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(54) **POLYAXIAL BONE SCREW WITH SPHERICAL CAPTURE, COMPRESSION INSERT AND ALIGNMENT AND RETENTION STRUCTURES**

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See application file for complete search history.

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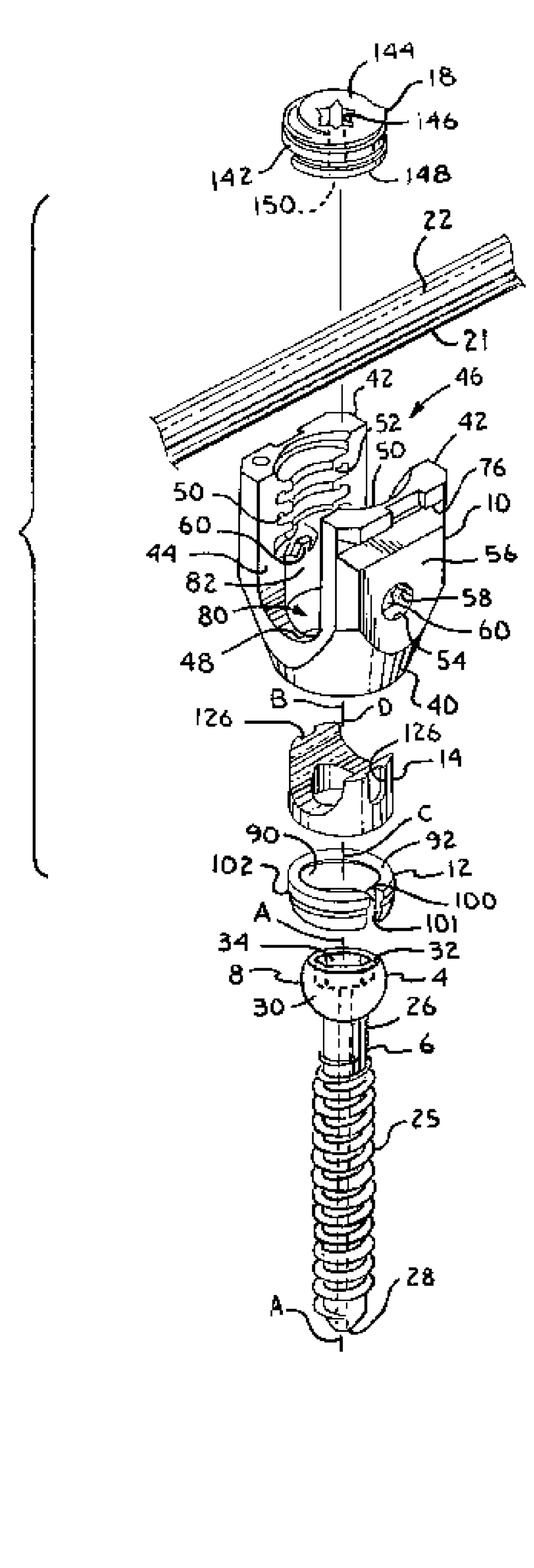
(57) **ABSTRACT**

A polyaxial bone screw assembly includes a receiver, a shank, an articulation structure for retaining the shank in the receiver and a compression insert for engagement with a longitudinal connecting member such as a rod. The articulation structure includes substantially spherical convex and concave surfaces that slidably engage both shank and receiver surfaces to provide compound articulation between the receiver and the shank. The receiver includes inwardly directed spring tabs engaging the insert and prohibiting rotation of the insert within the receiver.

46 Claims, 9 Drawing Sheets



Related U.S. Application Data

11/385,957, filed on Mar. 21, 2006, now abandoned, which is a continuation-in-part of application No. 11/178,854, filed on Jul. 11, 2005, now Pat. No. 7,789,896.

