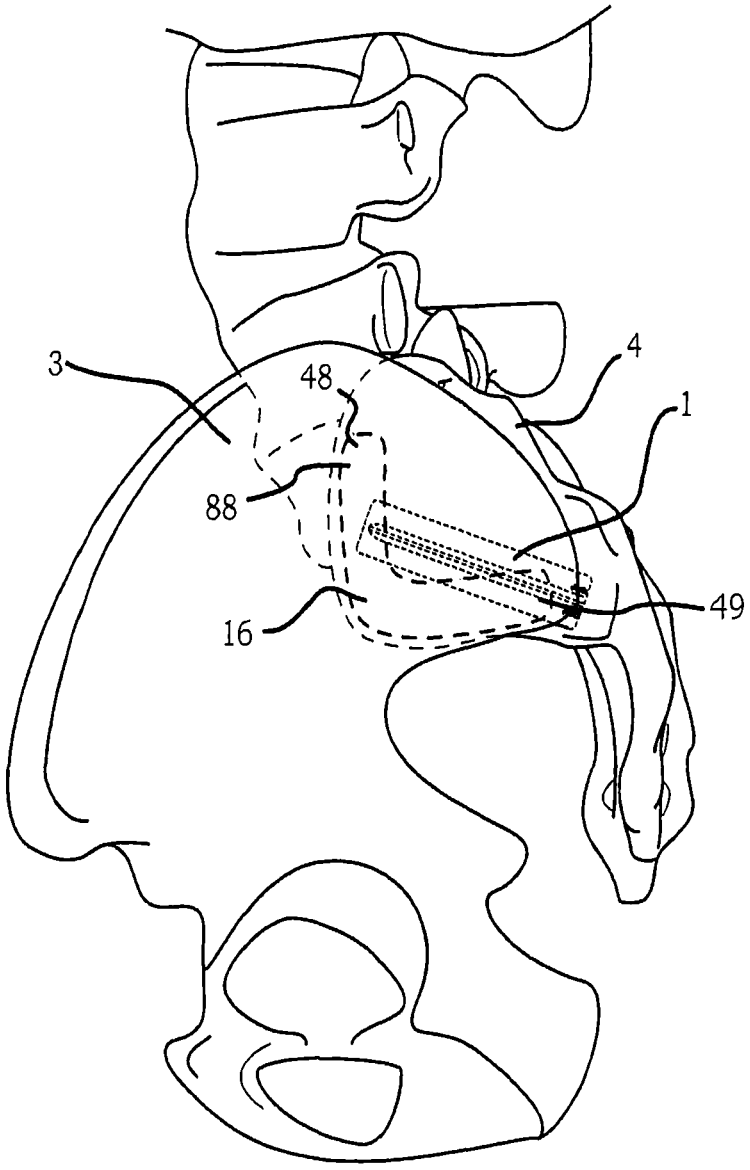

FIG.46

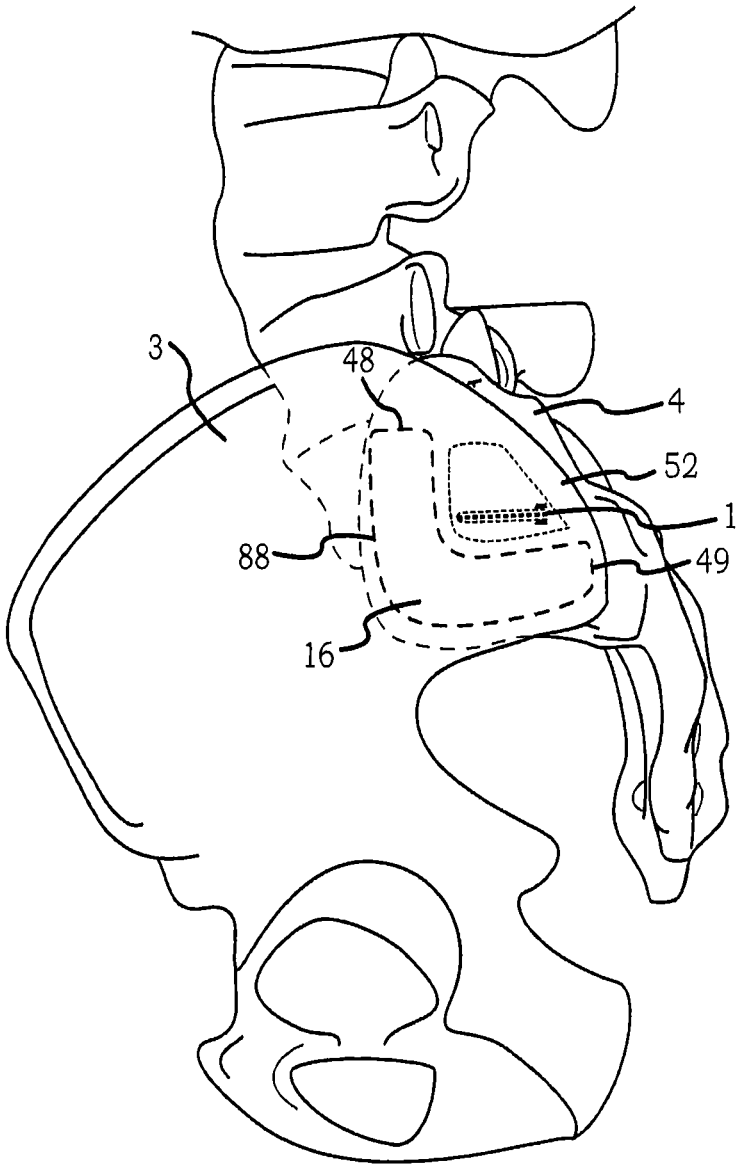

FIG.47

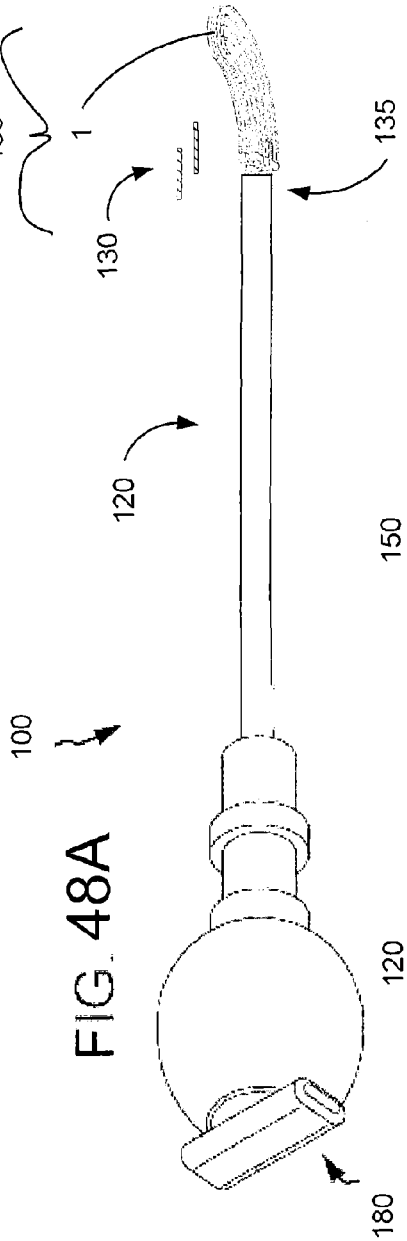

FIG. 48A

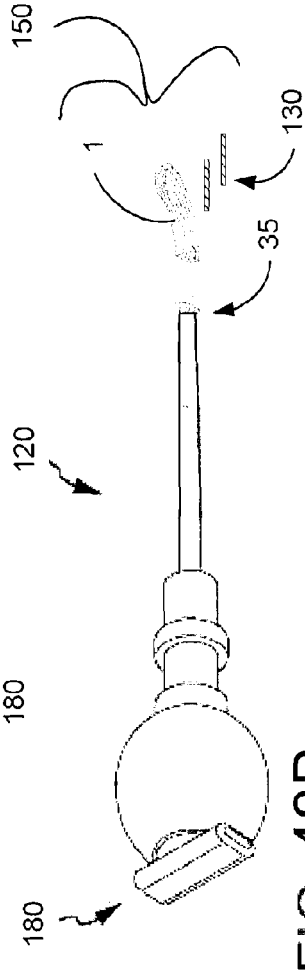

FIG. 48B

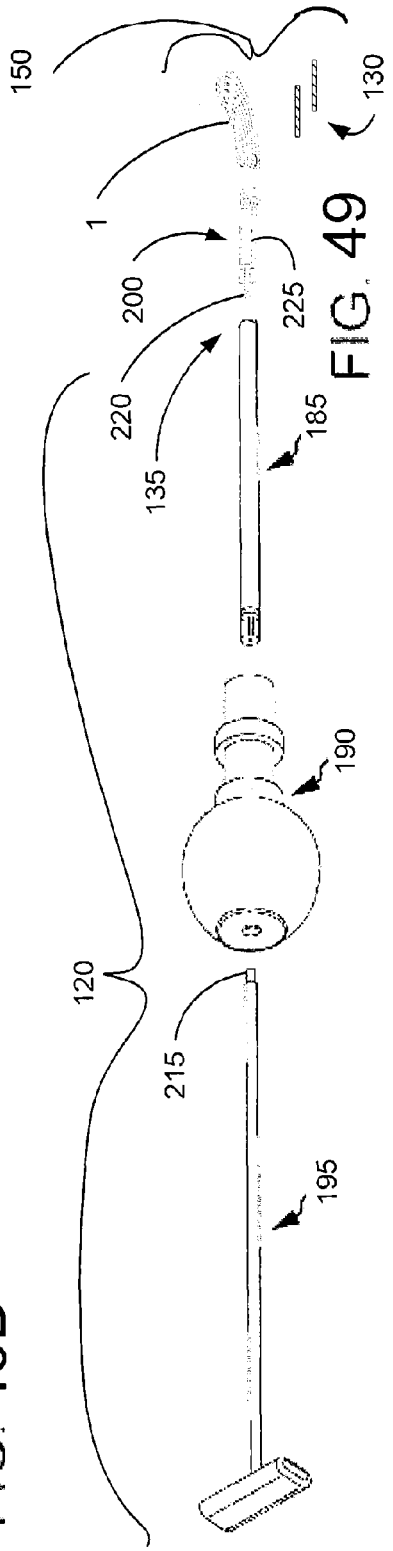

FIG. 49

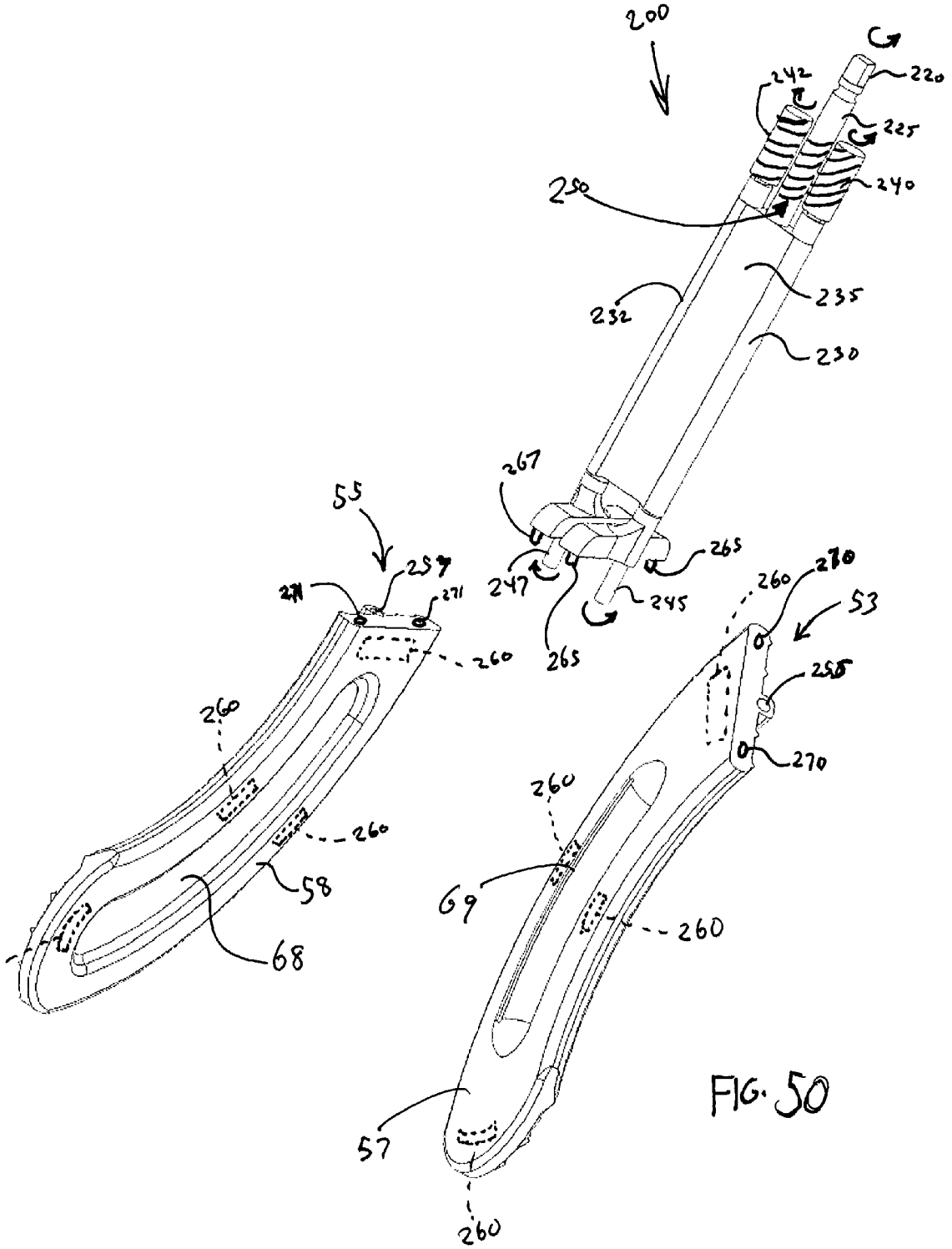
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FIG. 50

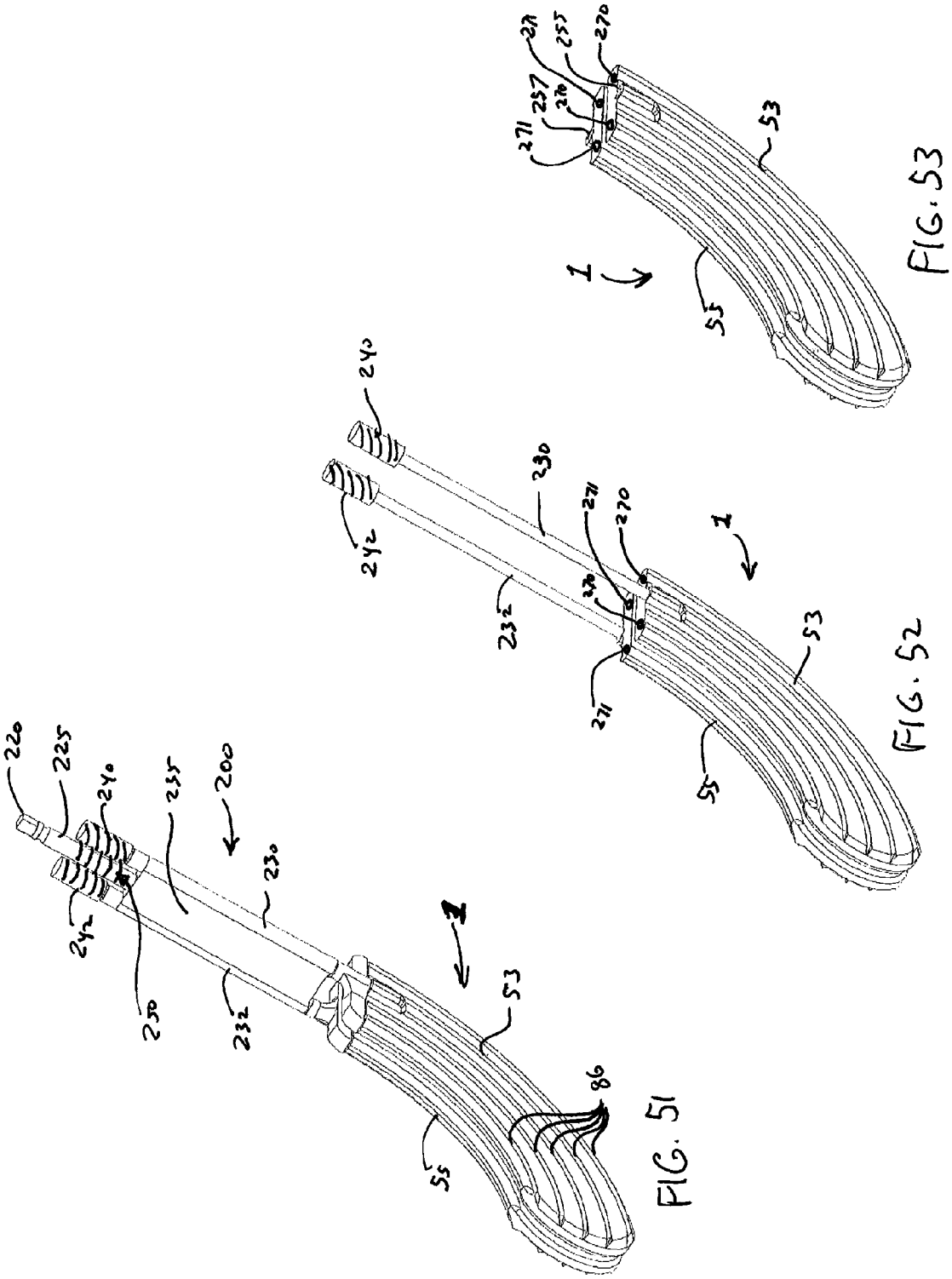

FIG. 53

FIG. 52

FIG. 51

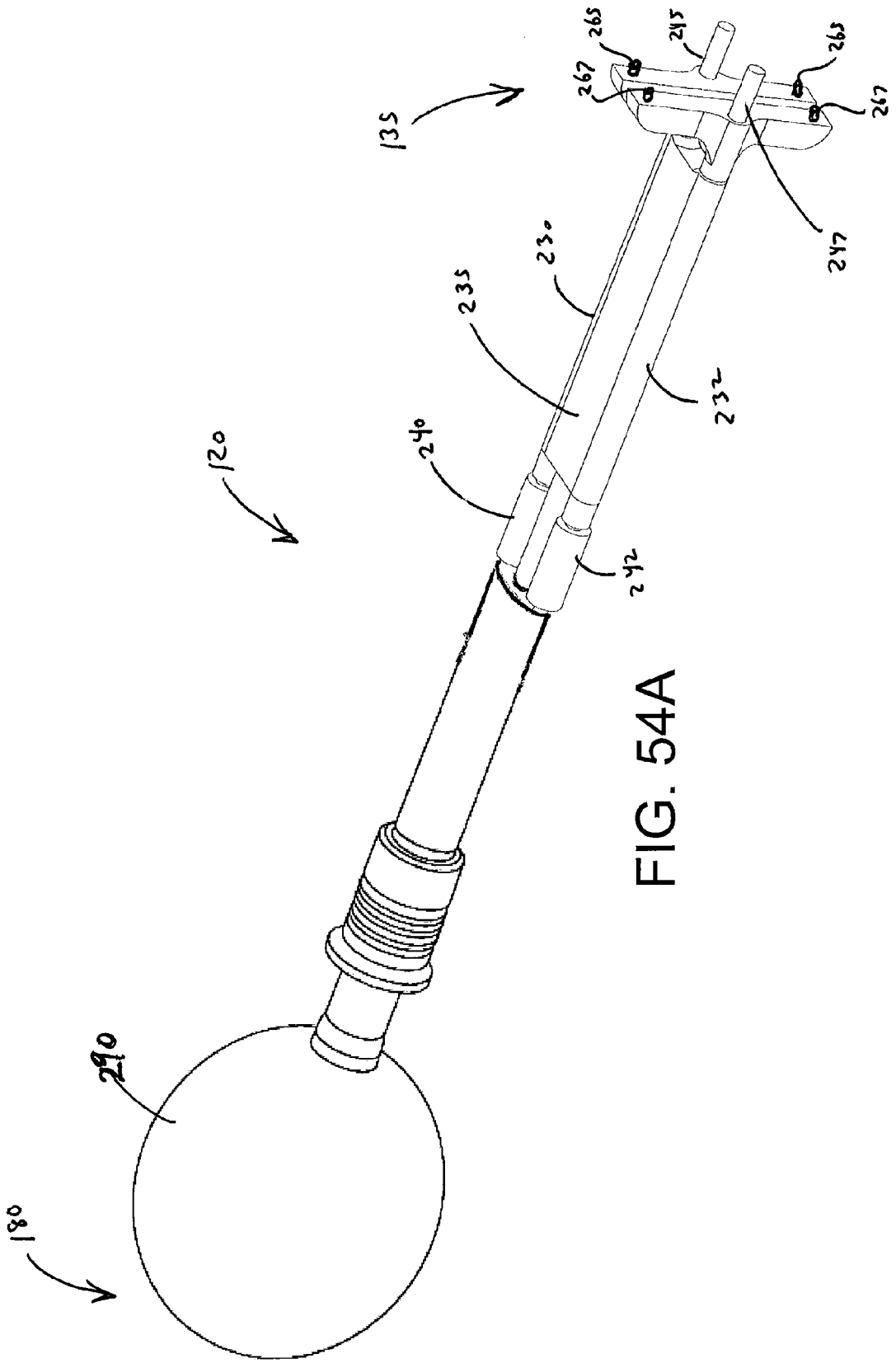

FIG. 54A

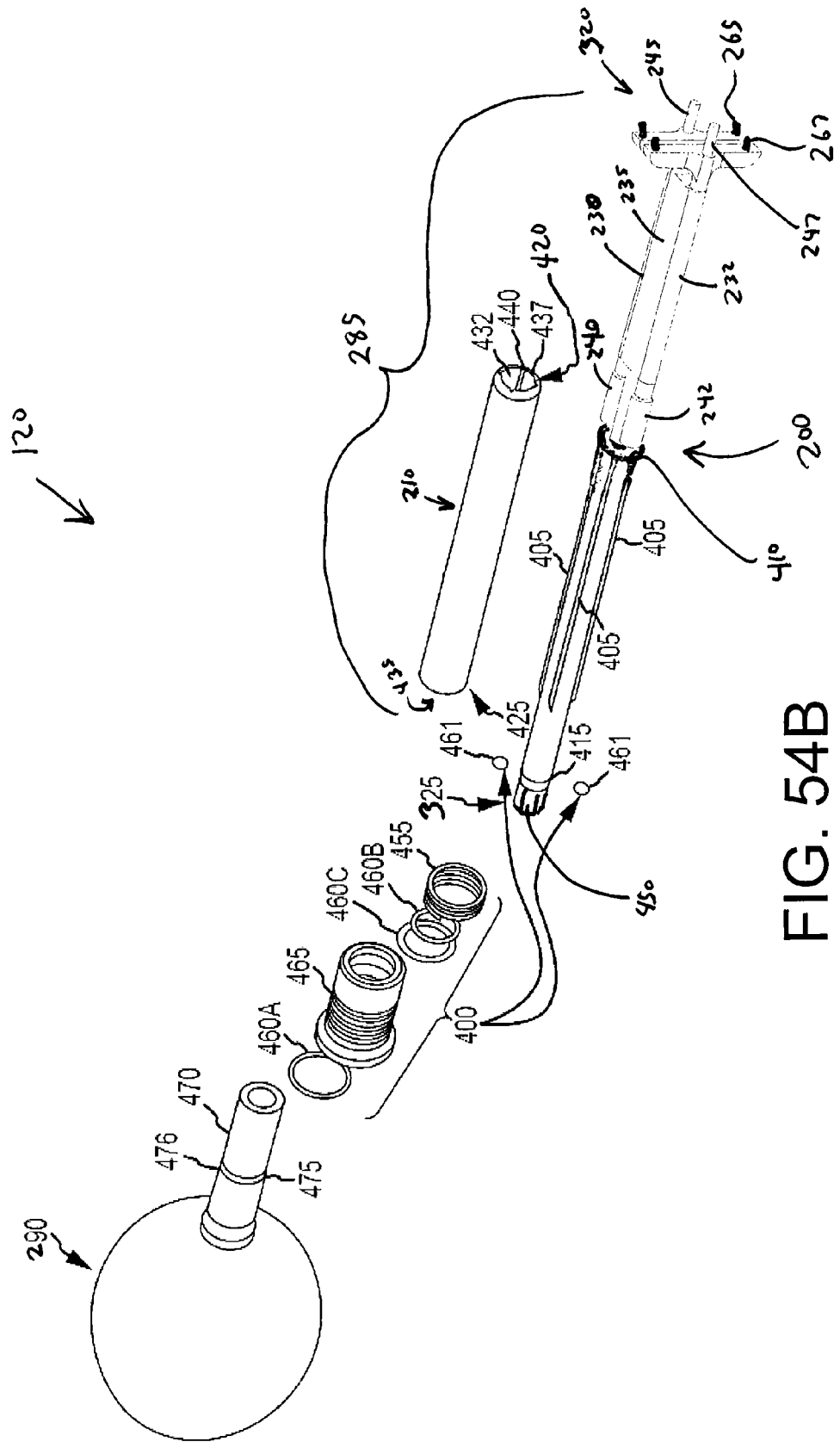
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FIG. 54B