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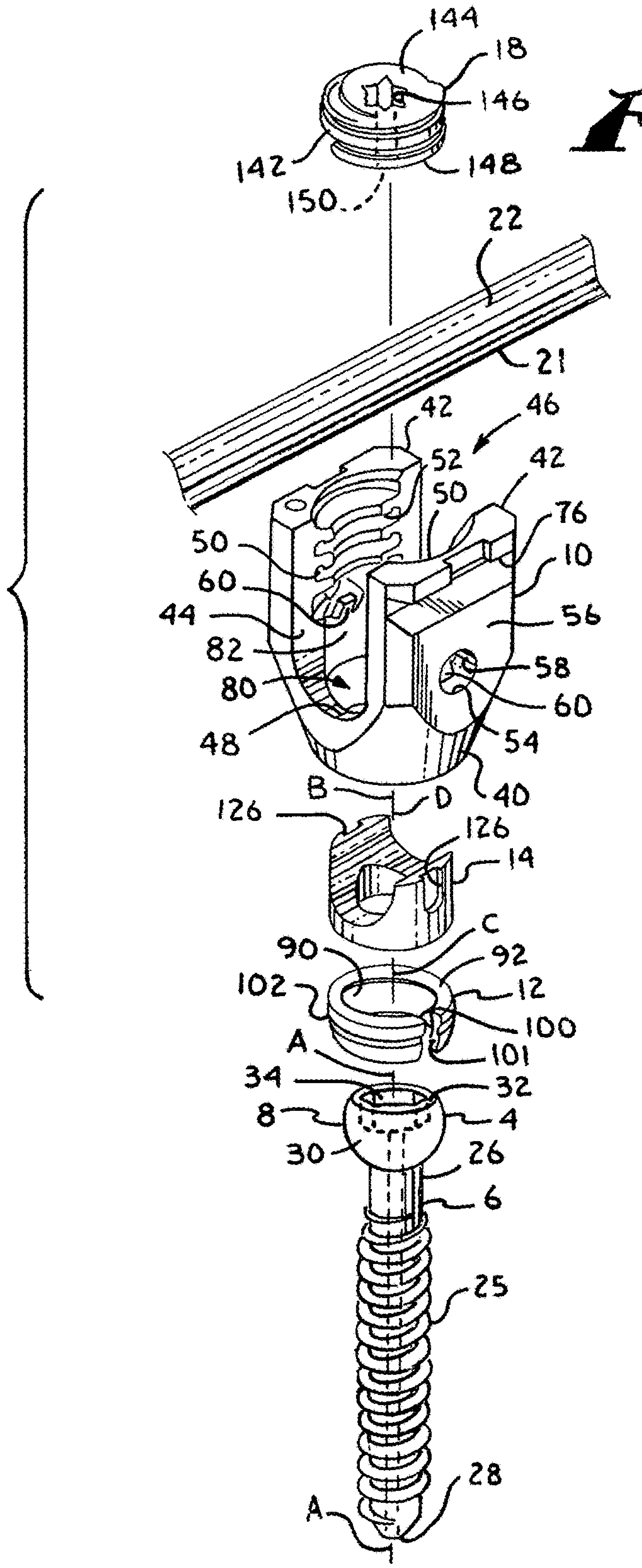
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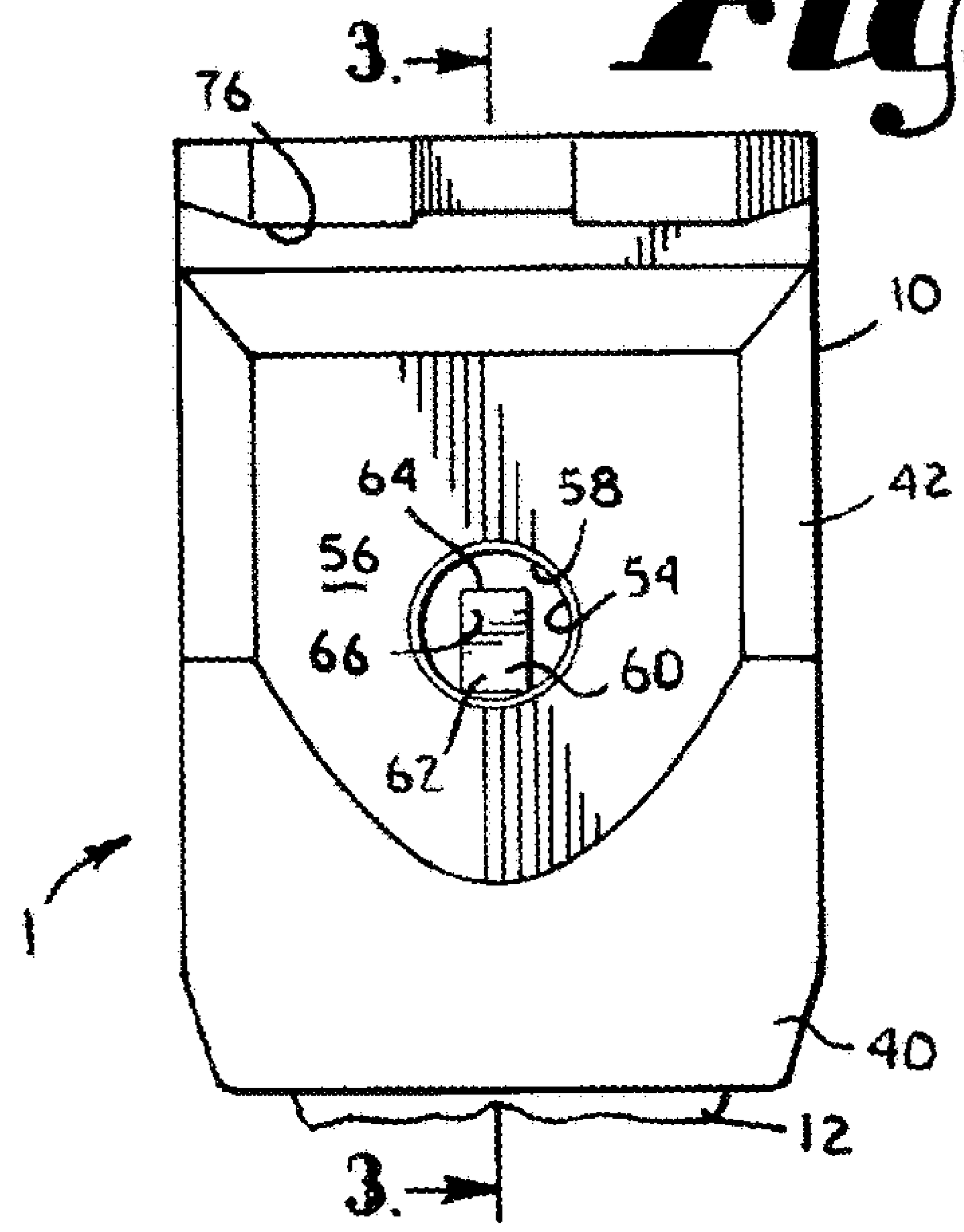
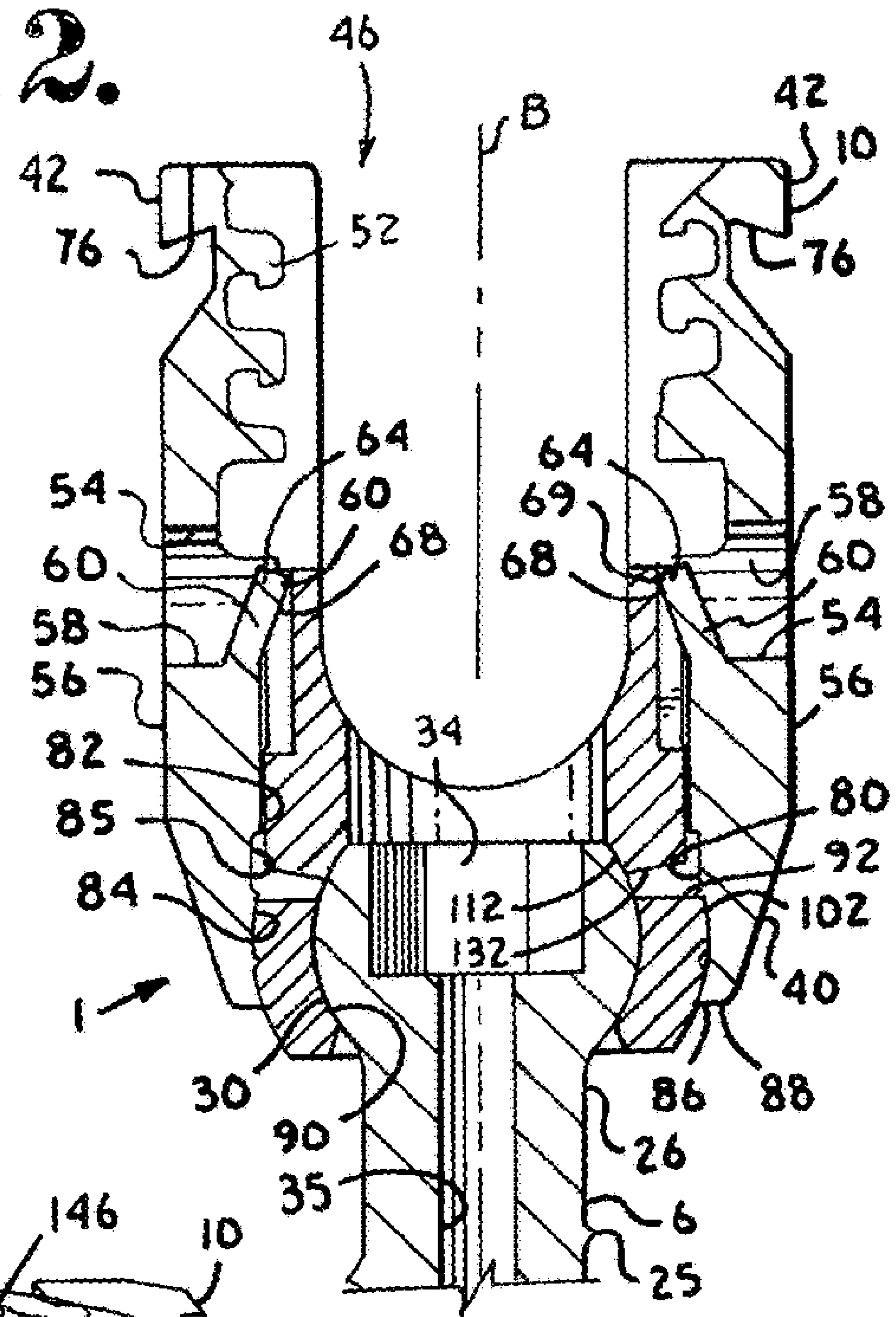
Fig. 1.