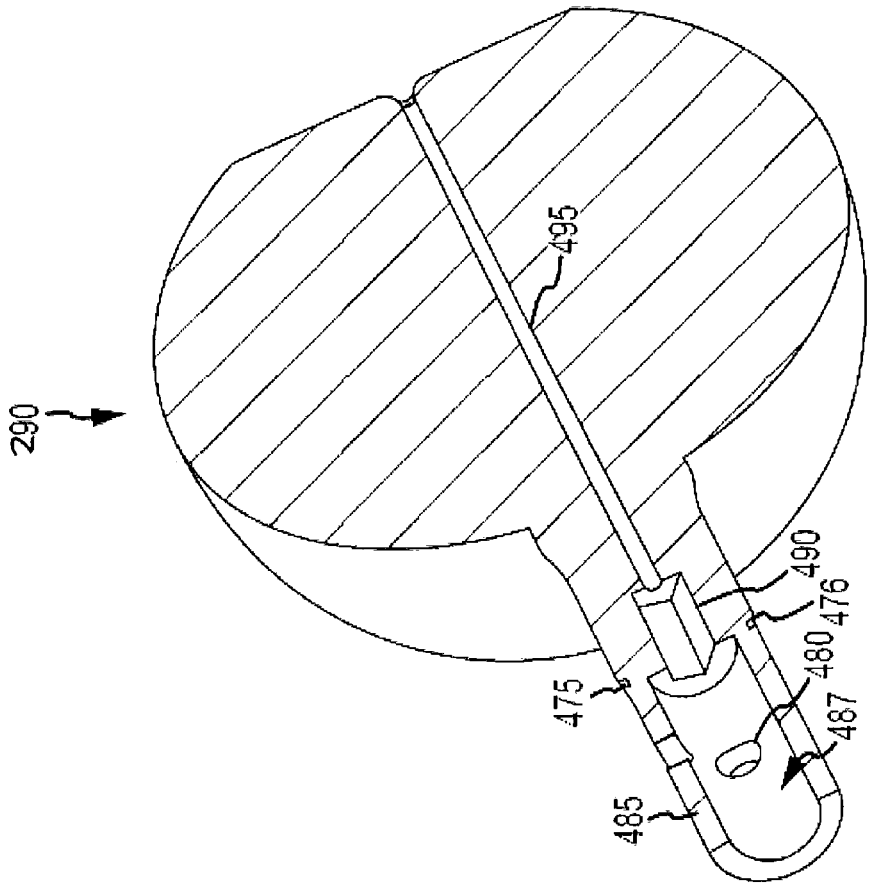


FIG. 54D

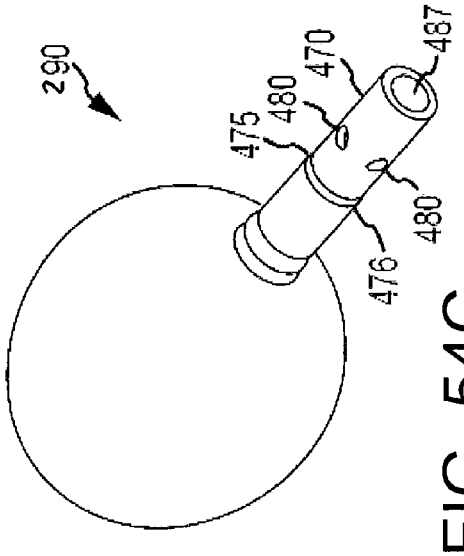
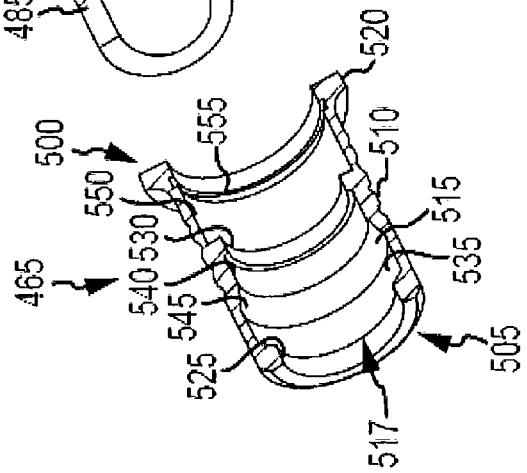