Fig. 2.





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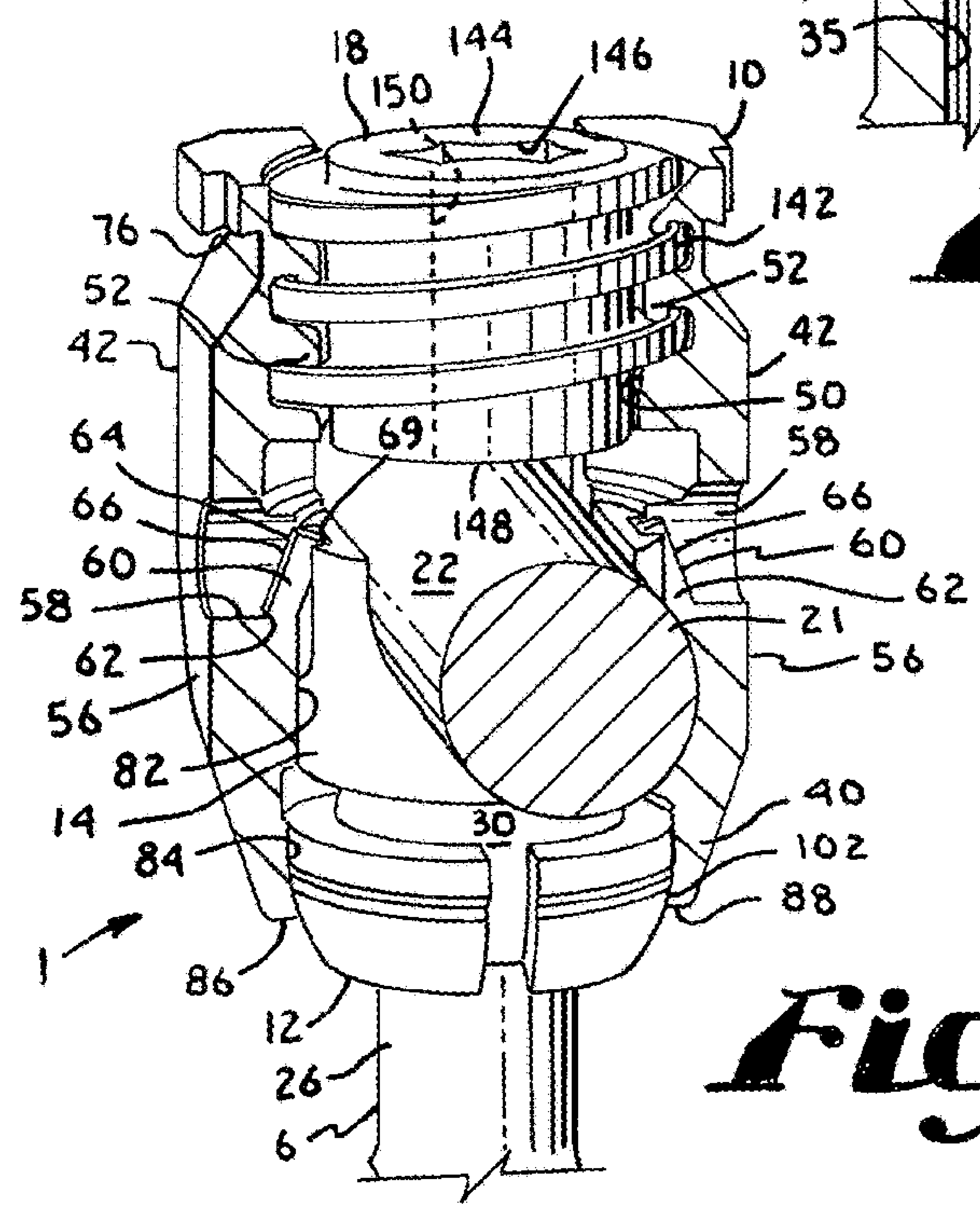
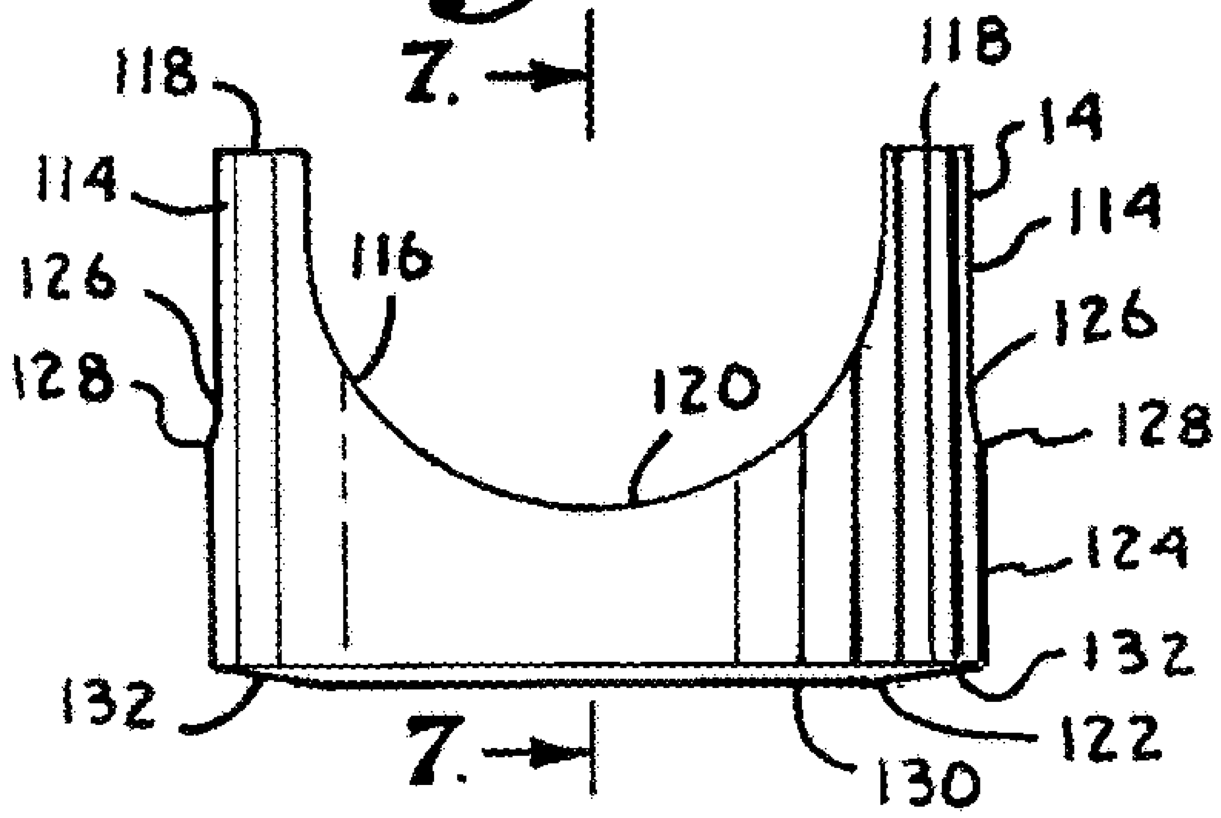