FIG. 54C



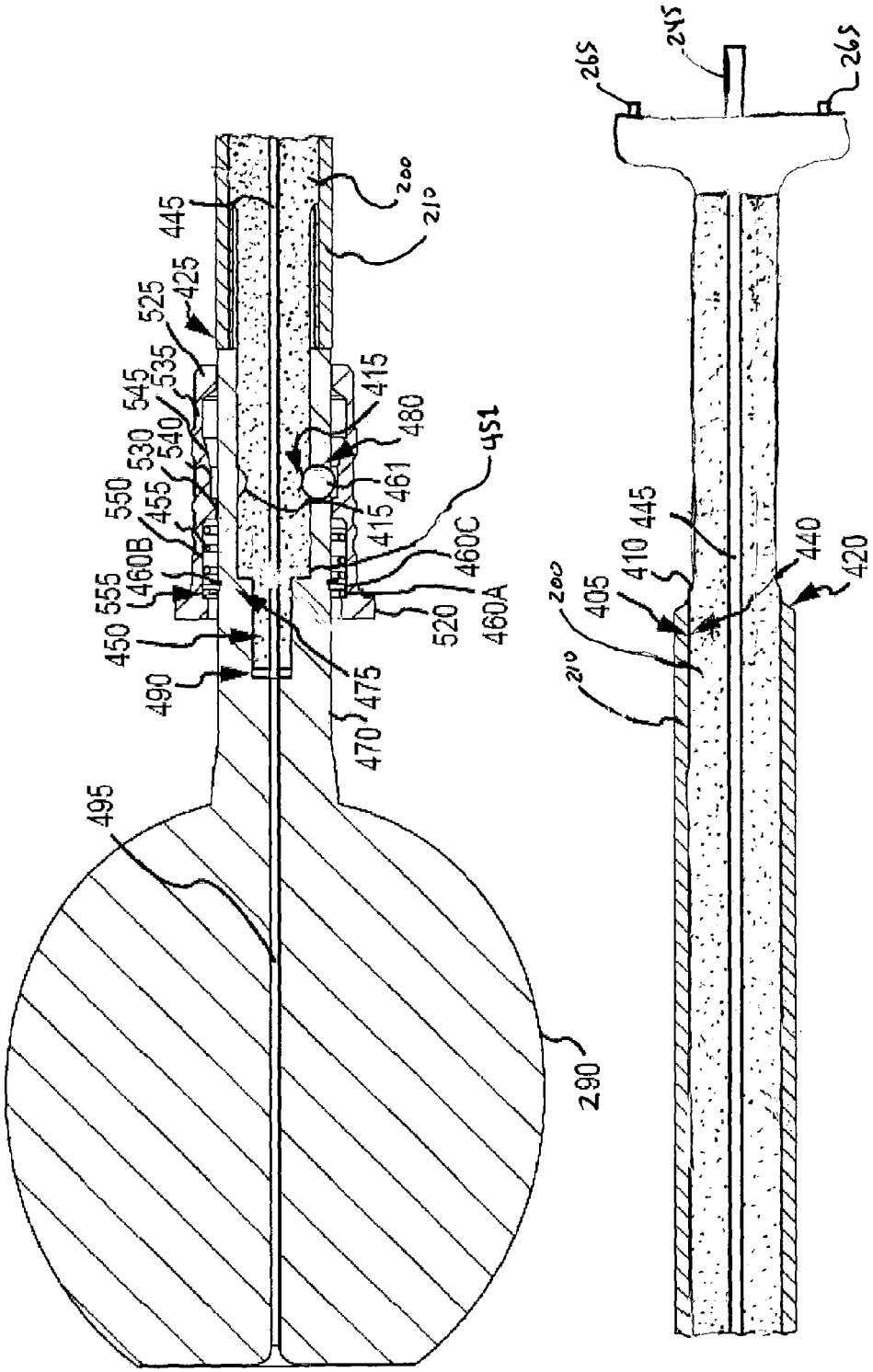

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FIG. 54E

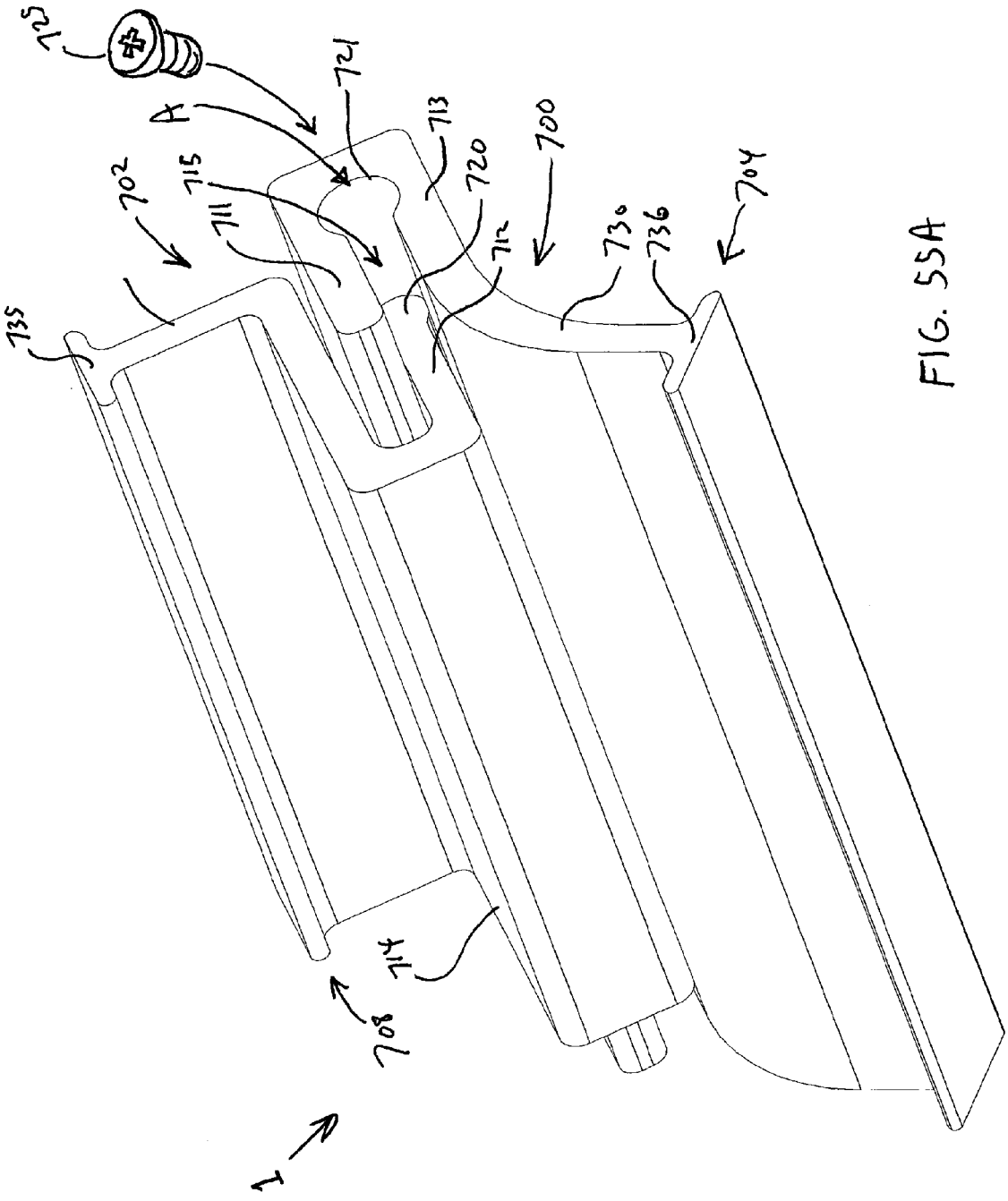

FIG. 55A

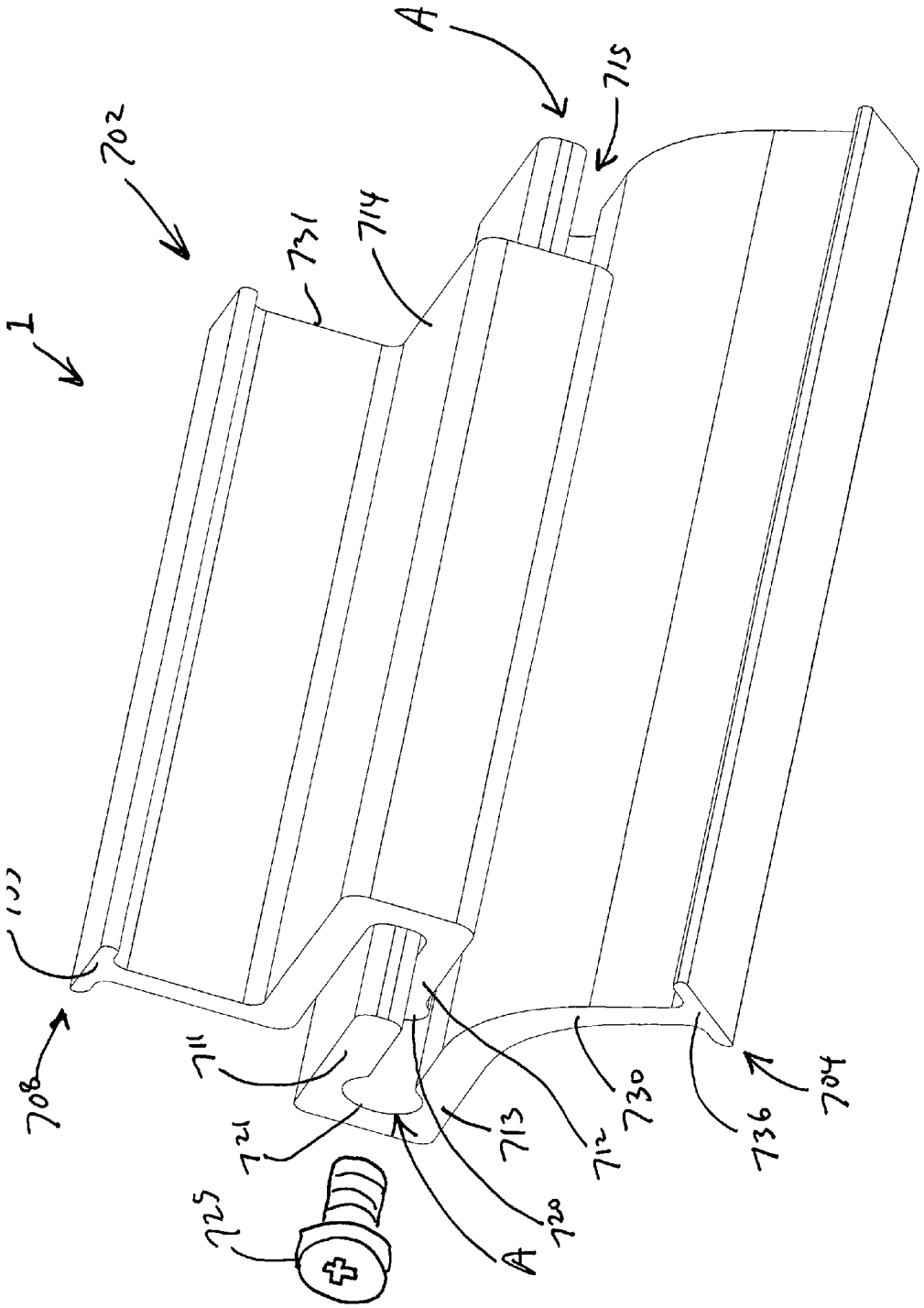

FIG. 55B

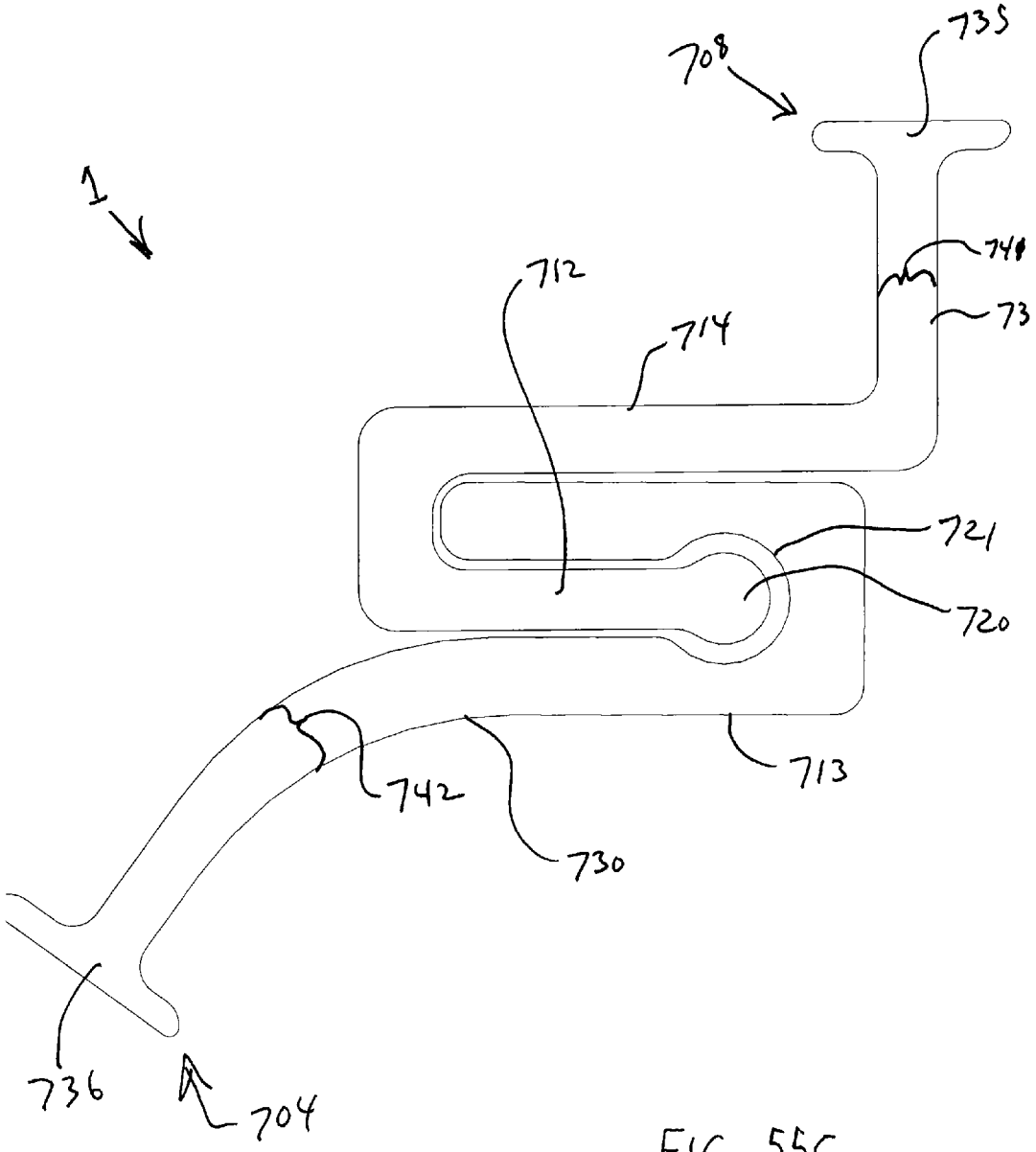

FIG. 55C

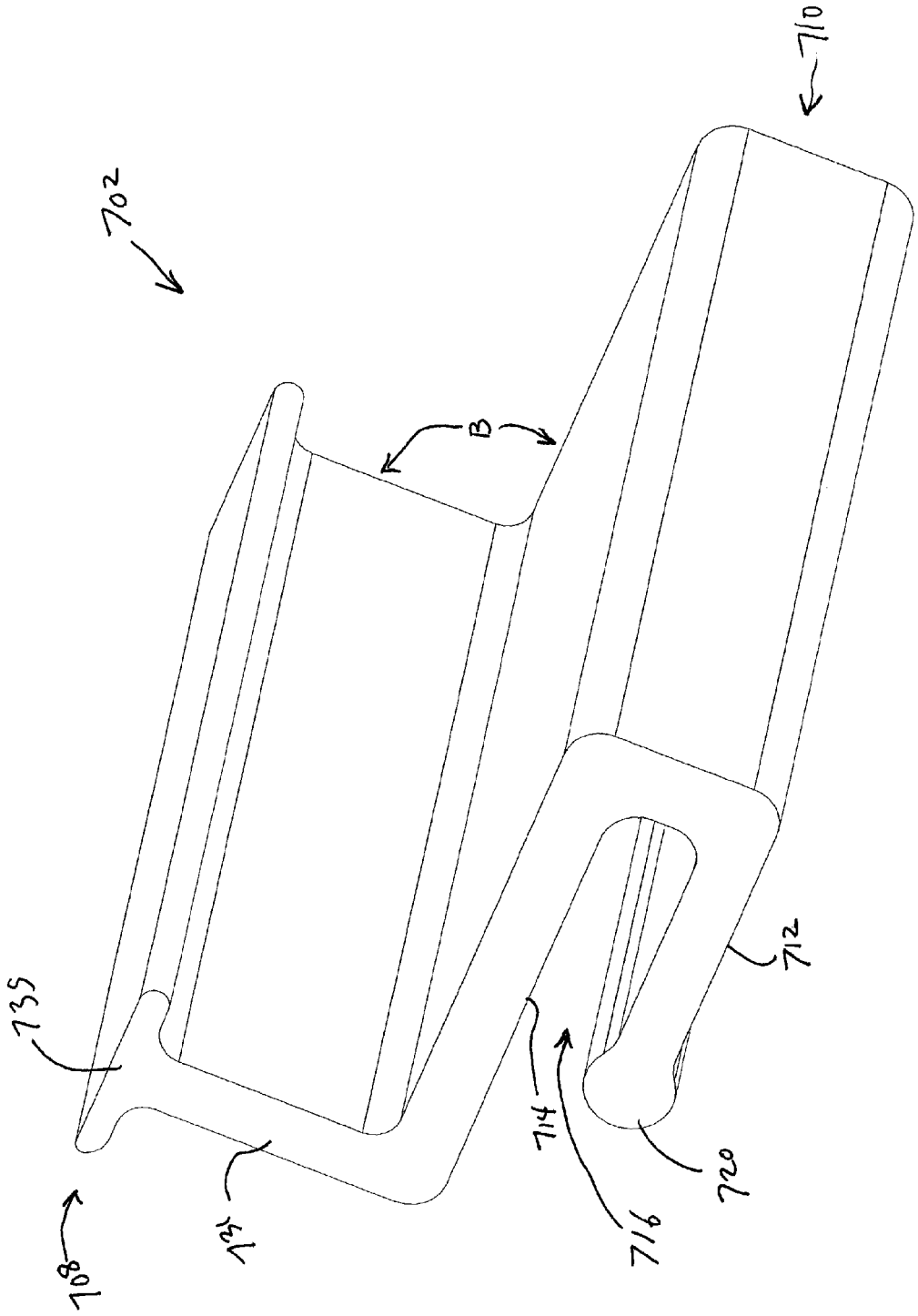

FIG. 55D

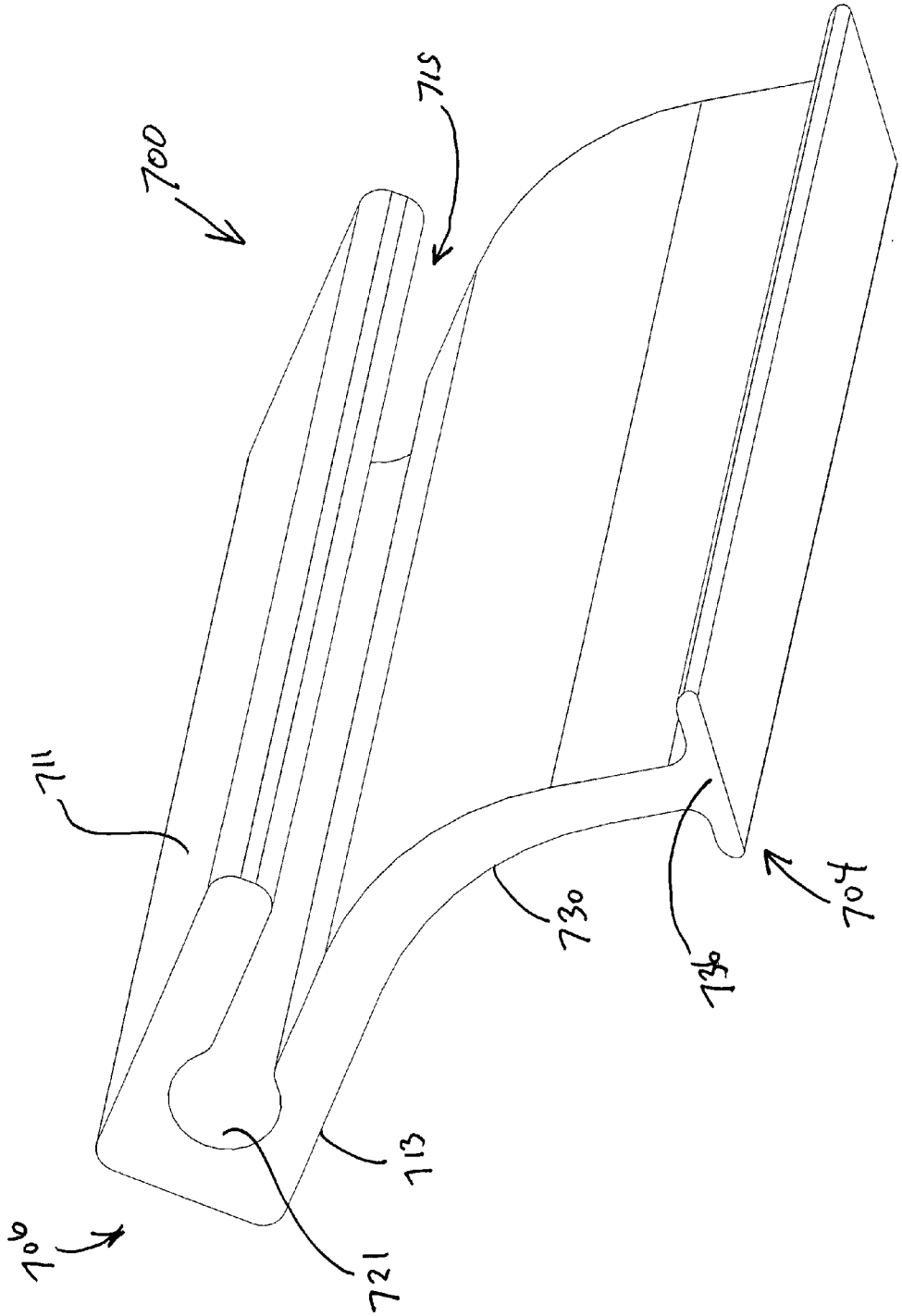

FIG. 55E

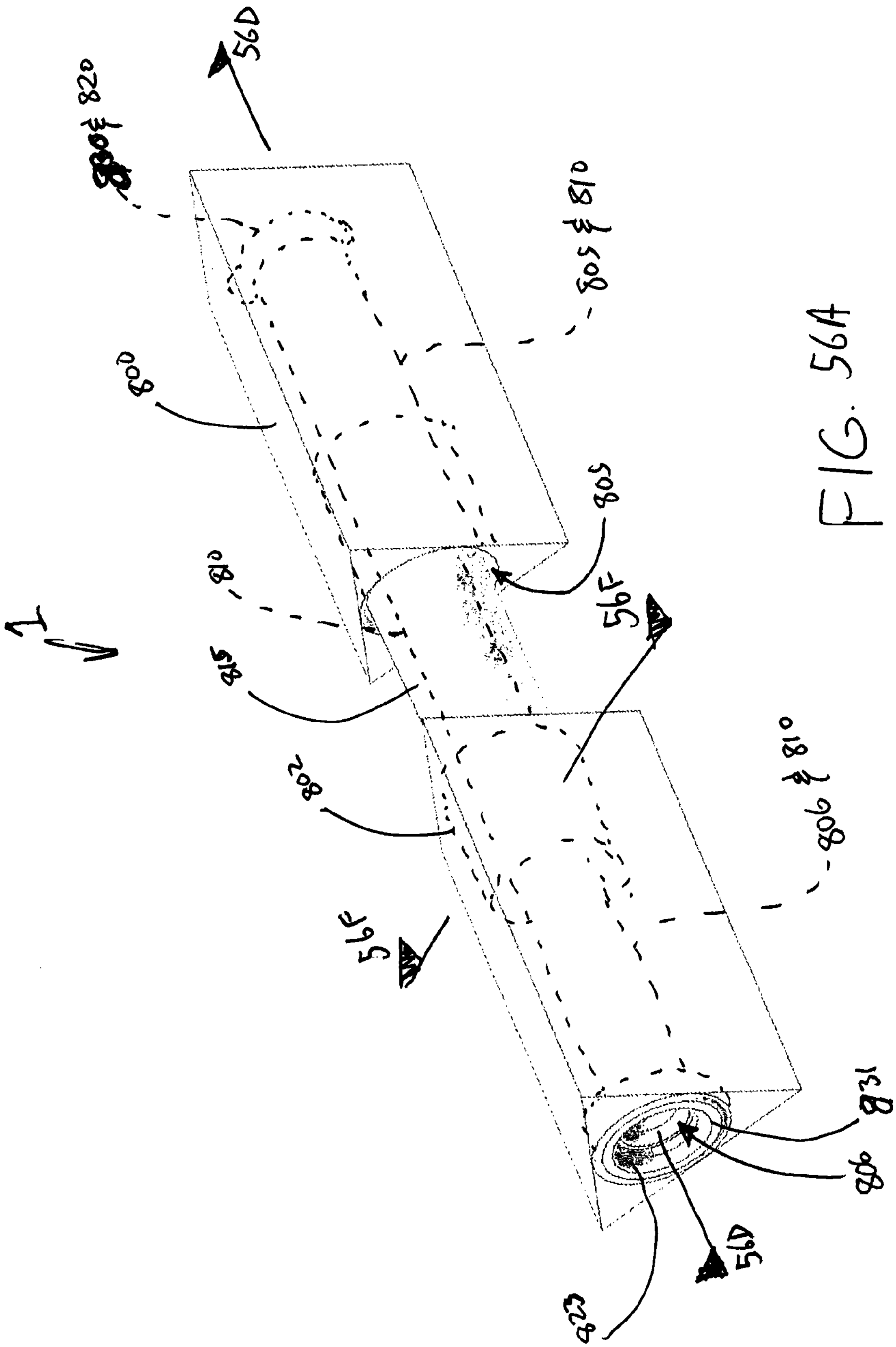

FIG. 56A

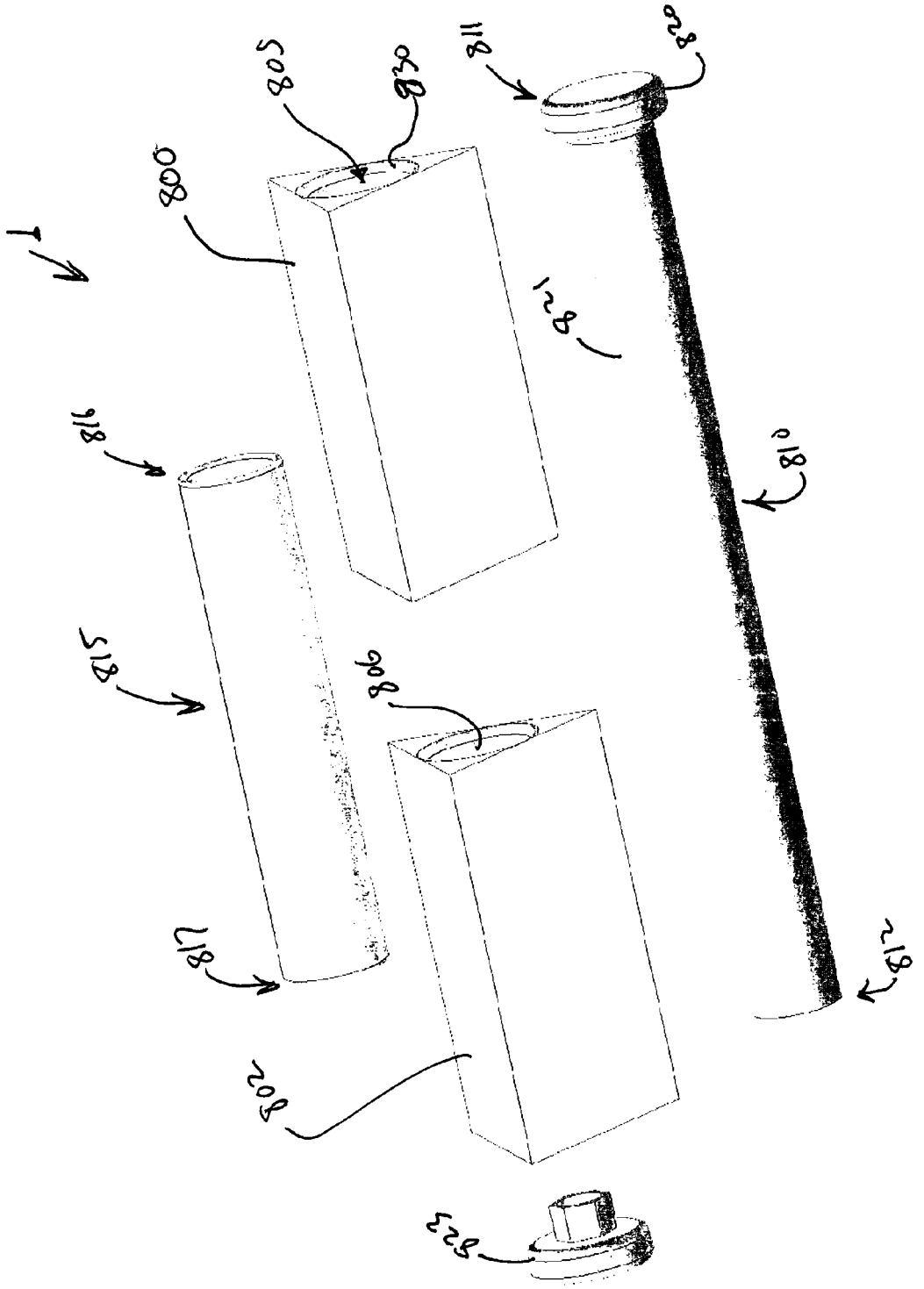

FIG. 56B

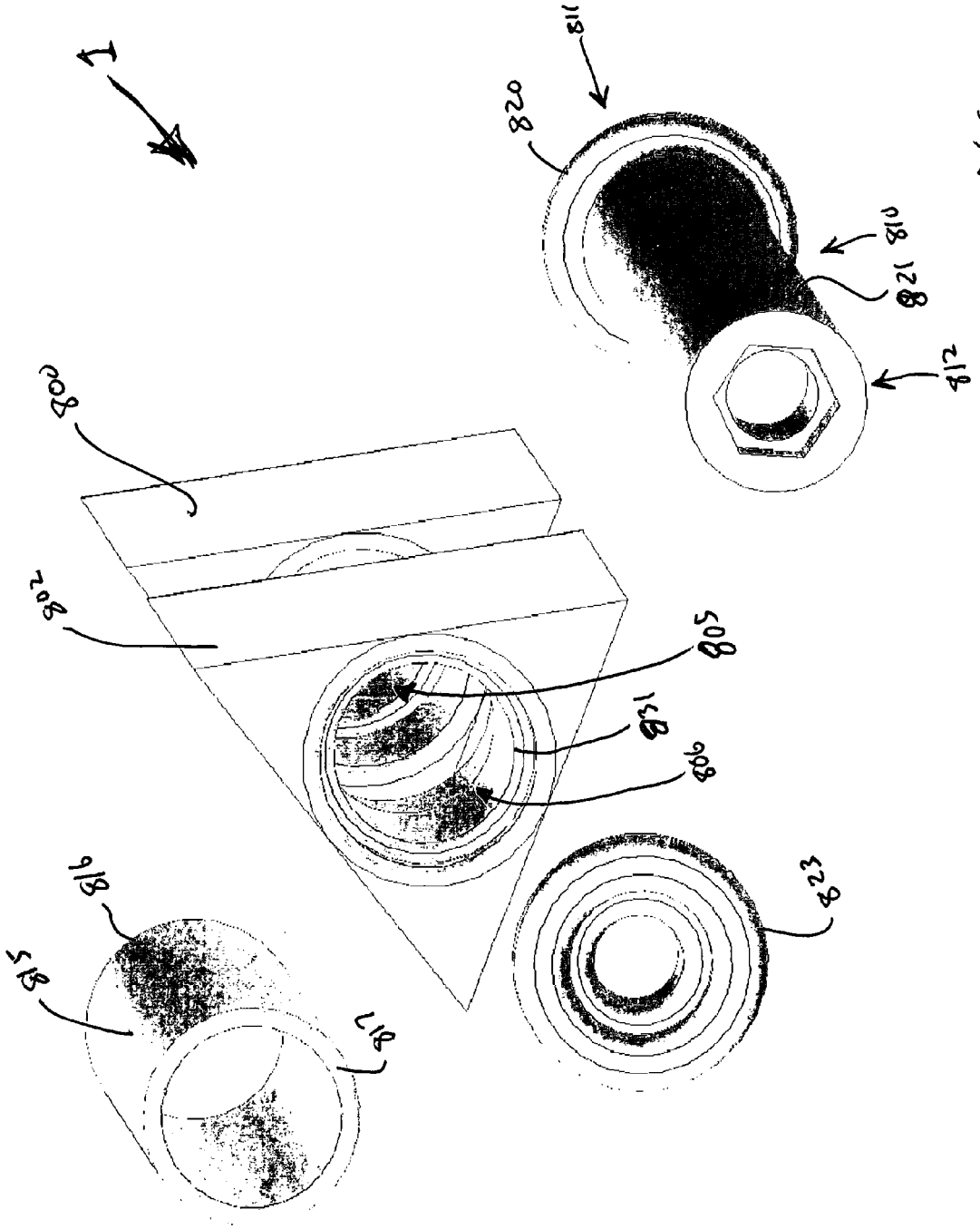

FIG. 56C

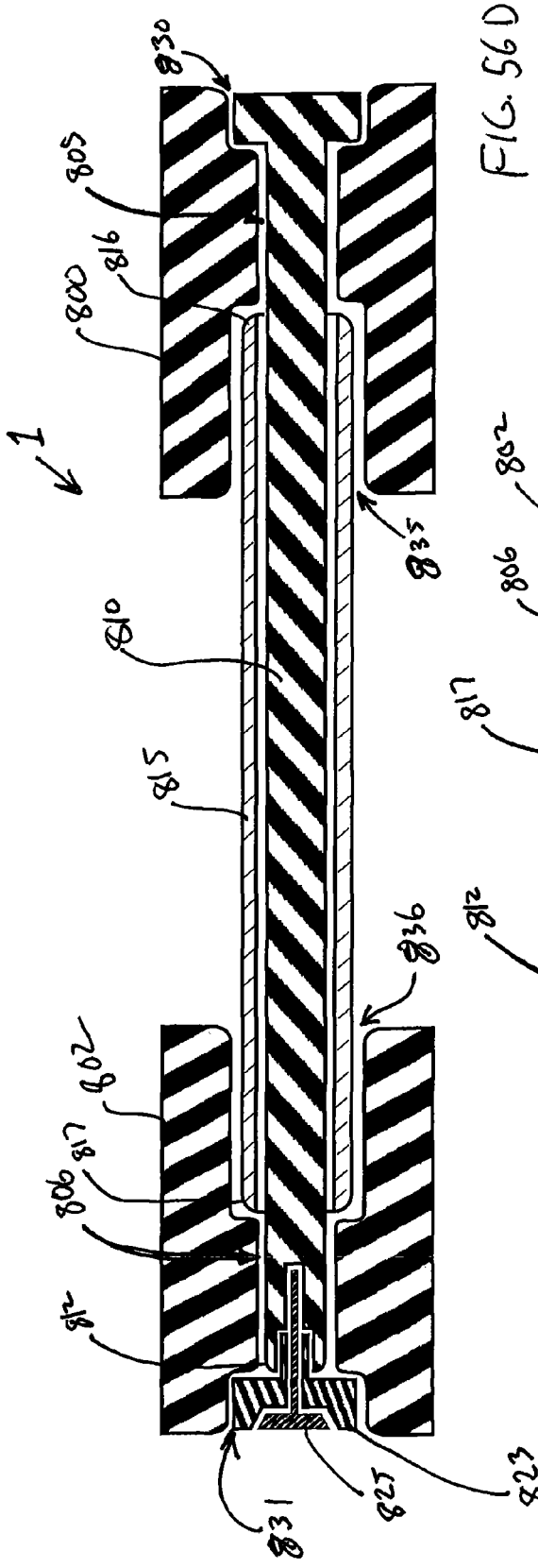

FIG. 56D

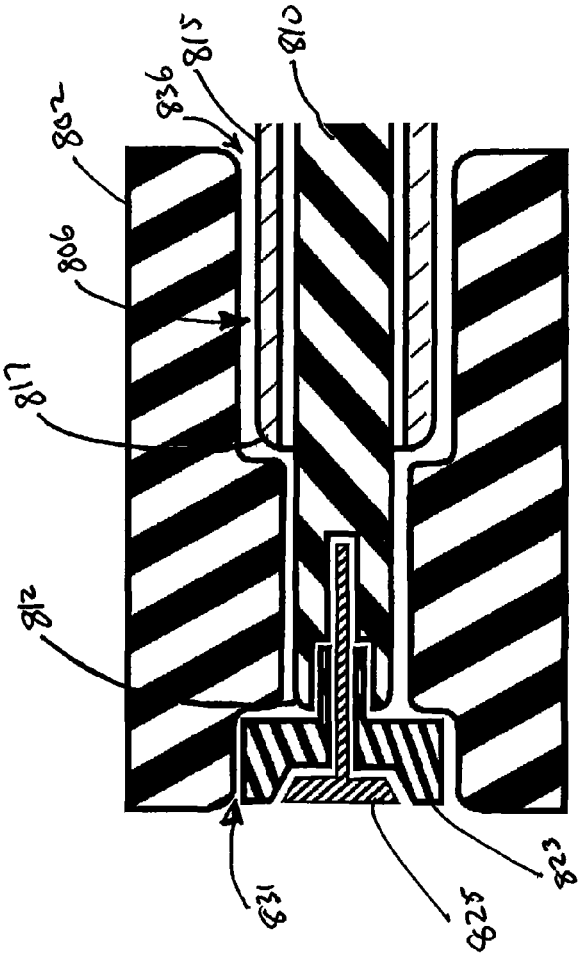

FIG. 56E

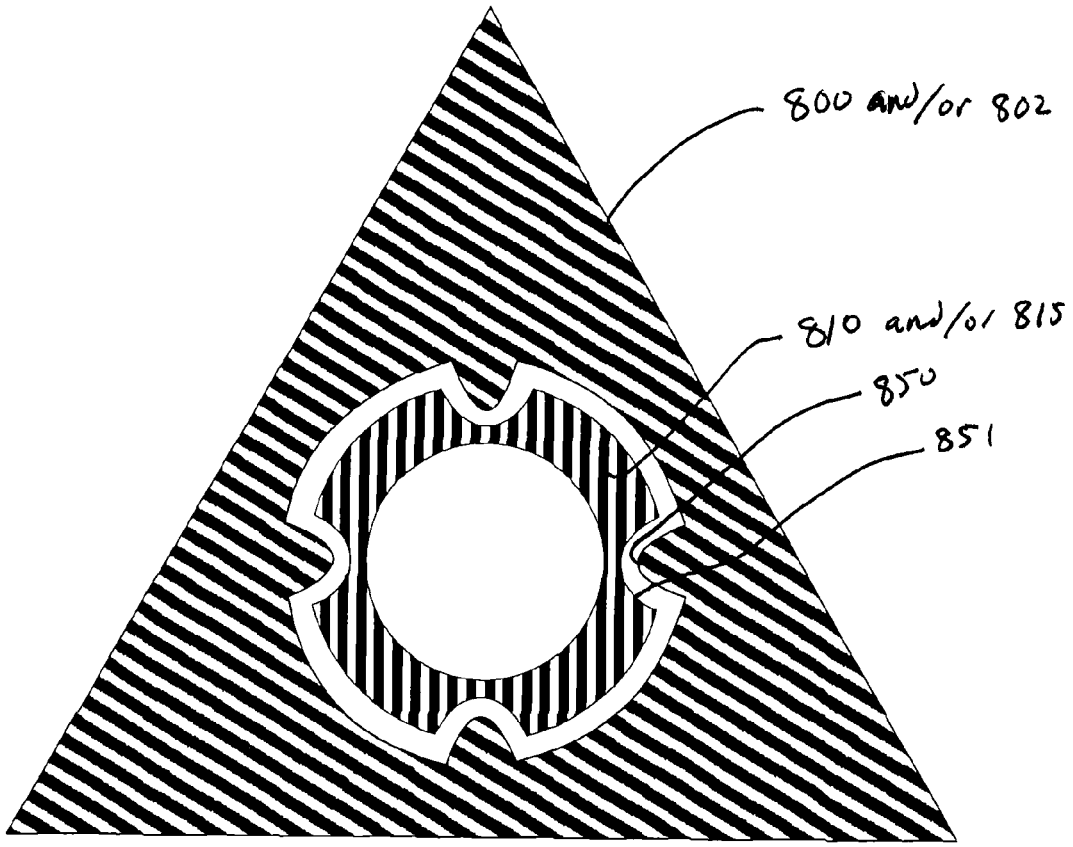

FIG. 56F

SACROILIAC JOINT IMPLANT SYSTEM

CROSS REFERENCE TO RELATED APPLICATIONS

This Patent Cooperation Treaty (PCT) patent application claims priority to and the benefit of U.S. Provisional Patent Application 61/520,956, which is entitled "Sacroiliac Joint Implant System" and was filed Jun. 17, 2011.