Fig. 4.

Fig. 5.



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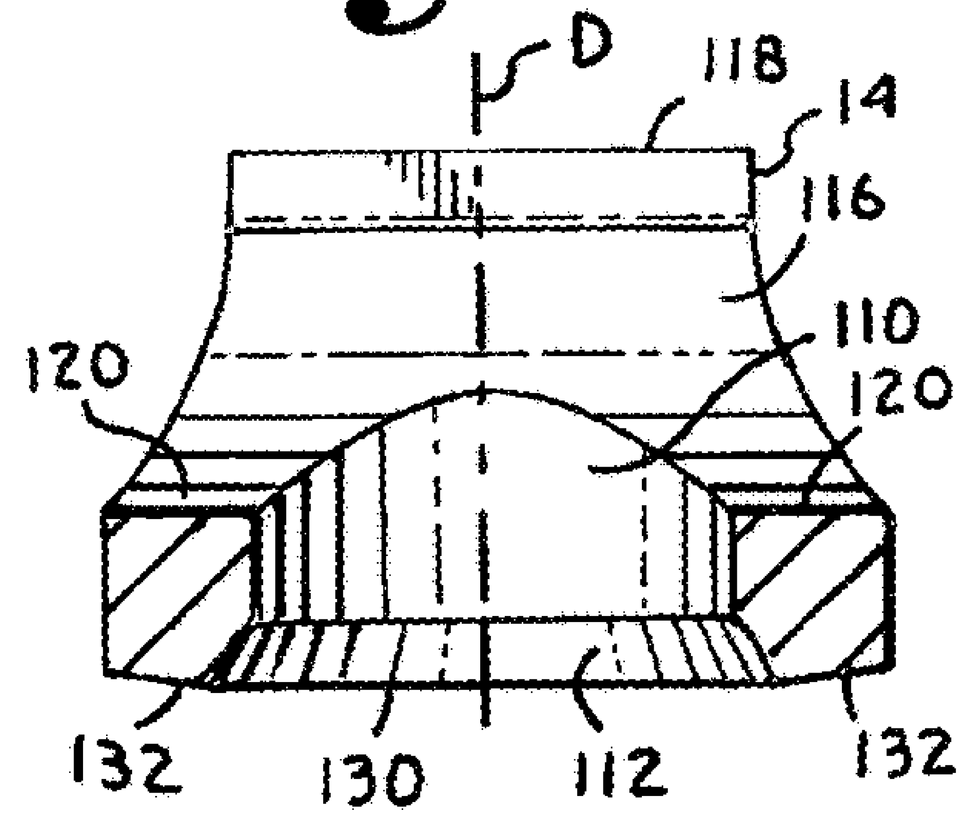

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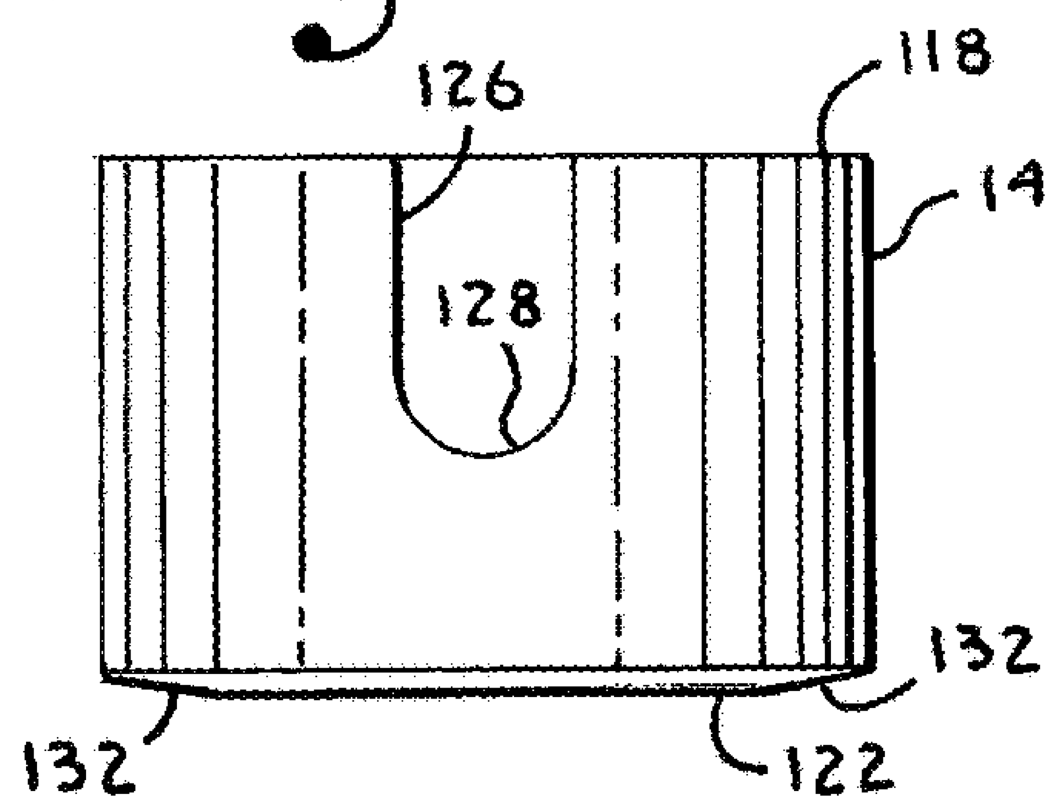