This PCT application is also a continuation-in-part (CIP) application of U.S. patent application Ser. No. 13/475,695 ("the '695 application"), which was filed May 18, 2012. The '695 application is a continuation-in-part (CIP) application of U.S. patent application Ser. No. 12/998,712 ("the '712 application"), which was filed May 23, 2011. The '712 application is the National Stage of International Patent Cooperation Treaty Patent Application PCT/US2011/000070 ("the '070 application"), which was filed Jan. 13, 2011. The '070 application claims the benefit of U.S. Provisional Patent Application 61/335,947, which was filed Jan. 13, 2010.

The present application is also a continuation-in-part (CIP) application of U.S. patent application Ser. No. 13/236,411, which is entitled "Systems for and Methods of Fusing a Sacroiliac Joint" and was filed Sep. 19, 2011.

All of the aforementioned applications are hereby incorporated by reference in their entireties into the present application.

FIELD OF THE INVENTION

A sacroiliac joint implant system that provides a sacroiliac joint implant and methods of placement of such implants in relation to a sacroiliac joint to facilitate stability while providing an amount of motion of the sacroiliac joint.

BACKGROUND

The sacroiliac joint is the joint between the sacrum and the ilium of the pelvis, which are joined by ligaments. In humans, the sacrum supports the spine and is supported in turn by an ilium on each side. The sacroiliac joint is a synovial joint with articular cartilage and irregular elevations and depressions that produce interlocking of the two bones.

Pain associated with the sacroiliac joint can be caused by traumatic fracture dislocation of the pelvis, degenerative arthritis, sacroiliitis, an inflammation or degenerative condition of the sacroiliac joint, osteitis condensans ilii, or other degenerative conditions of the sacroiliac joint. Currently, sacroiliac joint fusion is most commonly advocated as a surgical treatment for these conditions. Fusion of the sacroiliac joint can be accomplished by several different conventional methods. However, while each of these methods have been utilized for fixation and fusion of the sacroiliac joint over the past several decades, the methods to remove the painful degenerative aspects and to provide stability of the joint while allowing a degree of motion remains unresolved.

The sacroiliac joints are multi-planar, simultaneously rotating and translating along three axis of motion and can have six degrees of freedom secondary to the three angular and three linear motions occurring at each joint. Generally, rotation can range between about 0 to about 8 degrees. Generally, translation can range between about 0 and about 8 millimeters ("mm").

The inventive sacroiliac joint implant system described herein provides apparatuses and methods of placement of the apparatuses in relation to the sacroiliac joint which facilitate stability while allowing an amount of motion of the sacroiliac joint.

SUMMARY OF THE INVENTION

Accordingly, a broad object of the invention can be to provide an inventive implant to facilitate stabilization while allowing an amount of motion of a sacroiliac joint. Embodiments of the sacroiliac joint implant can provide an elongate body, which can further include at least one fixation member, or a pair of fixation members which extend a distance outward from the longitudinal axis of the implant body adapted for non-transverse placement between the articular surfaces of the sacroiliac joint, and as to certain embodiments can further provide a third fixation member and additionally a fourth fixation member each adapted to extend a distance outward from the elongate body into the bone of the sacrum or the ilium.

Another broad object of the invention can be to provide an inventive method to facilitate stabilization of the sacroiliac joint while allowing an amount of motion utilizing particular embodiments of the inventive sacroiliac implant. Particular embodiments of the inventive method can include the steps of performing a minimally invasive posterior surgery that allows access to the posterior aspect of the sacroiliac joint. A sufficient portion of the articular cartilage or tissue between the articular surfaces of the sacroiliac joint can be removed to allow placement of particular embodiments of the inventive sacroiliac implant between surfaces of the sacroiliac joint. As to particular embodiments, a portion of the subcondral bone of the sacroiliac joint can be removed to provide an implant receiving space in the plane of the sacroiliac joint configured to allow interference fitting of the elongate member, or the elongate member with at least a first radial member between the opposed surfaces of the implant receiving space. The inventive method can further include the step of providing the implant receiving space with one or more radial member receiving channels cut into the bone (including one or more of the subchondral, cortical, or cancellous) and thereby locating one or more radial members in the bone of the sacrum or the bone of the ilium.

Another broad object of the invention can be to provide a surface capable of osseointegration having a configuration which allows the bone of the sacrum or ilium to grow into the implant to facilitate fixation of the implant to the sacrum or the ilium.

Another broad object of the invention can be to provide particular embodiments of the inventive sacroiliac implant with an amount of curvature along the length of the implant which allows placement of embodiments of the sacroiliac implant which have an increased surface area which remain within or substantially within the articular portion of the sacroiliac joint.

Another broad object of the invention can be to provide particular embodiments of the inventive sacroiliac implant configured to allow placement of embodiments of the implant which have an increased surface area which remain within or substantially within the sacral fossa and iliac tuberosity portion of the sacroiliac joint.

Another broad object of the invention can be to provide particular embodiments of the inventive sacroiliac implant with a compressible element or elements which can receive, control or dissipate truncal loads.

Disclosed herein is a sacroiliac joint implant system for implantation in a sacroiliac joint space defined between an ilium and a sacrum. In one embodiment, the system includes an iliac member and a sacrum member. The iliac member includes an interface surface and a fixation surface generally opposite the interface surface. The fixation surface is configured to engage the ilium when the iliac member is implanted in the sacroiliac joint space. The sacrum member includes an interface surface and a fixation surface generally opposite the interface surface. The fixation surface is configured to engage the sacrum when the sacrum member is implanted in the sacroiliac joint space. When the iliac member and sacrum member are both implanted in the sacroiliac joint space such that the fixation surface of the ilium member engages the ilium, the fixation surface of the sacrum member engages the sacrum, and the iliac member and the sacrum member are located in the sacroiliac joint space immediately adjacent each other in an opposed fashion, the interface surface of the iliac member and the interface surface of the sacrum member are each configured so as to contact each other.

The interface surface of the iliac member and interface surface of the sacrum member may be both substantially planar and result in a sliding mating contact. At least one of the interface surface of the iliac member or the interface surface of the sacrum member may include a surface material that has at least one of high abrasion resistance or low coefficient of friction. For example, the surface material may include at least one of a ceramic, a polymer, Polyether ether ketone (PEEK), Polytetrafluoroethylene (PTFE), High-density polyethylene (HDPE), or Ultra High-density polyethylene (UHDPE).

The iliac member may further include at least one magnet at the interface surface of the iliac member and the sacrum member may further include at least one magnet at the interface surface of the sacrum member. At least one of the magnet of the iliac member and the at least one magnet of the sacrum member are arranged so as to draw the respective interface surfaces together. Alternatively, at least one of the magnet of the iliac member and the at least one magnet of the may be arranged to repel the respective interface surfaces away from each other.

The interface surface of the iliac member may include a first feature and interface surface of the sacrum member may include a second feature that engages the first feature to partially limit sliding of the sliding mating contact. Alternatively, the interface surface of the iliac member may include a first feature and interface surface of the sacrum member may include a second feature that engages the first feature so as to substantially, but not completely, limit movement between the iliac member and the sacrum member.

The sacrum member may be formed of a polymeric material and the second feature may have rigidity greater than a body portion of the sacrum member. The first feature may include a protrusion and the second feature may include a recess in which the protrusion is received, or the second feature may include a protrusion and the first feature may include a recess in which the protrusion is received. The protrusion may include a cylindrical element and the recess a channel element. The protrusion may include a guide element generally in the form of an elongated ridge and the recess an elongated channel element. The protrusion may include a convex surface and the recess a concave feature. The protrusion may include a generally T-shaped cross section transverse to a length of the protrusion, and the recess a generally T-shaped cross section transverse to a length of the recess.

The iliac member may have a curved length, and the sacrum member may have a curved length. At least one of the protrusion or recess may extend along the curved length of the iliac member, and at least one of the protrusion or recess may extend along the curved length of the sacrum member.

At least one of the fixation surface of the iliac member or the fixation surface of the sacrum member may include an outwardly projecting fixation member. The fixation member may include at least one of a longitudinally extending rib or a longitudinally extending member having a T-shaped transverse cross section.

Disclosed herein is another sacroiliac joint implant system for implantation in a sacroiliac joint space defined between an ilium and a sacrum. In one embodiment, the system includes a body and a fixation member. The body includes a longitudinal length extending between opposed extreme ends, opposed faces extending between the opposed extreme ends, and opposed sides separating the opposed faces and extending between the opposed extreme ends. The opposed faces are substantially wider than the opposed sides. The fixation member projects outwardly from each of the opposed faces and extends along the longitudinal length of the body.

The body may include a generally oval transverse cross section. At least one of the fixation members may have a transverse T-shaped cross section.

At least one of the fixation members may be separately formed from the body and mechanically coupled to the body via at least one of a grooved arrangement, an adhesive, or a weld. The separately formed fixation member may include a transverse I-shaped cross section and the grooved arrangement a slot defined in the body and including a transverse T-shaped cross section. One end of the transverse I-shaped cross section may be matingly received in the transverse T-shaped cross section.

The body may include a guide pin orifice extending longitudinally through the body to daylight at each of the opposed ends. The body and fixation members may curve along their respective longitudinal lengths. The body as defined by the opposed ends and opposed sides when viewed generally perpendicular to one of the opposed faces may have a generally rectangular shape. One of the opposed ends of the body may be tapered and the other of the opposed ends of the body may be configured to be coupled to a delivery device.

Each of the fixation members may include opposed ends, and one of the opposed ends may be tapered as compared to the other of the opposed ends. The implant may be segmented along its length into multiple distinct sections that can be assembled together in the sacroiliac joint space to form the implant.

Disclosed herein is yet another sacroiliac joint implant system for implantation in a sacroiliac joint space defined between an ilium and a sacrum. In one embodiment, the system includes an iliac member, a sacrum member, and a core element. The iliac member includes an interface surface and a fixation surface generally opposite the interface surface. The fixation surface is configured to engage the ilium when the iliac member is implanted in the sacroiliac joint space. The interface surface includes a recess. The sacrum member includes an interface surface and a fixation surface generally opposite the interface surface. The fixation surface is configured to engage the sacrum when the sacrum mem-

ber is implanted in the sacroiliac joint space. The interface surface includes a recess. The core element includes a first interface surface and a second interface surface opposite the first interface surface. The first interface surface includes a feature extending outwardly from the first interface surface. The second interface surface includes a feature extending outwardly from the second interface surface. When the system is assembled, the core element is sandwiched between the iliac member and sacrum member and the feature of the first interface surface of the core element is received in the recess of the interface surface of the iliac member and the feature of the second interface surface of the core element is received in the recess of the interface surface of the sacrum member.

When the system is assembled, the interface surface of the iliac member may be maintained in a spaced-apart relationship with the interface surface of the sacrum member. The interface surface of the iliac member may be generally a surface negative of the first interface surface of the core element such that a surface contour of the interface surface of the iliac member generally matingly engages and generally matches a surface contour of the first interface surface of the core element. The interface surface of the sacrum member may be generally a surface negative of the second interface surface of the core element such that a surface contour of the interface surface of the sacrum member generally matingly engages and generally matches a surface contour of the second interface surface of the core element.

The feature of the first interface surface may include a raised ridge, and the recess of the interface surface of the iliac member includes a channel that has a complementary shape to a shape of the feature of the first interface surface. The iliac member, sacrum member and core element may curve along their respective lengths. Each of the fixation surfaces may include a fixation member projecting outwardly and extending along the longitudinal length of the respective sacrum member or iliac member. The fixation member may include a ridge.

Disclosed herein is a method of treating a sacroiliac joint via implantation of an implant into a space of the sacroiliac joint. In one embodiment, the method includes: providing an iliac member including an interface surface and a fixation surface generally opposite the interface surface; providing a sacrum member including an interface surface and a fixation surface generally opposite the interface surface; delivering the iliac member into the sacroiliac joint space such that the fixation surface of the iliac member engages the ilium and the interface surface of the iliac member faces in the direction of the sacrum; delivering the sacrum member into the sacroiliac joint space such that the fixation surface of the sacrum member engages the sacrum and the interface surface of the sacrum member faces in the direction of the ilium; and engaging the interface surface of the iliac member with the interface surface of the sacrum member such that substantially restricted movement of the iliac member relative to the sacrum member is possible when both the iliac member and sacrum member are implanted in the sacroiliac joint space and the interface surfaces are engaged with each other.

The method may further include sandwiching a core element between the interface surface of the iliac member and the interface surface of the sacrum member, such a sandwiched arrangement being a mechanism for engaging the interface surface of the iliac member with the interface surface of the sacrum member. The interface surface of the iliac member may be maintained in a spaced-apart arrangement from the interface surface of the sacrum member when the core element is sandwiched between the interface surfaces and the interface surfaces are engaged with each other. The sandwiched arrangement may be established before the iliac member and sacrum member are delivered into the sacroiliac joint space. The sandwiched arrangement may be established after the iliac member and sacrum member are delivered into the sacroiliac joint space.

In engaging the interface surface of the iliac member with the interface surface of the sacrum member, the interfaces surfaces may make direct physical contact and a feature of one of the interface surfaces may be received in a feature of the other of the interface surfaces. The interface surface of the iliac member and interface surface of the sacrum member may be both substantially planar and result in a sliding mating contact. The interface surface of the iliac member may include a first feature, and interface surface of the sacrum member may include a second feature that engages the first feature to partially limit sliding of the sliding mating contact. Alternatively, the interface surface of the iliac member may include a first feature and interface surface of the sacrum member may include a second feature that engages the first feature so as to substantially, but not completely, limit movement between the iliac member and the sacrum member.

The first feature may include a protrusion and the second feature a recess in which the protrusion is received, or the second feature may include a protrusion and the first feature a recess in which the protrusion is received. The protrusion may include a cylindrical element and the recess a channel element. The protrusion may include a guide element generally in the form of an elongated ridge and the recess an elongated channel element. The protrusion may include a convex surface and the recess a concave feature. The protrusion may include a generally T-shaped cross section transverse to a length of the protrusion, and the recess a generally T-shaped cross section transverse to a length of the recess. The iliac member may have a curved length, and the sacrum member a curved length. At least one of the protrusion or recess may extend along the curved length of the iliac member, and at least one of the protrusion or recess along the curved length of the sacrum member.

At least one of the fixation surface of the iliac member or the fixation surface of the sacrum member may include an outwardly projecting fixation member. The fixation member may include at least one of a longitudinally extending rib or a longitudinally extending member having a T-shaped transverse cross section.

The engagement of the interface surface of the iliac member with the interface surface of the sacrum member may be established before the iliac member and sacrum member are delivered into the sacroiliac joint space. Alternatively, the engagement of the interface surface of the iliac member with the interface surface of the sacrum member may be established after the iliac member and sacrum member are delivered into the sacroiliac joint space. The limited movement between the iliac member and the sacrum member may allow for at least one of a rocking or sliding between the iliac member and the sacrum member.

Disclosed herein is a method of treating a sacroiliac joint via implantation of an implant into a space of the sacroiliac joint. In one embodiment, the method includes: positioning a generally empty balloon in the sacroiliac joint space; filling the positioned balloon with a curable biomaterial such that the balloon expands to fill at least a portion of the sacroiliac joint space to substantially restore a desired anatomy of the sacroiliac joint space; and allowing the

biomaterial to cure. The cured biomaterial may exhibit elastic properties when submitted to forces present in the sacroiliac joint space.

The balloon may be constructed in two layers. For example, an outer of the two layers may be configured to facilitate tissue ingrowth into the outer of the two layers.

The outer layer of the balloon may include a sacrum face, an ilium face and intermediate regions extending between the sacrum face and the ilium face. The sacrum face and ilium face may be configured to facilitate tissue ingrowth and the intermediate regions configured to inhibit tissue ingrowth.

Disclosed herein is yet another sacroiliac joint implant system for implantation in a sacroiliac joint space defined between an ilium and a sacrum. In one embodiment, the system includes an iliac member, a sacrum member, and a delivery tool. The iliac member includes an interface surface, a fixation surface generally opposite the interface surface, and a threaded bore near a proximal end of the iliac member. The fixation is configured to engage the ilium when the iliac member is implanted in the sacroiliac joint space. The sacrum member includes an interface surface, a fixation surface generally opposite the interface surface, and a threaded bore near a proximal end of the sacrum member. The fixation surface is configured to engage the sacrum when the sacrum member is implanted in the sacroiliac joint space. The interface surface of the sacrum member is configured to engage the interface surface of the iliac member. The delivery tool includes an implant retainer having a drive shaft, a first shaft distally terminating in a first threaded distal end, and a second shaft distally terminating in a second threaded distal end. Rotation of the drive shaft causes the first and second shafts to rotate oppositely from each other. Rotation of the drive shaft in a first direction causes the first and second threaded distal ends to respectively threadably engage with the threaded bore of the sacrum member and threaded bore of the ilium member.

Naturally, further objects of the invention are disclosed throughout other areas of the specification, drawings, photographs, and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a particular embodiment of the sacroiliac joint implant.

FIG. **2** is a first end view of the particular embodiment of the sacroiliac joint implant shown in FIG. **1**.

FIG. **3** is a side view of the particular embodiment of the sacroiliac joint implant shown in FIG. **1**.

FIG. **4** is a second end view of the particular embodiment of the sacroiliac joint implant shown in FIG. **1**.

FIG. **5** is a first end view of a particular embodiment of the sacroiliac joint implant.

FIG. **6** is a side view of the particular embodiment of the sacroiliac joint implant shown in FIG. **5**.

FIG. **7** is a second end view of the particular embodiment of the sacroiliac joint implant shown in FIG. **5**.

FIG. **8** is a perspective view of a fixation member removably insertable into the embodiment of the sacroiliac joint implant shown in FIG. **5**.

FIG. **9** is a first end view of the particular embodiment of the sacroiliac joint implant shown in FIGS. **5-7** coupled to the fixation member shown in FIG. **8**.

FIG. **10** is a second end view of the particular embodiment of the sacroiliac joint implant shown in FIGS. **5-7** coupled to the fixation member shown in FIG. **8**.

FIG. **11** is a perspective view of another particular embodiment of the sacroiliac joint implant.

FIG. **12** is a top view of the particular embodiment of the sacroiliac joint implant shown in FIG. **11**.

FIG. **13** is a first end view of the particular embodiment of the sacroiliac joint implant shown in FIG. **11**.

FIG. **14** is a side view of the particular embodiment of the sacroiliac joint implant shown in FIG. **11**.

FIG. **15** is a second end view of the particular embodiment of the sacroiliac joint implant shown in FIG. **11**.

FIG. **16** is a perspective view of a particular embodiment of a sacroiliac joint implants disposed in a plurality of segments.

FIG. **17** is a perspective view of a particular embodiment of a sacroiliac joint implant having a sacral member which matably engages an iliac member.

FIG. **18** is a first end view of the particular embodiment of a sacroiliac joint implant shown in FIG. **17** having the sacral member matably engaged to the iliac member.

FIG. **19** is a second end view of the particular embodiment of a sacroiliac joint implant shown in FIG. **17** having the sacral member matably engaged to the iliac member.

FIG. **20** is a first side view of the sacral member showing a sacral member interface surface.

FIG. **21** is a first side view of the iliac member showing an iliac member interface surface.

FIG. **22** is a second side view of the sacral member showing sacral member fixation surface.

FIG. **23** is a second side view of the iliac member showing iliac member fixation surface.

FIG. **24** is a perspective view of a particular embodiment of a sacroiliac joint implant having a sacral member which matably engages an iliac member.

FIG. **25** is a perspective view of the particular embodiment of a sacroiliac joint implant shown in FIG. **24** having the sacral member matably engaged to the iliac member.

FIG. **26** is a first end view of the particular embodiment of a sacroiliac joint implant shown in FIG. **24** having the sacral member matably engaged to the iliac member.

FIG. **27** is a side view of the particular embodiment of a sacroiliac joint implant shown in FIG. **24** having the sacral member matably engaged to the iliac member.

FIG. **28** is a second end view of the particular embodiment of a sacroiliac joint implant shown in FIG. **24** having the sacral member matably engaged to the iliac member.

FIG. **29** is a cross section **29-29** shown in FIG. **25** of the particular embodiment of a sacroiliac joint implant shown in FIG. **24** having the sacral member matably engaged to the iliac member.

FIG. **30** is a perspective view of a particular embodiment of a sacroiliac joint implant having a sacral member which matably engages an iliac member.

FIG. **31** is a perspective view of the particular embodiment of a sacroiliac joint implant shown in FIG. **30** having the sacral member matably engaged to the iliac member.

FIG. **32** is a second end view of the particular embodiment of a sacroiliac joint implant shown in FIG. **30** having the sacral member matably engaged to the iliac member.

FIG. **33** is a side view of the particular embodiment of a sacroiliac joint implant shown in FIG. **30** having the sacral member matably engaged to the iliac member.

FIG. **34** is a first end view of the particular embodiment of a sacroiliac joint implant shown in FIG. **30** having the sacral member matably engaged to the iliac member.

FIG. **35** is a cross section **35**-**35** shown in FIG. **33** of the particular embodiment of a sacroiliac joint implant shown in FIG. **30** having the sacral member matably engaged to the iliac member.

FIG. **36** is an exploded perspective view of a particular embodiment of a sacroiliac joint implant having a sacral member which matably engages an iliac member.

FIG. **37** is a perspective view of the particular embodiment of a sacroiliac joint implant shown in FIG. **36** having the sacral member matably engaged to the iliac member.

FIG. **38** is a first end view of the particular embodiment of a sacroiliac joint implant shown in FIG. **36** having the sacral member matably engaged to the iliac member.

FIG. **39** is a side view of the particular embodiment of a sacroiliac joint implant shown in FIG. **36** having the sacral member matably engaged to the iliac member.

FIG. **40** is a second end view of the particular embodiment of a sacroiliac joint implant shown in FIG. **36** having the sacral member matably engaged to the iliac member.

FIG. **41** is a cross section **41**-**41** of the particular embodiment of a sacroiliac joint shown in FIG. **37** having the sacral member engaged to the iliac member having a core element disposed between.

FIG. **42**A is a cutaway view of the sacroiliac joint showing placement of a particular embodiment of the sacroiliac joint implant implanted between the articular surfaces of the sacroiliac joint.

FIG. **42**B is an enlarged cutaway view of FIG. **42**A showing placement of a particular embodiment of the sacroiliac joint implant implanted between the articular surfaces of the sacroiliac joint.

FIG. **42**C is a cross section **42**C-**42**C shown in FIG. **42**B showing placement of a particular embodiment of the sacroiliac joint implant between the articular surfaces of the sacroiliac joint or within an implant receiving space established between the articular surfaces of the sacroiliac joint.

FIG. **43** is a side view of the ilium with the articular region shown bounded by broken line showing placement of an embodiment of the sacroiliac joint implant in the cranial portion of the articular region between the articular surfaces of the sacroiliac joint.

FIG. **44** is a side view of the ilium with the articular region shown bounded by broken line showing placement of an embodiment of the sacroiliac joint implant in the caudal portion of the articular region between the articular surfaces of the sacroiliac joint.

FIG. **45** is a side view of the ilium with the articular region shown bounded by broken line showing placement of an embodiment of the sacroiliac joint implant in both the cranial portion and caudal portions of the articular region between the articular surfaces of the sacroiliac joint.

FIG. **46** is a side view of the ilium with the articular region shown bounded by broken line showing placement of an embodiment of the sacroiliac joint implant both within and without the articular region and engaging both the articular surfaces and the extra-articular surfaces of the sacroiliac joint.

FIG. **47** is a side view of the ilium with the articular region shown bounded by broken line showing placement of an embodiment of the sacroiliac joint implant outside of the articular region and engaging only the extra-articular surfaces of the sacroiliac joint.

FIG. **48**A is an isometric view of an embodiment of a system for treating a sacroiliac joint.

FIG. **48**B is the same view as FIG. **48**A, except the delivery tool and implant assembly are decoupled from each other.

FIG. **49** is the same view as FIG. **48**A, except the system is exploded to better illustrate its components.

FIG. **50** is an exploded isometric view of the implant retainer and implant indicated in FIG. **49**.

FIG. **51** is an isometric view of the implant retainer coupled to a proximal end of the implant.

FIG. **52** is the same view as FIG. **51**, except the frame and drive shaft of the implant retainer are hidden for clarity purposes.

FIG. **53** is the same view as FIG. **51**, except the implant retainer is hidden for clarity purposes.

FIG. **54**A is an isometric view of the delivery tool.

FIG. **54**B is an isometric view of the delivery tool in an exploded state.

FIG. **54**C is an isometric view of the handle.

FIG. **54**D is an exploded isometric view of the retaining collar and handle shown in longitudinal cross section.

FIG. **54**E is a longitudinal cross section of the delivery tool when assembled as shown in FIG. **54**A.

FIGS. **55**A and **55**B are isometric views of an embodiment of the implant wherein the implant includes an iliac member and a sacrum member configured for overlapping, interlocking attachment with each other.

FIG. **55**C is a distal end view of the implant of FIGS. **55**A and **55**B.

FIG. **55**D is an isometric view of the sacrum member of the implant of FIGS. **55**A and **55**B.

FIG. **55**E is an isometric view of the ilium member of the implant of FIGS. **55**A and **55**B.

FIG. **56**A is an isometric view of an implant configured for transverse implantation across a sacroiliac joint.

FIGS. **56**B and **56**C are exploded isometric views of the implant of FIG. **56**A.

FIG. **56**D is a longitudinal cross sectional elevation of the implant as taken along section line **56**D-**56**D in FIG. **56**A.

FIG. **56**E is an enlarged view of one end of the cross section of FIG. **56**D.

FIG. **56**F is a transverse cross sectional elevation of the implant as taken along section line **56**F-**56**F in FIG. **56**A.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Generally, a sacroiliac joint implant system that provides embodiments of a sacroiliac joint implant and methods of placing the sacroiliac joint implant in relation to a sacroiliac joint to facilitate stabilization and allow an amount of motion of the sacroiliac joint.

Now referring primarily to FIGS. **1**-**16**, a non-limiting embodiment of an inventive sacroiliac joint implant (**1**) is shown which in part can include a first implant body (**2**). The first implant body (**2**) can have a generally rectangular configuration in plan view (see as a non-limiting example FIG. **3**) and can have a generally oval or ellipsoidal configuration in end view (see as a non-limiting example FIGS. **42**A-C). The first implant body (**2**) can have a configuration of sufficient dimensional relations to allow non-traverse placement between the surfaces of an ilium (**3**) and a sacrum (**4**) (see as non-limiting examples FIGS. **42**A through **42**C) and which avoid deformation under the normal forces of surgical placement and stabilization of the ilium (**3**) in relation to the sacrum (**4**). A particular non-limiting embodiment of the first implant body (**2**) shown in FIGS. **1**-**4** can, depending on the application, have a length disposed between a first implant end (**5**) and a second implant end (**6**) in the range of about 3 cm and about 6 cm and a width disposed between a first implant side (**7**) and a second

implant side (**8**) in the range of about 2 cm and about 4 cm and a height disposed between a first implant face (**9**) and a second implant face (**10**) in the middle of the first implant body (**2**) of about 0.75 cm and about 1.5 cm. Additionally, while the embodiment of the implant body (**2**) of the sacroiliac joint implant (**1**) shown in FIGS. **1-4** can be generally oval or ellipsoidal in end view or cross section; the invention is not so limited, and the first implant body (**2**) can have any of a numerous and varied configurations in cross section across the longitudinal axis (**11**) consistent with the method herein after described such as oval, triangular, rectangular, square, diamond, or the like.

Now referring primarily to FIGS. **11-16** and **45**, particular embodiments of the first implant body (**2**) can further provide an amount of curvature (**15**) between the first implant end (**5**) and the second implant end (**6**). The amount of curvature (**15**) sufficient to allow placement of the first implant body (**2**) non-transversely between the articular surfaces (**16**) (see for example FIG. **45**) of the sacrum (**4**) and the ilium (**3**), as further described below.

Embodiments of the first implant body (**2**) can further include an axial bore (**12**) that bounds an axial pathway (**13**) which communicates between a first implant end (**5**) and a second implant end (**6**). The axial bore (**12**) can allow sliding engagement of a guide pin (**14**) (or other guide member) within the axial pathway (**13**) to facilitate insertion and placement of the sacroiliac joint implant (**1**) between the surfaces of the ilium (**3**) and the sacrum (**4**), as further described below.

Again referring primarily to FIG. **16**, particular embodiments of the first implant body (**1**) can be provided as two or more implant body segments (**17**), each of the implant body segments implanted separately between the sacrum (**4**) and the ilium (**3**) to collectively stabilize the sacrum (**4**) in relation to the ilium (**3**).

Again referring primarily to FIGS. **1-4** and **11-16**, embodiments of the sacroiliac joint implant (**1**) can further include one or more fixation members (**18**) coupled to the external surface of the implant body (**2**). As to certain embodiments of the first implant body (**2**), the one or more fixation members (**18**) can include a corresponding one or more projection elements (**19**) which can extend along a part of or substantially along the entire length of the implant body (**2**) substantially aligned with the longitudinal axis (**11**) (as shown for example in FIGS. **1** through **7**) or generally along the implant body mid-line (**20**) corresponding to the amount of curvature (**15**) of the implant body (**2**), (as shown in FIGS. **11** through **16**). As to other embodiments of the implant body (**2**), the projection elements (**19**) can extend outward from the external surface of implant body (**2**) and terminate in an enlarged terminal member (**21**). The terminal element (**21**), as shown in FIGS. **1** through **4**, can be configured as a generally rectangular volume to which the projection element (**19**) couples to a first side (**22**) substantially along the terminal element longitudinal midline (**23**); however, the invention is not so limited and the terminal element (**21**) can be configured in cross section generally perpendicular to the terminal element midline (**23**) as a circle, rectangle, dovetail, oval, or the like.

Again referring to FIGS. **1-4** and FIGS. **42**A through **42** C, a particular embodiment of the first implant body (**2**) can have a pair of fixation members (**18**) which can function to correspondingly engage the bone of the sacrum (**4**) and the ilium (**3**), as further described below. Understandably, particular embodiments of the first body (**2**) can have one fixation member (**18**) which can correspondingly engage only the bone of the sacrum (**4**) or the ilium (**3**). Certain embodiments of the first implant body (**2**), do not have any fixation members (**18**) and can be non-transversely placed between surfaces of the ilium (**3**) and sacrum (**4**).

Now referring primarily to FIGS. **5** through **7**, certain embodiments of the sacroiliac joint implant (**1**) provide a second implant body (**24**) which can be but is not necessarily similar in configuration to the first implant body (**2**). The second implant body (**24**) can provide a fixation member receiving channel (**25**) disposed in the external surface thereof, typically either in the first implant face (**9**) or in the second implant face (**10**). The fixation member receiving channel (**25**) can be configured to slidably matingly engage a fixation member (**18**) of the first implant body (**2**). In accordance with the example of FIGS. **1** through **7**, the fixation member (**18**) extending from the external surface of the first implant body (**2**) has a projection element (**19**) and a terminal member (**20**) configured in a T shape. The fixation member receiving channel (**25**) of the second implant body (**24**) can correspondingly provide a T shape channel which communicates with the external surface of the second implant body (**24**) to provide a slot (**28**) in which the projection element (**19**) of the fixation member (**18**) of the first implant body passes through in sliding engagement with the second implant body (**24**) to dispose the first or second face (**9**)(**10**) of the first implant body (**2**) and the first or second face (**9**)(**10**) of the second implant body (**24**) in opposed adjacent relation. A greater or lesser distance between the faces (**9**)(**10**) of the first and second implant bodies (**2**)(**24**) can be established by a correspondingly varying the projection member height (**29**). The fixation member receiving channel (**25**) can be open at a first channel end (**26**) and closed at a second channel end (**27**) such that the fixation member (**18**) advances a limited distance within fixation member receiving channel (**25**).

The amount of movement whether in a first, second, or third axis between the first implant body (**2**) and the second implant body (**24**) can be adjusted by alteration of the configuration of the fixation member (**18**) and the fixation member receiving channel (**25**). Accordingly, upon placement of the coupled first implant body (**2**) and the second implant body (**24**) between the sacrum (**4**) and ilium (**3**), the first implant body (**2**) and the second implant body (**24**) as constrained by placement between the sacrum (**4**) and the ilium (**3**) can have an amount of movement in relation to each other. Alternatively, movement can be permitted by configuring the first implant body (**2**) and the second implant body (**24**) by selecting a material which exhibits elastic properties under the normal forces present at the sacroiliac joint. Furthermore, fixation member (**18**) may also be constructed of a similar material or alternatively a metal may be selected which can be more readily adapted for osseointegration with either the sacrum (**4**) or ilium (**3**).

Now referring primarily to FIGS. **8-10**, particular embodiments of the second implant body (**24**) can further provide a fixation member (**18**) which can be inserted, whether removably, nonremovably, slidably, stepwise or forced inward against resisting elements, into the fixation member receiving channel (**25**). The fixation member (**18**) can provide the projection element (**19**) having the terminal element (**21**) coupled to a first edge (**40**) as above described and can further provide a channel insertion element (**39**) which couples to the second edge (**41**) of the projection element (**19**). The channel insertion element (**39**) can be configured to engage the fixation member receiving channel (**25**) as above described to provide a second implant body (**24**) having a fixation member (**18**) extending outward from the external surface of the second implant body (**24**) which can

upon placement between the sacrum (**4**) and the ilium (**3**) correspondingly engage the bone of the sacrum (**4**) or the ilium (**3**). Alternately, the second implant body (**24**) having the fixation member (**18**) coupled can function as the first implant body (**2**) and the extending fixation element (**18**) can be coupled within the fixation member receiving channel (**25**) of a second implant body (**24**), thereby each of the first implant body (**2**) and the second implant body (**24**) can move in relation to one another.

As a non-limiting example, the first implant body (**2**) and the second implant body (**24**) and the fixation member (**18**) can be fabricated, formed or molded from a material such as HYDRAFLEX available from Raymedica Inc., 9401 James Avenue South, Suite 120, Minneapolis, Minn. 55431.

As another non-limiting example, the first implant body (**2**) and the second implant body (**24**) and the fixation member (**18**) can be configured as a material which exhibits controlled and consistent bulk and surface properties such as polymeric material CADISC or similar material by using proprietary precision polyurethane manufacturing technology available from Ranier Technology Limited, Greenhouse Park Innovation Centre, Newmarket Road, Teversham, Cambridge, CB5 8AA, U.K.

As another non-limiting example, the first implant body (**2**) and the second implant body (**24**) and the fixation member (**18**) can be fabricated, formed or molded from a material with biomimetic three-dimensional fabric with multiaxial fiber alignment such as FABRICUBE® by Takiron Co., Ltd., 3-13, Azuchimachi 2-chome, Chuo-ku, Osaka, 541-0052, Japan.

As another non-limiting example, the first implant body (**2**) and the second implant body (**24**) can be configured to have a surface, or a portion thereof, with a low coefficient of friction, on which a sacrum or ilium can articulate, and can be fabricated, formed or molded from a material such as PEEK, polyethylene, a ceramic or the like. Additionally, the first implant body (**2**) and the second implant body (**24**) can be configured to have a surface, or a portion thereof, coated in a chemical or biological substance or a combination thereof, which promotes the development of cartilage in order to provide a surface on a portion of a sacrum (**4**) or an ilium (**3**) with a low coefficient of friction on which the implant body may articulate, such as NUQU, which is composed of culture-expanded juvenile cartilage cells in a protein-based carrier, available from Isto Technologies, Inc., 1155 Olivette Executive Parkway, Suite 200, St. Louis, Mo. 63132, USA.

As another non-limiting example, the first implant body (**2**) and the fixation member (**18**) can be fabricated, formed or molded from a material by a method including the steps of providing, inserting, and positioning a device that includes an inflatable balloon which can be configured or adapted to non-transversely locate between the articular surfaces (**16**) or extra-articular surfaces (**52**) of the sacroiliac joint (**47**) or within an implant receiving space (**50**) surgically produced as further described below. Once positioned, the balloon can be filled with a curable biomaterial until the balloon expands to the desired size and dimensions, thereby transforming or already in the form of the first implant body (**2**) and the fixation member (**18**), whereupon the biomaterial is then permitted to fully cure in situ to form a final prosthesis having the aforementioned desired geometry and dimensions to substantially provide or restore the desired anatomy and function of the sacroiliac joint. The balloon can be fabricated as one layer or as two-layers and can be constructed as disclosed in WO/2002/017825. Likewise, a desirable curable biomaterial is also disclosed in the aforementioned reference. The desirable curable biomaterial selected exhibits elastic properties when submitted to the forces present in the joint. In embodiments where the balloon is constructed in two layers, the outer layer, or a portion thereof, may be configured for tissue ingrowth to fixate a first implant face (**9**) and a second implant face (**10**) to the sacrum (**4**) and ilium (**3**) while configuring the outer layer of a first implant side (**7**) and a second implant side (**8**) to inhibit bone ingrowth or ongrowth to prohibit potentially motion inhibiting bone bridging between the sacrum (**4**) and ilium (**3**). The inner layer of the balloon can be configured to contain the curable biomaterial. Consequently, the balloon and cured biomaterial selected can permit motion at the joint.

The various embodiments of the invention as exemplified by FIGS. **1** through **16**, can provide a sufficient amount of surface area engageable with the corresponding surfaces of the bone of the sacrum (**4**) and ilium (**5**) upon implantation to substantially immobilize the sacrum (**4**) in relation to the ilium (**5**) or stabilize the sacrum (**4**) in relation to the ilium (**3**) while providing limited movement between mated parts of the implant embodiments to provide a corresponding limited movement of the sacrum (**4**) in relation to the ilium (**3**).

Again referring primarily to FIGS. **1** through **16**, particular embodiments of the sacroiliac joint implant (**1**) can further include one or more aperture elements (**30**) which communicate between the opposed sides (**22**)(**31**) of the terminal member (**21**) or communicate between opposed sides (**32**)(**33**) of the projection member (**19**) or both. The amount of open space (**34**) of an aperture element (**30**) can be defined by an aperture perimeter (**35**) which can be of numerous and varied configurations of sufficient dimension to allow the bone of the ilium (**3**) or sacrum (**4**)(or both) to grow a distance into or through or fuse within or fuse to an amount of material (**36**) located within one or more of the aperture elements (**30**). The amount of material (**36**) can include: osseointegratable, osteoinductive, osteoconductive, osteogenic materials or biologically active agents, or combinations and permutation thereof.

As a non-limiting example, the aperture perimeter (**35**) can be of generally oval configuration resulting in an oval aperture element (**30**) located in the projection member (**19**) or terminal member (**21**). The length of the oval aperture element (**30**) can be aligned with the length of the projection member (**19**) or terminal member (**21**) and can for example be about one quarter to about two thirds the length of the fixation member (**18**). Additionally, the either or both of the first implant body (**2**) and the second implant body (**24**) can further include one or more aperture elements (**30**) which communicate between the external surfaces of the implant body (**2**)(**24**).

Again referring primarily to FIGS. **1** through **16**, embodiments of the sacroiliac joint implant (**1**) can further include an anti-migration element (**37**) coupled to the external surface of to the first implant body (**2**) or the second implant body (**24**), or both. The anti-migration element (**37**) can take the form of an enlarged terminal portion of the second implant end (**6**) of the first implant body (**2**) or the second implant body (**24**), an increase in the projection member (**19**) (such as flaring outward) proximate the second implant end (**6**). As one non-limiting example, the anti-migration element (**37**) can take the form of an end cap (**38**) having a generally oval configuration coupled to the end of the terminal member (**21**) (see FIG. **16**) which extends outward a sufficient distance to prevent advancement of the second implant end (**6**) of the sacroiliac joint implant (**1**) further into

the joint between the sacrum (**4**) and the ilium (**3**) subsequent to implantation. As to embodiments which the fixation member (**18**) removably couples to the first implant body (**2**) or the second implant body (**24**) the end cap (**38**) can be configured to prevent the fixation member (**18**) from separating from first or second implant body (**2**)(**24**). While the end cap (**38**) shown in FIG. **16**, is generally oval in configuration, the end cap (**38**) can have end cap perimeter (**35**) which defines an oval, square, rectangle, or other configuration useful in fixing the location of the sacroiliac joint implant (**1**) between the sacrum (**4**) and the ilium (**3**). Additionally, the end cap (**38**) can have sufficient dimensional relations to further include one or more bores (**42**) which communicate between opposed surfaces and dimensioned to receive mechanical fasteners (**43**)(such as threaded members, barbed members, locking members or the like) which can be driven or rotated to engage a portion of the sacrum (**4**) or the ilium (**3**), or in embodiments which the fixation member (**18**) removably couples to the first implant body (**2**) or second implant body (**24**) a portion of the mechanical fastener (**43**) can engage with the first or second implant body (**2**) (**24**), the bones of the sacrum (**4**) or ilium (**3**), or all of them (see for example FIG. **16**). Now referring primarily to FIGS. **1** and **3**, the anti-migration element (**37**) can also take the form of tapered elements (**44**) on a part or the entirety of the external surface which taper outward from the external surface of the sacroiliac joint implant (**1**) allowing insertion of embodiments between the sacrum (**4**) and the ilium (**3**) but opposes backward travel of the sacroiliac joint implant (**1**).

Embodiments of the sacroiliac joint implant (**1**) described herein can be fabricated or formed from a plurality of pieces or as a single piece of biocompatible material or a combination of biocompatible and biodegradable materials of suitably dimensioned particles, sheets, or other constructional forms machineable or formable or moldable materials suitably bound or formed or molded to provide configurations in accordance with the invention.

Again referring primarily to FIGS. **1-16**, embodiments of the sacroiliac joint implant (**1**) can further include a coat (**91**) coupled, generated or integral to all or a part of the external surface of the sacroiliac joint implant (**1**). The coat (**91**) can be of any composition that can be coupled to the sacroiliac joint implant (**1**) capable of biocompatible osseointegration with the bone of the ilium (**3**) and sacrum (**4**), such as pure alumina, titanium-dioxide, hydroxyapatite, calcium triphosphate, or the like. As a non-limiting example, the coat (**91**) can be applied by plasma spraying with a plasma torch, a plasmatron or a plasma gun. Alternately, the coat (**91**) can be achieved by producing a surface roughness, porosity, or irregularity of the sacroiliac joint implant (**1**) by sand blasting, bead blasting, molding, or the like. The coat (**91**) can have a thickness in the range of about 40 μm and about 100 μm. Again, embodiments of the sacroiliac joint implant (**1**) can be configured as a material having interconnecting pores throughout such as TRABECULAR METAL available from Zimmer, P.O. Box 708, 1800 West Center Street, Warsaw, Ind. 46581-0708 or a metallic foam such as a titanium foam available from the National Research Council Canada, 1200 Montreal Road, Bldg. M-58, Ottawa, Ontario, Canada or fully-engineered, porous, titanium structures such as TRABECULITE available from Tecomet, 115 Eames Street, Wilmington, Mass. 01887.

Again referring primarily to FIGS. **1-15**, embodiments of the invention can further include one or more bores (**92**) which communicate inwardly from a first implant end (**5**) useful for attachment of coupling elements (not shown) which may extend from embodiments of the sacroiliac joint implant (**1**) to join other portions of the skeleton or to other implants assist stabilizing the sacroiliac joint (**47**).

Again referring primarily to FIGS. **1-16**, embodiments of the invention can further include one or more biologically active agent(s)(**45**) which can be applied directly to the external surface of the sacroiliac joint implant (**1**) or can be mixed with an amount of material (**36**) such as biocompatible material or biocompatible biodegradable material or biocompatible osseointegratable material which can be applied to the external surface of the sacroiliac joint implant (**1**) or otherwise made a part of the sacroiliac joint implant (**1**). As to particular embodiments of the sacroiliac joint implant (**1**), the biologically active agent(s)(**45**) can be mixed with the amount of material (**36**) and located within one or more of the aperture elements (**30**).

"Biocompatible" for the purposes of this invention means the ability of any material to perform the intended function of an embodiment of the invention without eliciting any undesirable local or systemic effects on the recipient and can include non-biodegradable materials such as: ceramic; metals or steels such as titanium alloys or rigid polymeric materials or rigid laminate materials or composites which include suitably dimensioned particles of metals or steels dispersed within rigid laminate materials, or suitably sized particles of biocompatible materials suitably bound or formed to provide configurations, polyurethanes, polyisobutylene, ethylene-alpha-olefin copolymers, acrylic polymers and copolymers, vinyl halide polymers and copolymers, polyvinyl esters, polyvinylidene chloride, polyacrylonitrile, polyvinyl ketones, polyvinyl aromatics such as polystyrene, copolymers of vinyl monomers and olefins such as ethylene-methyl methacrylate copolymers, acrylonitrile-styrene copolymers, ABS resins, ethylene-vinyl acetate copolymers, polyamides such as Nylon 66 and polycaprolactone, alkyd resins, polycarbonates, polyoxyethylenes, polyimides, polyesters, epoxy resins, rayon-triacetate, cellophane, polyether ether ketone (PEEK), polyetherketoneketone (PEKK), bone-from-wood available from the Istituto di Scienza e Tecnologia dei Mareriali Ceramici, Faenza, Italy, or the like, or biodegradable materials, as herein described.