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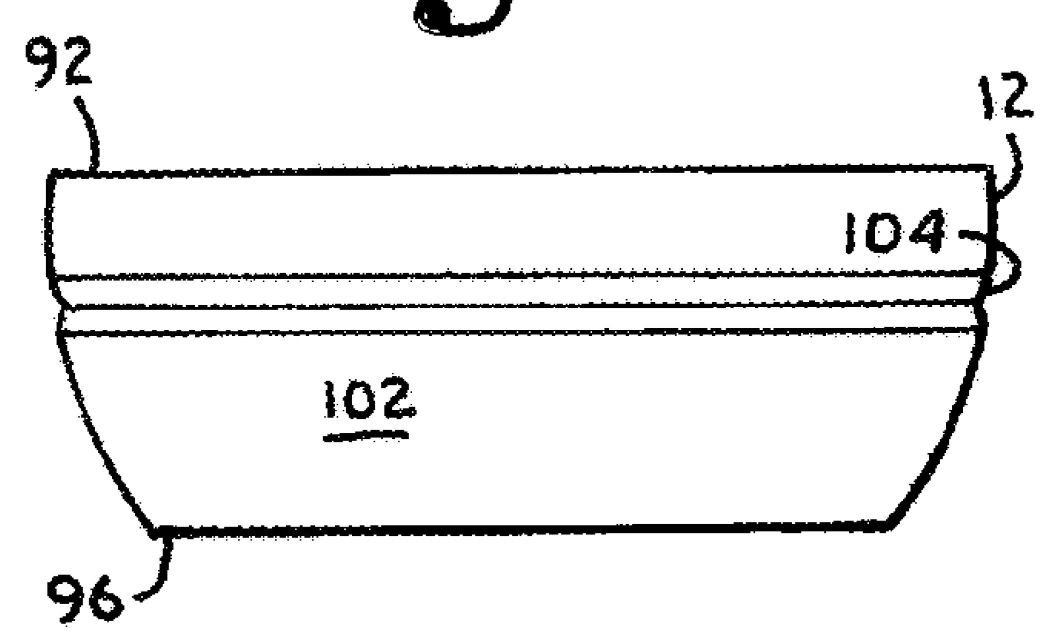

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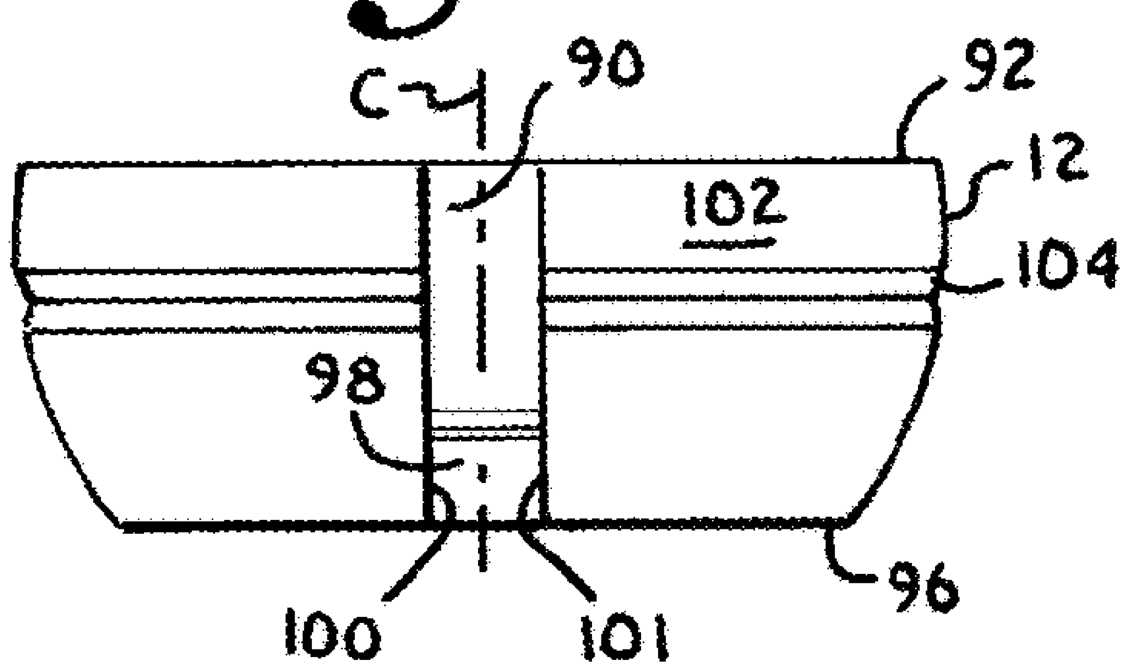