"Biodegradable" for the purposes of this invention means the ability of any biocompatible material to breakdown within the physiological environment of the sacroiliac joint by one or more physical, chemical, or cellular processes at a rate consistent with providing treatment of a condition of the sacroiliac joint at a therapeutic level controllable by selection of a polymer or mixture of polymers (also referred to as polymeric materials), including, but not limited to: polylactide polymers (PLA), copolymers of lactic and glycolic acids (PLGA), polylactic acid-polyethylene oxide copolymers, poly(ϵ-caprolactone-co-L-lactic acid (PCL-LA), glycine/PLA copolymers, PLA copolymers involving polyethylene oxides (PEO), acetylated polyvinyl alcohol (PVA)/polycaprolactone copolymers, hydroxybutyrate-hydroxyvalerate copolymers, polyesters such as, but not limited to, aspartic acid and different aliphatic diols, poly (alkylene tartrates) and their copolymers with polyurethanes, polyglutamates with various ester contents and with chemically or enzymatically degradable bonds, other biodegradable nonpeptidic polyamides, amino acid polymers, polyanhydride drug carriers such as, but not limited to, poly(sebacic acid) (PSA), aliphatic-aromatic homopolymers, and poly(anhydride-co-imides), poly(phosphoesters) by matrix or pendant delivery systems, poly (phosphazenes), poly(iminocarbonate), crosslinked poly(ortho ester), hydroxylated polyester-urethanes, or the like.

"Biologically active agents" for the purposes of this invention means those agents or mixture of agents which can be varied in kind or amount to provide a therapeutic level effective to mediate the formation or healing of bone, cartilage, tendon, or to reduce, inhibit, or prevent a symptom of a condition of the sacroiliac joint subsequent to placement of an embodiment of the implant within the sacroiliac joint (**1**) such as infection or pain and without limitation can include agents that influence the growth of bone, demineralized bone matrix, stem cells, alleografts, bone forming protein, bone morphogenetic protein **2**, bone morphogenetic protein **7**, analgesics, anesthetics, anti-inflammatory agents, antibacterials, antivirals, antifungals, antiprotozoals, anti-infectives, antibiotics such as aminoglycosides such as gentamicin, kanamycin, neomycin, and vancomycin; amphenicols such as chloramphenicol; cephalosporins, such as cefazolin HCl; penicillins such as ampicillin, penicillin, carbenicillin, oxycillin, methicillin; lincosamides such as lincomycin; polypeptide antibiotics such as polymixin and bacitracin; tetracyclines such as tetracycline, minocycline, and doxycycline; quinolones such as ciprofloxacin, moxifloxacin, gatifloxacin, and levofloxacin; anti-viral drugs such as acyclovir, gancyclovir, vidarabine, azidothymidine, dideoxyinosine, dideoxycytosine; analgesics, such as codeine, morphine, ketorolac, naproxen, an anesthetic, lidocaine; cannabinoids; antifungal agents such as amphotericin; anti-angiogenesis compounds such as anecortave acetate; retinoids such as tazarotene, steroidal anti-inflammatory agents such as 21-acetoxypregnenolone, alclometasone, algestone, amcinonide, beclomethasone, betamethasone, budesonide, chloroprednisone, clobetasol, clobetasone, clocortolone, cloprednol, corticosterone, cortisone, cortivazol, deflazacort, desonide, desoximetasone, dexamethasone, diflorasone, diflucortolone, difluprednate, enoxolone, fluazacort, flucloronide, flumethasone, flunisolide, fluocinolone acetonide, fluocinonide, fluocortin butyl, fluocortolone, fluorometholone, fluperolone acetate, fluprednidene acetate, fluprednisolone, flurandrenolide, fluticasone propionate, formocortal, halcinonide, halobetasol propionate, halometasone, halopredone acetate, hydrocortamate, hydrocortisone, loteprednol etabonate, mazipredone, medrysone, meprednisone, methylprednisolone, mometasone furoate, paramethasone, prednicarbate, prednisolone, prednisolone 25-diethylamino-acetate, prednisolone sodium phosphate, prednisone, prednival, prednylidene, rimexolone, tixocortol, triamcinolone, triamcinolone acetonide, triamcinolone benetonide, triamcinolone hexacetonide; or allograft cellular matrix containing viable mesenchymal stem cells such as OSTEOCEL PLUS available from NuVasive, Inc., 7475 Lusk Blvd., San Diego, Calif. 92121 USA, and any of their derivatives, whether separately or in combinations thereof.

As to particular embodiments of the inventive implant (**1**) the biologically active agent(s)(**45**) can be dispersed throughout the amount of material (**36**) whether a biocompatible or biocompatible biodegradable material (or mixture of biocompatible materials or mixture of biocompatible biodegradable materials) by mixing biologically active agent(s)(**45**) into a melted biocompatible or biodegradable polymer and then solidifying the resulting material (**36**) by cooling, to substantially uniformly disperse the biologically active agent(s)(**45**) substantially throughout the material (**36**). The biodegradable material or biocompatible material or mixture thereof can be selected to have a melting point that is below the temperature at which the biologically active agent(s)(**45**) becomes reactive or degrades. Alternatively, the biologically active agent(s)(**45**) can be dispersed throughout the biocompatible or biodegradable material by solvent casting, in which the biocompatible or biodegradable material is dissolved in a solvent, and the biologically active agent(s)(**45**) dissolved or dispersed in the solution. The solvent can then be evaporated, leaving the biologically active agent(s)(**45**) in the matrix of the material (**36**). Solvent casting requires that the biocompatible or biodegradable material be soluble in organic solvents. Alternatively, the sacroiliac joint implant (**1**) can be placed in a solvent having a concentration of the biologically active agent(s)(**45**) dissolved and in which the sacroiliac joint implant (**1**) or the biocompatible or biocompatible biodegradable material (**36**) located in one or more of the aperture elements (**30**), or applied to the external surface, swells. Swelling of the sacroiliac joint implant (**1**) or portions thereof can draw in an amount of the biologically active agent(s)(**45**). The solvent can then be evaporated leaving the biologically active agent(s)(**45**) within the biocompatible or biocompatible biodegradable material (**36**). As to each method of dispersing the biologically active agent(s)(**45**) throughout the biocompatible or biodegradable biocompatible material (**36**) of or coupled to the sacroiliac implant (**1**), therapeutic levels of biologically active agent(s)(**45**) can be included in biocompatible biodegradable material (**36**) to provide therapeutically effective levels of the biologically active agent(s)(**45**) to the sacroiliac joint to treat a particular sacroiliac joint condition.

Other non-active agents (**46**) may be included in the biocompatible biodegradable material for a variety of purposes. For example, buffering agents and preservatives may be employed. Preservatives which may be used include, but are not limited to, sodium bisulfate, sodium bisulfate, sodium thiosulfate, benzalkonium chloride, chlorobutanol, thimerosal, phenylmercuric acetate, phenylmercuric nitrate, methylparaben, polyvinyl alcohol and phenylethyl alcohol. Examples of buffering agents that may be employed include, but are not limited to, sodium carbonate, sodium borate, sodium phosphate, sodium acetate, sodium bicarbonate, and the like, as approved by the FDA or other appropriate agencies in the United States or foreign countries, for the desired route of administration. Electrolytes such as sodium chloride and potassium chloride may also be included in the formulation.

A non-limiting example, embodiments of the sacroiliac joint implant (**1**) having a biocompatible biodegradable portion with biologically active agent(s)(**45**) for treating the sacroiliac joint (**47**)(also referred to as the "implant") can be made by dispersing a biologically active agent(s)(**45**) in a biocompatible biodegradable material (**36**) as above described to provide biologically active agent(s)(**45**) release characteristics at a therapeutic level. Upon implantation of the sacroiliac joint implant (**1**), as described below, the biocompatible biodegradable portion of the sacroiliac joint implant (**1**) can substantially continuously release biologically active agent(s)(**45**) to provide a localized amount of bone morphogenetic protein **2** at therapeutic levels of about 1 milligram to about 4 milligrams to facilitate bone regrowth. It is to be understood that this specific example of providing an embodiment of the sacroiliac joint implant (**1**) which delivers an amount of bone morphogenetic protein **2** to facilitate bone regrowth, is not intended to be limiting, and embodiments of the implant (**1**) can be utilized to deliver numerous and varied active agent(s)(**45**) individually or in combination to treat a wide range of conditions of the sacroiliac joint (**47**) subsequent to implantation of embodiments of the implant (**1**).

Again referring primarily to FIG. **11-16**, particular embodiments of the invention can further include an amount

of curvature (**15**) between the first implant end (**5**) and the second implant end (**6**) of the inventive implant (**1**). The amount of curvature (**15**) can vary from embodiment to embodiment of the inventive implant (**1**) depending on the application, between a substantially linear body as above described and shown in FIGS. **1-7** to including an amount of curvature (**15**) which defines a radius (**51**) to facilitate placement in the cranial portion (**48**) and caudal portion (**49**) between the articular surfaces (**16**) of the sacroiliac joint (**47**) or in the corresponding implant receiving space (**50**), as further described below. As one non-limiting embodiment the radius (**51**) can be within a range of about 2 cm and about 6 cm.

Now referring primarily to FIG. **16**, certain embodiments of the invention having an amount of curvature (**15**) can be provided in a plurality of implant segments (**17**) which can be individually implanted within the articular region (**16**). Understandably, embodiments of the inventive sacroiliac joint implant (**1**) whether separately or in joined relation, whether the same or different embodiments, can be utilized with conventional or the inventive methods of implantation herein described for stabilization and to permit movement of the sacroiliac joint (**47**).

Now referring primarily to FIGS. **17-41**, particular embodiments of sacroiliac joint implant (**1**) can be configured to provide a sacral member (**53**) having a sacral fixation surface (**54**) which can engage the sacrum (**4**) and a iliac member (**55**) having a iliac fixation surface (**56**) which can engage the ilium (**3**). The sacral fixation surface (**54**) and the iliac fixation surface (**56**) can be configured or adapted to non-transversely locate between the articular surfaces (**16**) or extra-articular surfaces (**52**) of the sacroiliac joint (**47**) or within an implant receiving space (**50**) surgically produced as further described below by removal of a portion the articular cartilage or bone of the ilium (**3**) or the sacrum (**4**)(or both) to correspondingly engage a portion of the sacrum (**4**) and the ilium (**3**). The sacral member (**53**) and the iliac member (**55**) can further correspondingly provide a sacral member interface surface (**57**) and an iliac member interface surface (**58**) which can disposed in opposed slidable mated relation. Upon implantation of such embodiments between the articular surfaces (**16**) or between the extra-articular surfaces (**52**) opposed slidable mated engagement of the sacral member interface surface (**57**) and the ilium member interface surface (**58**) can afford a limited amount of travel between the sacral member (**53**) and the iliac member (**55**) of the implant (**1**).

For the purposes of this invention, the term "non-transversely" as used herein means not lying or extended across the joint between the sacrum (**4**) and the ilium (**5**) and in particular does not include trans-iliac placement of a sacroiliac joint implant (**1**). The term "articular surfaces" includes the two paired L-shaped surfaces formed between the surfaces of the sacrum (**4**) and the ilium (**3**) having a cranial portion (**48**) and a caudal portion (**49**) as shown for example in FIGS. **43-47** (within the broken line). The term "extra-articular surfaces" includes structures or regions of the sacrum (**4**) or the ilium (**3**) outside of the articular surfaces (**16**), such as, the paired iliac tuberosity and sacral fossa.

Referring primarily to FIGS. **17-23**, a particular embodiment of implant (**1**) is shown which includes a sacral member (**53**) and an iliac member (**55**) each having separately and in mated relation sufficient dimensions to avoid deformation under the normal forces of surgical placement and stabilization of the ilium (**3**) in relation to the sacrum (**4**). Accordingly, while the embodiment of the sacroiliac joint implant (**1**) shown in FIGS. **17-23** provides the sacral member (**53**) and the iliac member (**55**) as a pair of mirror image quadrilateral polygons each having a first side (**59**) and a second side (**60**) disposed in substantially perpendicular relation and a third side (**61**) of lesser length than said first or second sides (**59**)(**60**). A fourth side (**62**) connects the second and third sides (**60**)(**61**) in angled relation. Each of the iliac member (**55**) and the sacral member (**53**) dispose the corresponding fixation surface (**54**)(**56**) and interface surfaces (**57**)(**58**) in substantially parallel opposed relation a distance apart affording sides (**59**)(**60**)(**61**)(**62**) each having a general rectangular configuration. The quadrilateral polygon as described can have dimensional relations which allow implantation between the extra-articular surfaces (**52**) of the sacrum (**4**) and the ilium (**3**) as shown in the non-limiting example of FIG. **47**. As one non-limiting example, the implant (**1**) having the quadrilateral form above described with the sacral member (**53**) and the ilium member (**55**) interface surfaces (**57**)(**58**) in mated engagement as shown in FIGS. **18** and **19** can have a width (**63**)(see FIG. **18**) in the range of about 0.5 cm centimeters ("cm") and about 2 cm and a height (**64**)(see FIG. **17**) in the range of about 1 cm to 5 cm and a length (**65**) (see FIG. **17**) disposed between a first implant end (**5**) and a second end (**6**) in the range of about 3 cm and about 6 cm. The sacral member interface surface (**57**) and the ilium member interface surface (**58**) can be substantially flat; however the invention is not so limited and interface surfaces (**57**)(**58**) can further include a matable convex surface element (**66**) or concave surface elements (**67**) which limits travel of the sacral member (**53**) in relation to the iliac member (**54**).

Now referring primarily to FIGS. **24-35**, embodiments of the sacroiliac joint implant (**1**) providing a sacral member (**53**) having a sacral fixation surface (**54**) which can engage the sacrum (**4**) and an iliac member (**55**) having a ilium fixation surface (**56**) which can engage the ilium (**3**). The sacral member (**53**) and the iliac member (**55**) can have an amount of curvature (**15**) between a first implant end (**5**) and a second implant end (**6**). The implant can have dimensional relations and curvature to allow implantation between the articular surfaces (**16**) of the sacrum (**4**) and the ilium (**3**) as shown in the non-limiting example of FIG. **45**. The sacral member interface surface (**57**) and the iliac member interface surface (**58**) can correspondingly provide a channel element (**68**) and a guide element (**69**), the guide element (**69**) configured to be received within the channel element (**68**). Depending upon the configuration of the guide element (**69**) and the channel element (**68**), the guide element (**69**) can travel within the channel element (**68**) to provide a corresponding amount of movement of the sacral member (**53**) in relation to the iliac member (**55**).

While the embodiment of the implant (**1**) shown in FIG. **24** through FIG. **29** shows a continuous channel element (**68**) which receives a correspondingly continuous guide element (**69**); the invention is not so limited and embodiments of the implant (**1**) a plurality of channel elements (**68**) discontinuous from each other and correspondingly receiving a plurality of guide elements (**69**) as shown for example in FIGS. **30-35**.

Again referring to FIGS. **30-35**, certain configurations of the channel element (**68**) can be configured to slidely mate in an interlocked configuration which upon implantation does not afford disengagement of the guide element (**69**) from the channel element (**68**). Now referring primarily to FIG. **35**, a non-limiting embodiment of the channel element (**68**) can have channel walls (**71**)(**72**) which are disposed a lesser distance apart proximate the interface surface (**57**) or (**58**) and a greater distance apart proximate the channel

bottom (73) a correspondingly configured guide element (69) can have greater dimension proximate the guide end terminal (74) and a lesser dimension at the guide base (75). As one example the guide element (69) can provide a first cylindrical member (76) (see FIGS. 30 and 35) which projects outwardly a first distance from the interface surface (57) or (58) and terminates in a second cylindrical member (77) of greater diameter which extends a second distance from the interface surface (57) or (58). The channel walls (71)(72) proximate the channel bottom (73) can be disposed a sufficient distance apart to receive between the second cylinder member (77) and the channel walls (71)(72) can step inwardly proximate the interface surface (57) or (58) to dispose the channel walls (71)(72) a sufficient distance apart to receive between the first cylindrical member (76) but sufficiently close together to prevent the first cylindrical member (76) to pass between, thereby interlocking the guide element (69) within the channel element (68). As another non-limiting example the channel element (68) can be configured as a dovetail slide and the guide element as a dovetail. As shown in FIGS. 30 through 35, the corresponding sacral member interface element (57) and iliac member interface element (58) can each provide generally flat interface surfaces disposed in opposed parallel relation external to the channel (68) and guide element (69).

Again referring primarily to FIGS. 24 through 29, particular embodiments of iliac member interface surface (58) can further provide a convex element (66) having a generally circular configuration in cross section disposed generally along the midline of the iliac member interface surface (58). The channel element (68) can be disposed to generally bisect the convex element (66) providing a generally curved convex interface surface (76) on either side of the channel element (68). The curved convex interface surface (76) can matably engage a corresponding concave element (66) disposed generally along the midline of the sacral member interface surface (58). The guide element (69) can generally bisect the concave element (66) to provide a curved concave interface surface (78) on either side of the guide element (69). Upon engagement of the sacral member interface surface (57) with the iliac member interface surface (58) the curved concave interface surface (78) can have limited rotation in relation to the curved convex interface surface (76) to correspondingly afford movement of the sacral member (53) in relation to the iliac member (55). The iliac member interface surface (58) can further include a ridge element (79) disposed along the perimeter of the curved convex interface surface (76). The sacral member interface surface (57) can further include a ridge receiving element (80) which receives the ridge element (79) upon mated engagement of the sacral member interface surface (57) with the iliac member interface surface (58).

As to embodiments as shown in FIGS. 24-29, the channel element (68) can have a width W_1 and the guide element (69) can have a lesser width W_2. The widths W_1 and W_2 can be adjusted in relation to each other provide an amount of longitudinal movement of the guide element (69) in the channel element (68) and an amount of rotation of the curved concave interface surface (78) over the curved convex interface surface (76). The ridge element (79) and the ridge receiving element (80) can be configured to further adjust the direction and amount of movement between the sacral member (53) and the iliac member (55).

Now referring primarily to FIGS. 36-41, an embodiment of an inventive sacroiliac joint implant (1) is shown which in part can include a sacral member (53) and an iliac member (55). The sacral member (53) and the iliac member (55) can have an amount of curvature (15) between a first implant end (5) and a second implant end (6). The implant (1) can have dimensional relations and curvature to allow implantation between the articular surfaces (16) of the sacrum (4) and the ilium (3) as shown in the non-limiting example of FIG. 45 (broken line). The sacral member interface surface (57) and the iliac member interface surface (58) can correspondingly provide a sacral member core receiving element (81) and an iliac member core receiving element (82) each configured as an elongate curved recess which as to particular embodiments can be configured as an elongate curved semi-cylinder or elongate curved semi-oval recess. The implant (1) can further include a core element (83) having a core body (84) received in part by the sacral member core receiving element (81) and in part by the iliac member core receiving element (82) upon mated engagement of the sacral member interface surface (57) and the iliac member interface surface (58). The core body (84) can be correspondingly configured to provide an elongate curved cylinder or oval which can have sufficient dimensions when received within the iliac member core receiving element (82) and the sacral member core receiving element (81) to dispose the interface surfaces (57)(58) outside of the perimeter of the core receiving elements (81)(82) a distance apart.

The core body (84) can further include a continuous or discontinuous circumferential radially extending fin (85). The core fin (85) can have a thickness which maintains the interface surfaces (57)(58) outside of the core receiving elements (81)(82) a distance apart. The core body (84) and the core fin (85) can be configured from the same or similar material as the sacral member (53) and the iliac member (55) but can also be made from a material which affords the core body (84) and the core fin (85) an amount of flexure or an amount of compression in response to movement of the sacral member (53) and the iliac member (55). As a non-limiting example, the core body (84) and the core fin (85) can be fabricated, formed or molded from materials such as polyethylene.

Again referring primarily to FIGS. 17 through 41, embodiments of the sacroiliac joint implant (1) can further include a sacral member fixation element (86) coupled to the sacral member fixation surface (54) or a iliac member fixation element (87) coupled to the iliac member fixation surface (56). The sacral member fixation element (86) can extend outwardly a sufficient distance to be disposed within the bone of the sacrum (4). The iliac member fixation element (87) can extend outwardly a sufficient distance to be disposed within the bone of the ilium (3). As to certain embodiments of the sacroiliac joint implant (1) as shown in FIGS. 17-23, the sacral or iliac fixation element (86)(87) can take the form of a projection member (19) and can further include a terminal member (21) as above described.

Now referring primarily to FIGS. 42A-C and 43-45, and incorporating by reference U.S. patent application Ser. No. 12/998,712, placement of various embodiments of the sacroiliac joint implant (1), above described, can be achieved by accessing an articular region (88) between the articular surfaces (16) (shown in broken line) of FIGS. 43-47 of the sacroiliac joint (47). The various embodiments of the, a sacroiliac joint implant (1) can be implanted non-transversely between the articular surfaces (16) within the articular region (88) of the sacroiliac joint (47) to dispose the sacrum (4) and the ilium (3) in substantially immobilized relation by corresponding engagement of the sacroiliac joint implant (1) by the articular surfaces (16) of the sacroiliac joint (47). The particular example of the method described is sufficient to enable a person of ordinary skill in the art to

utilize embodiments of the sacroiliac joint implant (**1**) and is not intended to be limiting with respect to the order of steps or the use of all or any of the steps or combination of one or more steps into one steps or performing any one step as substeps, or other similar, equivalent, or conventional steps to implant embodiments of the sacroiliac joint implant (**1**) within the sacroiliac joint (**47**).

Now referring primarily to FIGS. **42**A-C and **43**-**47**, an embodiment of the method of implanting the various embodiments of the sacroiliac joint implant (**1**) can include the step of placing a patient under sedation prone on a translucent operating table (or other suitable surface). The sacroiliac joint (**47**) can be locally anesthetized to allow for injecting a radiographic contrast (as a non-limiting example, Isoview 300 radiographic contrast) under fluoroscopic guidance into the inferior aspect of the sacroiliac joint (**47**) to outline the articular surfaces (**16**) of the sacroiliac joint (**47**). Injection of the radiographic contrast within the sacroiliac joint (**47**) can be accomplished utilizing a tubular member (such as a syringe needle) having first tubular member end which can be advanced between the articular surfaces (**16**) of the sacroiliac joint (**47**) and having a second tubular member end which removably couples to a hub. The hub can be configured to removably couple to a syringe barrel (or other device to contain and deliver an amount of radiographic contrast). In the example of a syringe barrel, the syringe barrel can have an internal volume capable of receiving an amount of the radiographic contrast sufficient for outlining the lateral articular surfaces of the sacroiliac joint. A plunger can be slidingly received within the barrel to deliver the radiographic contrast through the tubular member into the sacroiliac joint. The tubular member can have a gauge in the range of about 16 gauge and about 20 gauge and can further be incrementally marked on the external surface to allow determination of the depth at which the first needle end has advanced within the sacroiliac joint (**47**). As the first needle end advances into the sacroiliac joint (**47**) the radiographic dye can be delivered from within the syringe barrel into the sacroiliac joint to allow visualization of the sacroiliac joint (**47**) and location of the tubular needle within the sacroiliac joint (**47**).

Once the first tubular member end has been sufficiently advanced into the sacroiliac joint and the articular surfaces (**16**) of the sacroiliac joint (**47**) have been sufficiently visualized, the hub can be removed from the tubular member leaving the tubular member fixed within the sacroiliac joint (**47**) as a initial guide for tools subsequently used to locate or place the sacroiliac joint implant (**1**) non-transversely between the articular surfaces (**16**) of the sacroiliac joint (**47**) or in removal of a portion of the sacroiliac joint (**47**) within the region defined by the articular surfaces (**16**) to generate an implant receiving space (**50**). Alternately, one or more guide pins (**14**) can be inserted along substantially the same path of the tubular member for fixed engagement within the sacroiliac joint (**47**) and used in subsequent steps as a guide(s).

A small incision can be made in the skin at the posterior superior (or as to certain embodiments inferior) aspect of the sacroiliac joint (**47**), extending proximal and distal to the tubular member along the line of the sacroiliac joint to provide a passage to access the interarticular space between the articular surfaces (**16**) of the sacroiliac joint (**47**). A cannulated probe can be slidingly engaged with the tubular member (or guide pin (**14**)) extending outwardly from the sacroiliac joint (while the sacroiliac joint (**47**) may be shown in the figures as being substantially linear for illustrative purposes, it is to be understood that the normal irregular features of the sacroiliac joint (**47**) have not been removed). The cannulated probe can have a probe body of generally cylindrical shape terminating in a spatulate tip at the end advanced into the sacroiliac joint. A removable cannulated probe handle couples to the opposed end of the probe body. The spatulate tip can be guided along the tubular needle (or guide wire) into the posterior portion of the sacroiliac joint and advanced to the anterior portion of the sacroiliac joint under lateral fluoroscopic visualization. The cannulated probe handle can then be removed providing the generally cylindrical probe body extending outwardly from the sacroiliac joint (**47**) through the incision made in the skin.

A passage from the incision to the sacroiliac joint (**47**) can be generated by inserting a cannula into the incision. A soft tissue dilator having a blunt end can be advanced over the probe body, or a plurality of soft tissue dilators of increasing size, until the blunt end of the soft tissue dilator and the corresponding cannula end contact the posterior aspect of the sacroiliac joint. The soft tissue dilator can be removed from within the cannula. The external surface of the cannula can be sufficiently engaged with the surrounding tissue to avoid having the tissue locate with in the hollow inside of the cannula. A non-limiting embodiment of the cannula provides a tubular body having substantially parallel opposed side walls which terminate in a radius at both ends (lozenge shape) into which a plurality of different jigs can be inserted.

A cannula alignment jig can be advanced over the probe body (or guide pins (**14**)) and received within the cannula. Substantially, identical cross hairs can be disposed on the upper jig surface and the lower jig surface. Alignment of the cross hairs under x-ray with the corresponding anterior and posterior joint lines of the sacroiliac joint can confirm that the cannula has proper orientation in relation to the paired articular surfaces of the sacroiliac joint (**47**). The cannula properly oriented with the paired articular surfaces (**16**) can then be disposed in fixed relation to the sacroiliac joint (**47**) by placement of fasteners through the cannula into the sacrum (**4**) or the ilium (**3**).

A first drill jig can be advanced over the probe body (or guide pins (**14**)) and received within the cannula. The probe body (or guide pins (**14**)) extending outwardly from the sacroiliac joint (**47**) passes through a drill guide hole of the first drill jig (or a plurality of guide pins (**14**)) can extend through a corresponding plurality of guide pin holes. The drill guide hole can take the form of a circular hole, a slot, or other configuration to restrict the movement of the drill bit within the drill jig and provide a guide for a drill bit in relation to the sacroiliac joint (**47**).

A cannulated drill bit can be advanced over the probe body and within a drill guide hole of the first drill jig. The cannulated drill bit under fluoroscopic guidance can be advanced into the interarticular region (**88**) between the articular surfaces (**16**) of the sacroiliac joint (**47**) to produce a first bore to a determined depth. As to certain embodiments of the method, an amount of articular cartilage or other tissues from between the articular surfaces (**16**) of the sacroiliac joint (**47**) can be removed sufficient to allow embodiments of the sacroiliac joint implant (**1**) to be implanted in replacement of the removed articular cartilage or tissue. Because the method removes the degenerative articular cartilage or tissue between the articular surfaces (**16**) of the sacroiliac joint (**47**), the articular surfaces (**16**) of the sacroiliac joint (**47**) can remain intact or substantially intact allowing the sacroiliac joint implant (**1**) to be non-transverely located between the articular surfaces (**16**) of the sacroiliac joint (**47**). Understandably, other instruments can

be utilized separately or in combination with a cannulated drill bit for the removal of articular cartilage or tissue between articular surfaces (**16**) such as: box chisels, burs, hole saws, curettes, lasers (such as CO2, Neodymium/YAG (yttrium-aluminum-garnet), argon, and ruby), electrosurgical equipment employing electromagnetic energy (the cutting electrode can be a fine micro-needle, a lancet, a knife, a wire or band loop, a snare, an energized scalpel, or the like) where the energy transmitted can be either monopolar or bipolar and operate with high frequency currents, for example, in the range of about 300 kHz and about 1000 kHz whether as pure sinusoidal current waveform where the "crest factor" can be constant at about 1.4 for every sinus waveform, and a voltage peak of approximately 300 V to enable a "pure" cutting effect with the smallest possible coagulation effect or as amplitude modulated current waveforms where the crest factor varies between 1.5 and 8, with decreasing crest factors providing less of a coagulation effect. Electrosurgical waveforms may be set to promote two types of tissue effects, namely coagulation (temperature rises within cells, which then dehydrate and shrink) or cut (heating of cellular water occurs so rapidly that cells burst). The proportion of cells coagulated to those cut can be varied, resulting in a "blended" or "mixed" effect. Additionally, a fully rectified current, or a partially rectified current, or a fulguration current where a greater amount or lateral heat is produced can be employed to find the articular surfaces (**16**) of the sacroiliac joint (**47**) and aid in advancing a probe or guide wire into a position in between the articular surfaces (**16**). These currents can effectively degrade the cartilage and allow advance into the joint without grossly penetrating much beyond the cartilage.

As to certain embodiments of the invention, the first drill jig can be removed from within the cannula and a second drill jig can be advanced over the probe body and received within the cannula; however, the invention is not limited to any particular number of drill jigs and as to certain embodiments of the method the first drill jig can include all the required drill guide hole(s)(or slots or other configurations of the drill guide) and as to other embodiments of the method a plurality of drill jigs can be utilized in serial order to provide all the drill guide holes.

The first drill jig can provide one or more additional drill guide holes which guide in relation to the first bore a second or more cannulated drills of the same or different configuration to be inserted within and advanced into the sacroiliac joint (**47**) to produce a second bore or a plurality of bores within the sacroiliac joint (**47**) spaced apart in predetermined pattern to allow removal of sufficient articular cartilage or other tissue from the interarticular space (**89**) of sacroiliac joint (**47**) for placement of embodiments of the sacroiliac joint implant (**1**) within the region defined by and between the paired articular surfaces (**16**) of the sacroiliac joint (**47**). As to certain methods of the invention, the first drill jig or the second drill jig or a plurality of drill jigs can be utilized in serial order to remove a portion of the sacroiliac joint (**47**) for generation of an implant receiving space (**50**).

As these embodiments of the method, articular cartilage or other tissues and sufficient subchondral bone can be removed from between the articular surfaces (**16**) of the sacroiliac joint (**47**) sufficient to allow placement of certain embodiments of the sacroiliac joint implant (**1**) and one or more fixation member receiving channels (**90**) can be cut into at least one of the articular surfaces (**16**) of said sacroiliac joint (**47**) sufficient to receive other embodiments of the sacroiliac implant (**1**). The one or more fixation member receiving channels (**90**) can be cut a depth into the subchondral, cortical bone or cancellous bone of the sacrum (**4**) or ilium (**3**).

In a subsequent step, the last in the serial presentation of drill jigs can be removed from within the cannula and a broach jig can be advanced over the probe body to locate within the cannula. The broach jig can include a broach guide hole which receives a first broach end of a cannulated broach advanced over the probe body. The first broach end can have a configuration which can be advanced into the sacroiliac joint (**47**). As to certain embodiments of the method, the first broach end can be adapted to remove an amount of articular cartilage and other tissue from the between the articular surfaces (**16**) within the articular region (**88**) of the sacroiliac joint (**47**) for non-transverse placement of a sacroiliac joint implant (**1**) between the articular surfaces (**16**) of the sacroiliac joint (**47**). As to other embodiments of the method, the cannulated broach can remove a sufficient a portion of the sacroiliac joint (**47**) to generate an implant receiving space (**50**) to receive embodiments of the sacroiliac joint implant (**1**) between the articular surfaces (**16**). The broach can be configured to remove a portion of the sacroiliac joint (**47**) to produce a implant receiving space (**50**) to receive embodiments of the sacroiliac joint implant (**1**) having a sacral member fixation element (**86**) and a iliac member fixation element (**87**) adapted to locate between the articular surfaces (**16**) of the sacroiliac joint (**47**).

Now referring primarily to FIGS. **42**A-**42**C, the implant receiving space (**50**) and the sacroiliac joint implant (**1**) can be configured having related dimension relations such that placement of the sacroiliac joint implant (**1**) within the implant receiving space (**50**) disposes the sacrum (**4**) and the ilium (**3**) in substantially immobilized relation or allows the sacrum (**4**) and the ilium (**3**) a limited amount of movement corresponding to the movement afforded between the sacral member interface (**57**) and the iliac member interface (**58**) of the implant (**1**) without substantial alteration or avoids alteration of the positional relation of the sacrum (**4**) and the ilium (**3**) from the normal condition, or avoids driving together or driving apart the sacrum (**4**) from the ilium (**3**) outside of or substantially outside of the normal positional relation. An intention in selecting configurations of the sacroiliac joint implant (**1**) and the implant receiving space (**50**) being immobilization or allowing limited movement of the sacrum (**4**) in relation to the ilium (**3**) while maintaining the sacroiliac joint (**47**) in substantially normal or substantially normal positional relation, or returning the sacroiliac joint (**47**) to a substantially normal positional relation to correct a degenerative condition of the sacroiliac joint (**47**).

Any of the above-described implant embodiments may be configured for delivery into the sacroiliac joint via any of the delivery tools described in U.S. patent application Ser. No. 13/475,695 ("the '695 application") (filed May 18, 2012) or U.S. patent application Ser. No. 13/236,411 ("the 411 application") (filed Sep. 19, 2011). The disclosures of these two applications are hereby incorporated by reference in their entireties.

In one embodiment, as indicated in FIGS. **48**A-**49**, a system for treating a sacroiliac joint **100** may include a delivery tool **120** for implanting any of the above-described implants **1**, wherein the implants **1** have been adapted for use with the delivery tool. An implant assembly **150** includes an implant **1** and, and in some embodiments, one or more anchor elements **130** (e.g., bone screws, nails or other elongated bodies) that may be used to secure the sacrum member of the implant **1** to the sacrum and the ilium

member of the implant **1** to the ilium, the sacrum member and ilium member being at least partially moveable relative each other once implanted, as described above in detail.

During the implantation of the implant assembly **150** at the sacroiliac joint, the implant **1** is supported by a distal end **135** of the delivery tool **120**, as illustrated in FIG. **48**A. As discussed in detail in the '695 application and '411 application, in some embodiments of the tool **120**, the tool may be configured to deliver an anchor element **130** to secure the implant **1** in place within the sacroiliac joint. Specifically, a portion of the tool **120**, or via separate other tools, an anchor element **130** may be delivered to extend into the sacrum and sacrum member of the implant **1** to fix the sacrum element of the implant to the sacrum. Similarly, a portion of the tool **120**, or via separate other tools, an anchor element **130** may be delivered to extend into the ilium and ilium member of the implant **1** to fix the ilium element of the implant to the sacrum. The sacrum member of the implant **1** and the ilium member of the implant **1** may interact with each via any of the above-described arrangements so as to allow at least some movement between the sacrum member and ilium member once implanted in the sacroiliac joint space.

In some embodiments of the implant **1** as described above, the sacrum and ilium members of the implant are simply respectively secured to the sacrum and ilium via features of the respective sacrum and ilium members and, as a result, do not require the use of anchor elements **130**.

As can be understood from FIGS. **48**A-**49**, in one embodiment, the distal end **135** of the delivery tool **120** may be fixed or non-removable from the rest of the delivery tool **120**. In other embodiments, the distal end **135** of the delivery tool **120** may be removable so as to allow interchanging of different sized or shaped distal ends **135** to allow matching to particular implant embodiments without requiring the use of a different delivery tool **120**. The delivery tool **120** is used to deliver the implant **1** into the sacroiliac joint space. The delivery tool **120** is then decoupled from the implanted implant assembly **150**, as can be understood from FIG. **48**B.

As shown in FIG. **48**A, the delivery tool **120** includes a distal end **135** and a proximal end **180**. The distal end **135** supports the implant **1** of the implant assembly **150**, and the proximal end **180** is configured to be grasped and manipulated to facilitate the implantation of the implant **1** in the sacroiliac joint.

As illustrated in FIG. **49**, the delivery tool **120** further includes a shaft **185**, a handle **190**, an implant retainer actuation rod **195**, and an implant retainer **200**. As can be understood from FIGS. **48**A-**49**, the handle **190** is coupled on a proximal end of the shaft **185**. A lumen extends through the tubular shaft **185**, and the implant retainer **195** extends through the lumen and includes a handle equipped proximal end and a distal end **215** configured to mechanically engage a proximal end **220** of a drive shaft **225** of the implant retainer **200**. The implant retainer **200** is positioned within a distal end of the shaft **185**. When the actuation rod **195** is rotated within, and relative to, the shaft **185**, the rotation of the actuation rod **195** causes the drive shaft **225** of the implant retainer **200** to rotate on account of the drive shaft proximal end **220** being mechanically coupled to the actuation rod distal end **215**.

As illustrated in FIG. **50-53**, the implant retainer **200** includes the drive shaft **225**, implant member engagement shafts **230**, **232**, and a frame **235**. The implant member engagement shafts **230**, **232** are rotatably supported in the frame **235** and include geared proximal ends **240**, **242** and threaded distal ends **245**, **247**. The drive shaft **225** is rotatably supported in the frame **235** and includes a geared portion **250** that is engaged via a geared relationship with the geared proximal ends **240**, **242** of the implant member engagement shafts **230**, **232** such that rotation of the drive shaft **225** causes rotation of the shafts **230**, **232**. Rotation of the drive shaft **225** causes rotation of the shafts **230**, **232** in first directions that allows the respective threaded ends **245**, **247** to rotate so as to be threadably received in threaded bores **255**, **257** of respective sacrum and ilium members **53**, **55**, thereby causing the members **53**, **55** to be secured to the implant retainer **200** and the distal end **135** of the delivery tool **120**. Opposite rotation of the drive shaft **225** causes the respective threaded ends **245**, **247** to threadably exit the respective threaded bores **255**, **257**, thereby allowing the delivery tool distal end **135** to uncouple from the implant members **53**, **55** once implanted in the sacroiliac joint space. Rotation arrows near the drive shaft proximal end and the proximal and distal ends of the respective shafts **230**, **232** illustrate the rotational relationships between the shafts **225**, **230**, **232**.

The implant **1** of FIGS. **50-53** has features similar to those described above with respect to FIGS. **24** and **25**, including, for example, arcuate or curved bodies of the members **53**, **55**, a guide element **69** and a complementarily shaped channel element **68**, and fixation members **86**. Additionally and as indicated in FIG. **50**, in one embodiment, magnets **260**, **262** may be supported in each member **53**, **55** near the interface surfaces **57**, **58** of the respective members **53**, **55**. The magnets **260**, **262** may be arranged in opposed paired fashion on the respective interface surfaces **57**, **58** in such a manner to cause the opposed paired magnets **260**, **262** to draw the opposed interface surfaces **57**, **58** towards each other or to cause the opposed interface surfaces **57**, **58** to repel each other. In such an embodiment, the repelling magnets may act to reduce abrasion or wear of the opposing interface surfaces.

In one embodiment, the implant members **53**, **55** may be constrained. For example, the implant members **53**, **55** may be connected to each other by structural elements extending between or around the surfaces of each implant member **53**, **55**. Such structural elements may include any of the constraining, linking or connecting structures discussed above with respect to FIGS. **9** and **10** or FIGS. **17-41**, for example. Alternatively or additionally, the constraining, linking or connecting structures may include fibers (e.g., woven) that extend between and/or about (e.g., circumferentially) the surfaces of the members **53**, **55**, those surfaces including the interface surfaces and/or the exterior side and back surfaces of the implant members.

As can be understood from FIGS. **50-53**, the distal end of the implant retainer **200** that interfaces with the proximal end of the implant **1** may have protruding tabs **265**, **267** that are respectively received in bores **270**, **271** defined in the proximal end of the implant **1**. Such tabs **265**, **267** prevent the implant portions **53**, **55** from rotating relative to the implant retainer **200** when the shafts **230**, **232** are being rotated to cause their distal ends **245**, **247** to be received in threaded engagement within the bores **255**, **257**.

In the embodiment of the delivery tool **120** depicted in FIGS. **48**A-**52**, an implant engagement arrangement exists wherein rotation of the retainer **195** relative to the rest of the delivery tool **120** results in the shafts **230**, **232** rotating appropriate to allow their respective threaded distal ends **245**, **247** to theadably couple to the threaded bores **255**, **257** of the implant **1**. In another embodiment of the delivery tool **120** as will now be discussed with respect to FIGS. **54**A-

54E, the shafts 230, 232 may be simply be caused to rotate via direct rotating action of the physicians fingers against the shafts 230, 232.

As shown in FIG. 54A, the delivery tool 120 includes a distal end 135 and a proximal end 180. As shown in FIG. 54B, the tool 120 further includes an arm assembly 285 and a handle 290.

As can be understood from FIGS. 54A-54B, the arm assembly 285 includes a sheath or shell 210 and an implant retainer 200 that resides within the shell 210 when the tool 120 is assembled. The retainer 200 includes a distal end 320 and a proximal end 325. Longitudinally extending raised ribs 405 are radially distributed about the outer circumferential surface of retainer 200. The longitudinal ribs 405 distally terminate by intersecting a raised circumferential ring 410 on the outer circumferential surface of the retainer 200. A groove 415 circumferentially extends about the outer circumference of the retainer 200. The proximal end 325 of the retainer 200 may include a squared, pentagonal or hexagonal outer surface configuration 450 that facilitates a mechanical engagement arrangement with the handle 90 such as the mechanical arrangement that exists between a wrench and nut.

As illustrated in FIG. 54B, the sheath 210 includes a distal end 420, a proximal end 425, a proximal cylindrical opening 435 of a cylindrical bore 432, and a distal cylindrical opening 437 of the bore 432. The cylindrical bore 432 extends the full length of the sheath 210 between the proximal opening 435 and the distal opening 437. Longitudinally extending grooves 440 are radially distributed about the inner circumferential surface of the bore 432 in an arrangement that matches the longitudinal raised ribs 405 of the retainer 200 such that the ribs 405 are received in the grooves 440 in a mated arrangement when the retainer 200 is received in the bore 432 of the sheath 210.

As illustrated in FIG. 54B, the collar assembly 400 includes a helical spring 455, rings 460A and 460B, washer 460C, retainer balls 461, and a retaining collar 465. As shown in FIG. 54C, which is an isometric view of the handle 290, a cylindrical neck portion 470 of the handle 290 includes a shoulder 476 which slopes down to a circumferential groove 475 and a pair of holes 480 defined in the outer circumferential surface of the neck 470.

As indicated in FIG. 54D, which is an exploded isometric view of the retaining collar 465 and handle 290 shown in longitudinal cross section, the holes 480 extend through the cylindrical wall 485 that defines the neck 470 and a cylindrical void 487 within the neck. A squared, pentagonal or hexagonal inner surface configuration 490 is defined in the handle 290 distal the cylindrical void 487 to receive in a mating arrangement the complementarily shaped outer configuration 450 of the proximal end of the retainer 200. A lumen 495 extends from a proximal end of the handle to open into the squared, pentagonal or hexagonal inner surface configuration 490.

As shown in FIG. 54D, the retaining collar 465 includes a proximal end 500, a distal end 505, an outer circumferential surface 510 and an inner circumferential surface 515 that defines the hollow interior of the collar 517. The outer circumferential surface 510 extends radially outward to form a rim 520 near the proximal end 500. The inner circumferential surface 515 has a stepped and ramped configuration. Specifically, working distal to proximal, the inner circumferential surface 515 includes a proximal inner ring 525 separated from an intermediate inner ring 530 by a proximal large diameter region 535 separated from a small diameter region 540 by a ramped surface 545. Proximal the intermediate inner ring 530 is another large diameter region 550 bordered on its proximal boundary by a groove 555.

As can be understood from FIG. 54E, which is a longitudinal cross section of the delivery tool 120 when assembled as shown in FIG. 54A, the implant retainer 200 is received in the sleeve 210 such that the ribs 405 are matingly received in the corresponding slots 440 and the ring 410 abuts against the distal end 420 of the sleeve 210. The implant retainer 200 extends through the sleeve 210 such that the distal end of the implant retainer distally extends from the distal end of the sleeve 210. The proximal end of the retainer 200 is received in the volume 487 (see FIG. 54D) of the neck 470, the squared, pentagonal, or hexagonal portion 450 of the retainer 200 matingly received in the complementarily shaped volume 490 of the neck such that a lip 451 abuts against the step in the neck between the volume 490 of the neck and the rest of the volume of the neck distal thereto. The distal end of the neck 470 abuts against the proximal end 425 of the sleeve 210.

As illustrated in FIG. 54E, a first lock ring 460A is received in the groove 555 in the collar 465. A second lock ring 460B is received in the circumferential groove 475. A washer 460C is received on the neck 470 and abuts shoulder 476, which prevents washer 460C from advancing proximally beyond shoulder 476, and washer 460C is held in place distally by second lock ring 460B. Helical spring 455 circumferentially extends about the neck 470 between the washer 460C and the intermediate inner ring 530 of the collar 465. Thus, the spring biases the collar 465 distally on the neck 470. First lock ring 460A prevents collar 465 from distal disengagement from neck 470; the ring 460A, due to the forces exerted by a compressed spring 455 abuts washer 460C under normal conditions until manipulation by a medical person acting to move collar 465 proximally which in turn moves first lock ring 460A proximally thereby creating a further distance between first lock ring 460A and washer 460C.

As depicted in FIG. 54E, neck holes 480 can be configured to have a sufficient diameter to allow the retaining balls 461 to enter from the opening nearest the outer circumferential surface of the neck 470 and to be seated within holes 480, the configuration further allowing a portion of the retaining balls 461 to extend into the cylindrical void 487 such to allow sufficient engagement with groove 415 as further described below. The neck holes 480 can be further configured, as depicted in FIG. 54E, to have a slight reduction in their diameter, the reduction of diameter occupying a small portion of the holes 480 nearest the cylindrical void 487, thereby allowing for a configuration between neck 470, neck holes 480 and retaining balls 461 such that the retaining balls 461 are resistant to completely entering cylindrical void 487 after the removal of inner portion of the implant retainer 95 and implant retainer 200. The balls 461 are each held in their respective holes 480 in the neck 470 by the balls 461 being trapped between the neck holes 480 and inner circumferential surface of the collar 465. Therefore, when the collar 465 is biased distally on the neck, the balls 461 are inwardly forced by the reduced diameter region 540 to lock into the groove 415 of the retainer 200, retaining the proximal end of the retainer 200 in the handle/collar assembly. When the collar 465 is pulled proximally by a medical person using the tool 120, the balls 461 are exposed to the large diameter region 535, allowing the balls 461 sufficient play to radially outwardly move in the holes 480 to allow the balls to escape the groove 415, thereby allowing the proximal end of the retainer 200 to be removed from the handle/collar assembly.

As shown in FIG. **54**E, the lumens **495** and **445** are aligned to make one continuous lumen through the assembled tool **120**. Thus, the tool **120** can be fed over a guidewire, stylet, needle or etc., or such implements can be fed through the lumen. Also, a bone paste, in situ curable biocompatible material, or similar material can be fed through the lumen to an implant **1** positioned in the joint via the tool.

As can be understood from FIGS. **54**A-**54**E, the collar assembly **400** retains the proximal end of the arm assembly **285** in the neck of the handle **290**. The collar assembly **400** can be displaced proximally on the neck of the handle **290** to allow the proximal end of arm **285** to be removed from the neck of the handle. When the implant arm **285** is coupled to the handle **290**, the portions **200**, **210** of the implant arm **285** are locked together and prevented from displacing relative to each other. The handle and rest of the tool can be caused to rotate or otherwise displaced as a unit.

In the embodiment of the delivery tool **120** depicted in FIGS. **54**A-**54**E, the implant engagement arrangement is such that the shafts **230**, **232** may be simply be caused to rotate via direct rotating action of the physicians fingers against the shafts **230**, **232** and, more specifically, the proximal heads **240**, **242** of the shafts **230**, **232**. Reversing the rotation of the shafts will allow the shaft distal ends **245**, **247** to unthread from the confines of the implant threaded bores **270**, **271**.

In one embodiment, as can be understood from U.S. patent application Ser. No. 13/475,695, which was filed May 18, 2012 and is hereby incorporated by reference in its entirety, the sleeve **210** may be used to support an anchor delivery arm for delivering one or more anchors into and/or about the implant **1** once implanted in the sacroiliac joint space.

FIGS. **55**A-**55**E illustrate yet another embodiment of a sacroiliac joint implant **1** for implantation in a sacroiliac joint space defined between an ilium and a sacrum. As indicated in FIGS. **55**A-**55**E, the implant **1** includes an iliac member **700** and a sacrum member **702**, wherein the iliac member and a sacrum member are configured for overlapping, interlocking attachment with each other.

As shown in FIG. **55**E, the ilium member **700** includes a ilium engaging end **704** and a sacrum member engaging end **706** generally opposite the ilium member from the ilium engaging end. As illustrated in FIG. **55**D, the sacrum member **702** includes a sacrum engaging end and a ilium member engaging end **710** generally opposite the sacrum member from the sacrum engaging end. As can be understood from FIGS. **55**A-**55**C, the sacrum member engaging end and the ilium member engaging end are configured for overlapping, interlocking attachment with each other. This type of attachment is at least in part made possible, for example, by the sacrum member engaging end and the ilium member engaging end each have a folded configuration. Each folded configuration includes a free end portion **711**, **712** extending into an intermediate portion **713**, **714** that is generally parallel to the free end portion and offset from the free end portion so as to define a gap **715**, **716** between the free end portion and the intermediate portion.

As illustrated in FIGS. **55**A-**55**C, when the sacrum member engaging end **706** and the ilium member engaging end **710** are in overlapping, interlocking attachment with each other, the free end portion **712** of the sacrum member engaging end is located in the gap **715** of the ilium member engaging end, and the free end portion **711** of the ilium member engaging end is located in the gap **716** of the sacrum member engaging end.

As shown in FIG. **55**D, the free end portion **712** of the sacrum member includes a cylindrical extreme edge **720**. As indicated in FIG. **55**E, the ilium member includes a cylindrical groove **721** defined in the gap of the ilium member at a junction between the free end and intermediate portions of the ilium member. Thus, as illustrated in FIGS. **55**A-**55**E, when the sacrum member engaging end and the ilium member engaging end are in overlapping, interlocking attachment with each other, the cylindrical extreme edge is matingly received in the cylindrical groove. In some embodiments, the overlapping, interlocking attachment may be such that the members **700**, **702** are held generally rigid relative to each other. In other embodiments, there may be some play between the members **700**, **702** when in the overlapping, interlocking attachment with each other. For example, the when the cylindrical extreme end is matingly received in the cylindrical groove, the cylindrical extreme end may be slid along the cylindrical groove. Alternatively or additionally, when the cylindrical extreme end is matingly received in the cylindrical groove, the ilium member and sacrum member may be displaced relative to each other transverse to a length of the cylindrical groove. Depending on the embodiment and the desires of the physician implanting the implant **1**, displacement between the members when interlocked may be limited to a greater or lesser extent by the placement of one or more end caps **725** threaded into or otherwise mechanically secured in one or more extreme ends of the cylindrical groove at points A, as indicated in FIGS. **55**A-**55**B. In one embodiment, a spring or resilient member may be positioned between an end cap **725** and the respective edge of the sacrum member to allow some movement of the sacrum member within the groove **721** yet bias the sacrum member to a neutral position within the groove **721**.

As shown in FIG. **55**E, the ilium member **700** further includes an extension portion **730** extending from its intermediate portion **713** and terminating in the ilium engaging end **704**. The extension portion of the ilium member curves as it extends from the intermediate portion of the ilium member to terminate in the iluim engaging end.

As indicated in FIG. **55**D, the sacrum member **702** further includes an extension portion **731** extending from its intermediate portion **714** and terminating in the sacrum engaging end **708**. The extension portion of the sacrum member is generally straight as it extends at an angle B from the intermediate portion of the sacrum member to terminate in the sacrum engaging end. The angle B may be approximately 90 degrees or, in some embodiments, between approximately 45 degrees and approximately 135 degrees.

In some embodiments, the ilium engaging end **704** and sacrum engaging end **708** may terminate in a feature **735**, **736** adapted to facilitating anchoring to the respective bones. For example, one or both of the respective features **735**, **736** may have T-flange configuration termination, as shown in FIGS. **55**A-**55**E.

As can be understood from FIGS. **55**A-**55**E, the various portions **711**, **713**, **730** of the iluim member **700** are formed of a generally continuous wall structure **740** having a length extent and a width that are both significantly greater than a thickness of the wall structure. Similarly, the various portions **712**, **714**, **731** of the sacrum member **702** are formed of a generally continuous wall structure **741** having a length extent and a width that are both significantly greater than a thickness of the wall structure. While the members **700**, **702** may have a generally rectangular shape, in other embodi-

ments, the members **700**, **702** may curve similar to the implant members **53**, **56** depicted in FIG. **36** discussed above.

In one embodiment, the iliac member **700** may be implanted first by inserting the iliac member **700** into the sacroiliac joint with the T-flange **736** extending into the ilium bone material and the sacrum member engaging portion **406** located in the space of the sacroiliac joint. In inserting the iliac member into the joint space, one edge of the wall structure **742** at one end of the cylindrical groove **721** and T-flange **736** may serve as the distal or leading edge of the iliac member **700**, and the opposite end may serve as the proximal or trailing edge of the member **700** and be configured for coupling with any of the delivery tools **120** discussed above. Once the ilium member **700** is implanted as desired, as similar process can be followed to implant the sacrum member **702**, with the T-flange extending into the sacrum bone material and the ilium member engaging portion **710** located n the space of the sacroiliac joint, the portion **712** sliding into the groove **715** to create the overlapping, interlocking attachment of the two members **700**, **702**. In some embodiments, to facilitate easy insertion, the wall structure of the members **700**, **702** may be bullet shaped at their respective distal end edges instead of having the distal blunt edges depicted in FIGS. **55**A-**55**E. Also, in some embodiments, instead of being inserted iliac member first, the order could be reversed or both members could be coupled together and then inserted together.

FIGS. **56**A-**56**F illustrate yet another embodiment of a sacroiliac joint implant **1**, wherein the implant **1** is configured for transverse implantation across a sacroiliac joint. As indicated in FIGS. **56**A-**56**F, the implant **1** includes an iliac member **800** and a sacrum member **802**. The iliac member **800** includes a first bore **805** defined in the iliac member. The iliac member may any shape, including, for example, the boxed-triangular shape illustrated. The sacrum member **802** includes a second bore **806** defined in the sacrum member. The sacrum member may be any shape, including, for example, the boxed-triangular shape illustrated. The bores **805**, **806** may extend through the longitudinal length of each respective member **800**, **802**.

The implant **1** also includes a connecting member **810** having a first end **811** and a second end **812** opposite the first end. The first end **811** is received in the first bore **805** and the second end **812** received in the second bore **806**. The connecting member connects the iliac member to the sacrum member.

The implant **1** also includes a spacing member **815** extending about the connecting member **810** and having a third end **816** and a fourth end **817** opposite the third end. The third end **816** contacts the iliac member **800** and the fourth end **817** contacts the sacrum member **802**. As shown in FIGS. **56**A and **56**D, the spacing member maintains the iliac member and sacrum member spaced apart from each other.

As indicated in FIG. **56**D, the first bore **805** extends a longitudinal length of the iliac member **800**. Similarly, the second bore **806** extends a longitudinal length of the sacrum member **802**.

As illustrated in FIGS. **56**A-**56**D, the first end **811** includes a head **820** having a diameter greater than a diameter of a shaft portion **821** of the connecting member **810**. Similarly, the second end **812** includes a head **823** having a diameter greater than the diameter of the shaft portion **821** of the connecting member **810**. In one embodiment, the at least one of the heads (e.g., the second head **823**) is removably coupled to the shaft portion **821**. As indicated in FIGS. **56**D and **56**E, this may coupling may be accomplished via a setscrew **825** extending through the second head **823** and into the second end **812** of the connecting member **810**.

As can be understood from FIGS. **56**A-**56**E, the end openings **730**, **731** of the respective bores **805**, **806** of the respective members **800**, **802** may have a stepped, recessed configuration and be configured to matingly receive the respective heads **820**, **823** in a recessed manner. In a similar fashion, each opposite opening **835**, **836** of the respective bores **805**, **806** of the respective members **800**, **802** may have a stepped, recessed configuration and be configured to receive in a recessed fashion the respective ends **816**, **817** of the spacing member **815**.

The connecting member **810** may be a cylindrical body and the spacing member **815** may be a cylindrical sleeve. The cylindrical body and cylindrical sleeve may be in coaxially arranged. The connecting member and spacing member may have sufficient rigidity to maintain the members **800**, **802** in a fixed spaced apart relationship once implanted such that the members **800**, **802** do not migrate towards or away from each other. However, in some embodiments, the connecting member **810** and spacing member **815** may have sufficient flexibility so as to allow the members **800**, **802** to deflect relative to each other a sufficient amount to mimic the natural flexion of a healthy sacroiliac joint while providing sufficient rigidity along the implant **1** so as to securely couple the sacrum and ilium together in a manner that generally replicates a natural connection between these two bones.

As illustrated in FIG. **56**F, in one embodiment, the interior of one or more of the respective bores **805**, **806** may have radially inward projecting features **850** that engage with radially recesses **851** defined in the outer circumferential surface of the connecting member **810** and/or the spacing member **815**. Such features **850** and recesses **851** may act to prevent rotation between the members **800**, **802** and the members **810**, **815**.

In one embodiment, the implant **1** of FIGS. **56**A-**56**E can be implanted via the following example method: drill a hole generally lateral-medial through a sacrum, across the sacroiliac joint space and into a ilium; provide an iliac member **800** including a first bore **805** defined in the iliac member; provide a sacrum member **802** including a second bore **806** defined in the sacrum member; provide a connecting member **810** having a first end **811** and a second end **812** opposite the first end; couple the first end to the first bore **805** and insert the iliac member into the hole; position the iliac member **800** in a portion of the hole existing in the ilium, the connecting member **810** extending along the hole; extend a spacing member **815** over the connecting member, the spacing member having a third end **816** and a fourth end **817** opposite the third end, the third end contacting the ilium member **800**; and position the sacrum member **802** in a portion of the hole existing in the sacrum and coupling the second end **812** to the second bore **806**, the fourth end **817** contacting the sacrum member.

As can be easily understood from the foregoing, the basic concepts of the present invention including the best mode may be embodied in a variety of ways. The invention involves numerous and varied embodiments of a sacroiliac joint implant (**1**).

As such, the particular embodiments or elements of the invention disclosed by the description or shown in the figures or tables accompanying this application are not intended to be limiting, but rather exemplary of the numerous and varied embodiments generically encompassed by

the invention or equivalents encompassed with respect to any particular element thereof. In addition, the specific description of a single embodiment or element of the invention may not explicitly describe all embodiments or elements possible; many alternatives are implicitly disclosed by the description and figures.

It should be understood that each element of an apparatus or each step of a method may be described by an apparatus term or method term. Such terms can be substituted where desired to make explicit the implicitly broad coverage to which this invention is entitled. As but one example, it should be understood that all steps of a method may be disclosed as an action, a means for taking that action, or as an element which causes that action. Similarly, each element of an apparatus may be disclosed as the physical element or the action which that physical element facilitates. As but one example, the disclosure of "an implant" should be understood to encompass disclosure of the act of "implanting"—whether explicitly discussed or not—and, conversely, were there effectively disclosure of the act of "implanting", such a disclosure should be understood to encompass disclosure of "implanting" and even a "means for implanting." Such alternative terms for each element or step are to be understood to be explicitly included in the description.

In addition, as to each term used it should be understood that unless its utilization in this application is inconsistent with such interpretation, common dictionary definitions should be understood to be included in the description for each term as contained in the Random House Webster's Unabridged Dictionary, second edition, each definition hereby incorporated by reference.

Moreover, for the purposes of the present invention, the term "a" or "an" entity refers to one or more of that entity. As such, the terms "a" or "an", "one or more" and "at least one" can be used interchangeably herein.

All numeric values herein are assumed to be modified by the term "about", whether or not explicitly indicated. For the purposes of the present invention, ranges may be expressed as from "about" one particular value to "about" another particular value. When such a range is expressed, another embodiment includes from the one particular value to the other particular value. The recitation of numerical ranges by endpoints includes all the numeric values subsumed within that range. A numerical range of one to five includes for example the numeric values 1, 1.5, 2, 2.75, 3, 3.80, 4, 5, and so forth. It will be further understood that the endpoints of each of the ranges are significant both in relation to the other endpoint, and independently of the other endpoint. When a value is expressed as an approximation by use of the antecedent "about," it will be understood that the particular value forms another embodiment.

Thus, the applicant(s) should be understood to claim at least: i) each of the devices herein disclosed and described, ii) the related methods disclosed and described, iii) similar, equivalent, and even implicit variations of each of these devices and methods, iv) those alternative embodiments which accomplish each of the functions shown, disclosed, or described, v) those alternative designs and methods which accomplish each of the functions shown as are implicit to accomplish that which is disclosed and described, vi) each feature, component, and step shown as separate and independent inventions, vii) the applications enhanced by the various systems or components disclosed, viii) the resulting products produced by such systems or components, ix) methods and apparatuses substantially as described hereinbefore and with reference to any of the accompanying examples, x) the various combinations and permutations of each of the previous elements disclosed.

The background section of this patent application provides a statement of the field of endeavor to which the invention pertains. This section may also incorporate or contain paraphrasing of certain United States patents, patent applications, publications, or subject matter of the claimed invention useful in relating information, problems, or concerns about the state of technology to which the invention is drawn toward. It is not intended that any United States patent, patent application, publication, statement or other information cited or incorporated herein be interpreted, construed or deemed to be admitted as prior art with respect to the invention.

The claims set forth in this specification, if any, are hereby incorporated by reference as part of this description of the invention, and the applicant expressly reserves the right to use all of or a portion of such incorporated content of such claims as additional description to support any of or all of the claims or any element or component thereof, and the applicant further expressly reserves the right to move any portion of or all of the incorporated content of such claims or any element or component thereof from the description into the claims or vice-versa as necessary to define the matter for which protection is sought by this application or by any subsequent application or continuation, division, or continuation-in-part application thereof, or to obtain any benefit of, reduction in fees pursuant to, or to comply with the patent laws, rules, or regulations of any country or treaty, and such content incorporated by reference shall survive during the entire pendency of this application including any subsequent continuation, division, or continuation-in-part application thereof or any reissue or extension thereon.

The claims set forth in this specification, if any, are further intended to describe the metes and bounds of a limited number of the preferred embodiments of the invention and are not to be construed as the broadest embodiment of the invention or a complete listing of embodiments of the invention that may be claimed. The applicant does not waive any right to develop further claims based upon the description set forth above as a part of any continuation, division, or continuation-in-part, or similar application.

The invention claimed is:

1. A method of treating a sacroiliac joint via implantation of an implant into a sacroiliac joint space defining a plane between a sacrum and an ilium and comprising a cranial portion and a caudal portion, the method comprising:

delivering an iliac member into the sacroiliac joint space, the iliac member including a first arcuate body including a distal end, a proximal end opposite the distal end, a concave superior surface, a convex inferior surface opposite the concave superior surface, an interface surface and a fixation surface generally opposite the interface surface, the iliac member delivered into the sacroiliac joint space such that: the concave superior surface faces an extra-articular region and the convex inferior surface faces away from the extra-articular region; the fixation surface of the iliac member engages the ilium; and the interface surface of the iliac member faces in a direction of the sacrum; and

delivering a sacrum member into the sacroiliac joint space, the sacrum member including a second arcuate body including a distal end, a proximal end opposite the distal end, a concave superior surface, a convex inferior surface opposite the concave superior surface, an interface surface and a fixation surface generally opposite the interface surface, the sacrum member delivered into

the sacroiliac joint space such that: the concave superior surface faces the extra-articular region and the convex inferior surface faces away from the extra-articular region; the fixation surface of the sacrum member engages the sacrum and the interface surface of the sacrum member faces in a direction of the ilium,

wherein the interface surface of the iliac member engages the interface surface of the sacrum member such that movement relative to one another is restricted when both the iliac member and the sacrum member are implanted in the plane of the sacroiliac joint space.

2. The method of claim **1**, further comprising sandwiching a core element between the interface surface of the iliac member and the interface surface of the sacrum member, such a sandwiched arrangement being a mechanism for engaging the interface surface of the iliac member with the interface surface of the sacrum member.

3. The method of claim **2**, wherein the interface surface of the iliac member is maintained in a spaced-apart arrangement from the interface surface of the sacrum member when the core element is sandwiched between the interface surfaces and the interface surfaces are engaged with each other.

4. The method of claim **2**, wherein the sandwiched arrangement is established before the iliac member and sacrum member are delivered into the sacroiliac joint space.

5. The method of claim **2**, wherein the sandwiched arrangement is established after the iliac member and sacrum member are delivered into the sacroiliac joint space.

6. The method of claim **1**, wherein, in engaging the interface surface of the iliac member with the interface surface of the sacrum member, the interface surfaces make direct physical contact and a feature of one of the interface surfaces is received in a feature of the other of the interface surfaces.

7. The method of claim **1**, wherein the engagement of the interface surface of the iliac member and the interface surface of the sacrum member results in a sliding mating contact.

8. The method of claim **7**, wherein the interface surface of the iliac member includes a first feature and the interface surface of the sacrum member includes a second feature that engages the first feature to partially limit sliding of the sliding mating contact.

9. The method of claim **1**, wherein the interface surface of the iliac member includes a first feature and the interface surface of the sacrum member includes a second feature that engages the first feature so as to limit movement between the iliac member and the sacrum member.

10. The method as in any of claim **8** or **9**, in which the first feature includes a protrusion and the second feature includes a recess in which the protrusion is received, or the second feature includes a protrusion and the first feature includes a recess in which the protrusion is received.

11. The method of claim **10**, wherein the protrusion includes a cylindrical element and the recess includes a channel element.

12. The method of claim **10**, wherein the protrusion includes a guide element generally in the form of an elongated ridge and the recess includes an elongated channel element.

13. The method of claim **10**, wherein the protrusion includes a convex surface and the recess includes a concave feature.

14. The method of claim **10**, wherein the protrusion includes a generally T-shaped cross section transverse to a length of the protrusion, and the recess includes a generally T-shaped cross section transverse to a length of the recess.

15. The method of claim **10**, wherein at least one of the fixation surface of the iliac member or the fixation surface of the sacrum member includes an outwardly projecting fixation member.

16. The method of claim **15**, wherein the fixation member includes at least one of a longitudinally extending rib or a longitudinally extending member having a T-shaped transverse cross section.

17. The method of claim **10**, wherein the engagement of the interface surface of the iliac member with the interface surface of the sacrum member is established before the iliac member and sacrum member are delivered into the sacroiliac joint space.

18. The method of claim **10**, wherein the engagement of the interface surface of the iliac member with the interface surface of the sacrum member is established after the iliac member and sacrum member are delivered into the sacroiliac joint space.

19. The method of claim **9**, wherein the restricted movement between the iliac member and the sacrum member allows for at least one of a rocking or sliding between the iliac member and the sacrum member.

20. The method of claim **1**, wherein at least one of the protrusion or recess extend along the first arcuate body of the iliac member, and at least one of the protrusion or recess extend along the second arcuate body of the sacrum member.

21. The method of claim **1**, wherein the iliac member and the sacrum member are delivered non-transversely into the sacroiliac joint space.

22. The method of claim **1**, wherein the iliac member and the sacrum member each comprise a curved longitudinal axis extending between the distal end and the proximal end.

23. The method of claim **1**, wherein the iliac member and the sacrum member are delivered into the sacroiliac joint space simultaneously with each other.

24. The method as in any of claim **1** or **23**, in which delivery of the iliac member and the sacrum member into the sacroiliac joint space is via a delivery tool releasably coupled at a distal end with the iliac member and the sacrum member.

25. The method of claim **24**, further comprising decoupling the iliac member and the sacrum member from the distal end of the delivery tool.

26. The method of claim **1**, wherein at least one of the fixation surface of the iliac member or the fixation surface of the sacrum member includes an outwardly projecting fixation member.

27. The method of claim **26**, wherein the fixation member includes at least one of a longitudinally extending rib or a longitudinally extending member having a T-shaped transverse cross section.

28. The method of claim **26**, wherein a curved length of the iliac member and the sacrum member defines a radius of about 20 mm to about 60 mm.

29. The method of claim **28**, wherein the outwardly projecting fixation member extends along at least a portion of the curved length of the iliac member or the sacrum member.

30. The method of claim **29**, wherein the outwardly projecting fixation member is curved along another radius that matches the radius.

31. The method of claim **1**, wherein a curved length of the iliac member and the sacrum member defines a radius of about 20 mm to about 60 mm.

32. The method of claim **1**, further comprising:

removing cartilage or bone from the sacroiliac joint space, the sacrum, or the ilium prior to delivery of the implant.

33. The method of claim 32, further comprising:

forming a sacral channel in the sacrum, and forming an iliac channel in the ilium.

34. The method of claim 1, wherein, upon delivery of the iliac member and the sacrum member into the sacroiliac joint space, the distal ends of the first arcuate body and the second arcuate body are positioned in the cranial portion of the sacroiliac joint space, and the proximal ends of the first arcuate body and the second arcuate body are positioned in the caudal portion of the sacroiliac joint space.

35. The method of claim 34, wherein a curved length of the iliac member and the sacrum member defines a radius of about 20 mm to about 60 mm.

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