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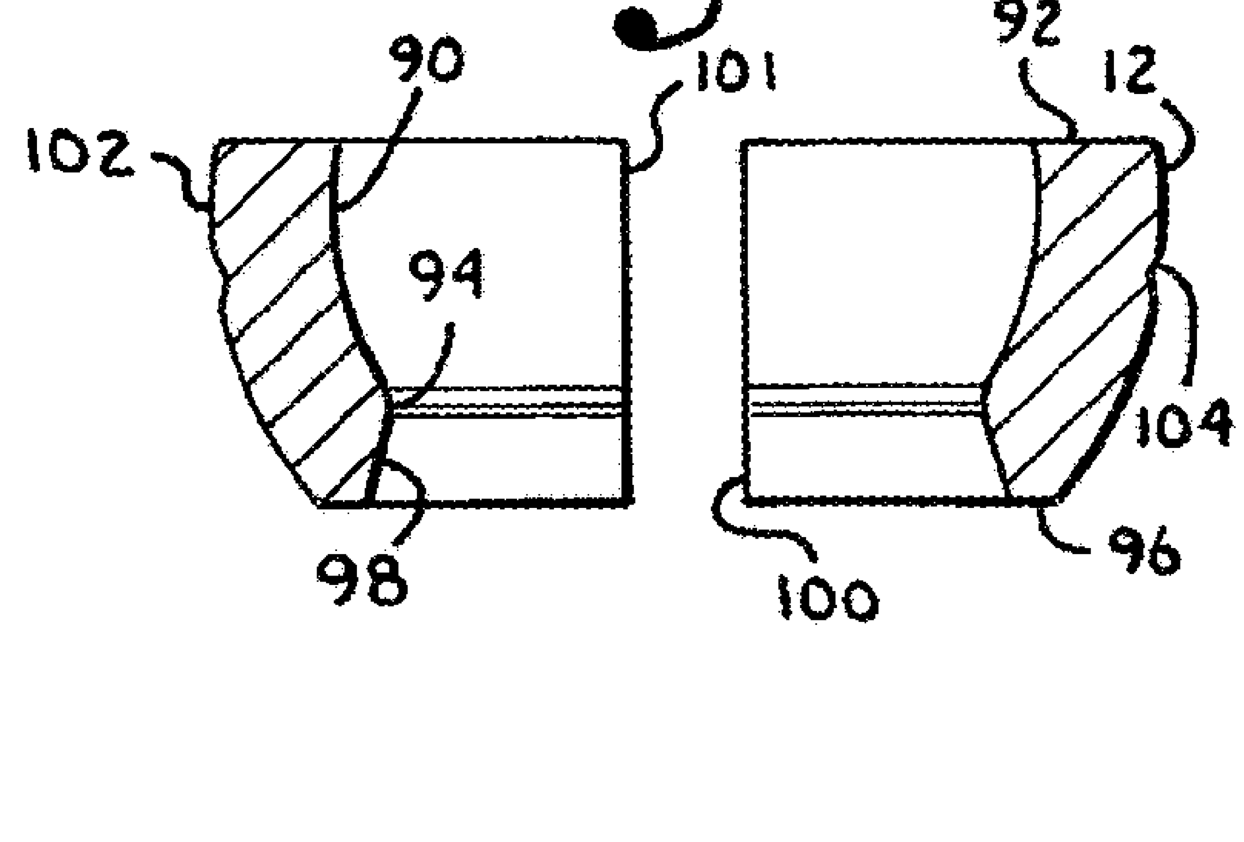

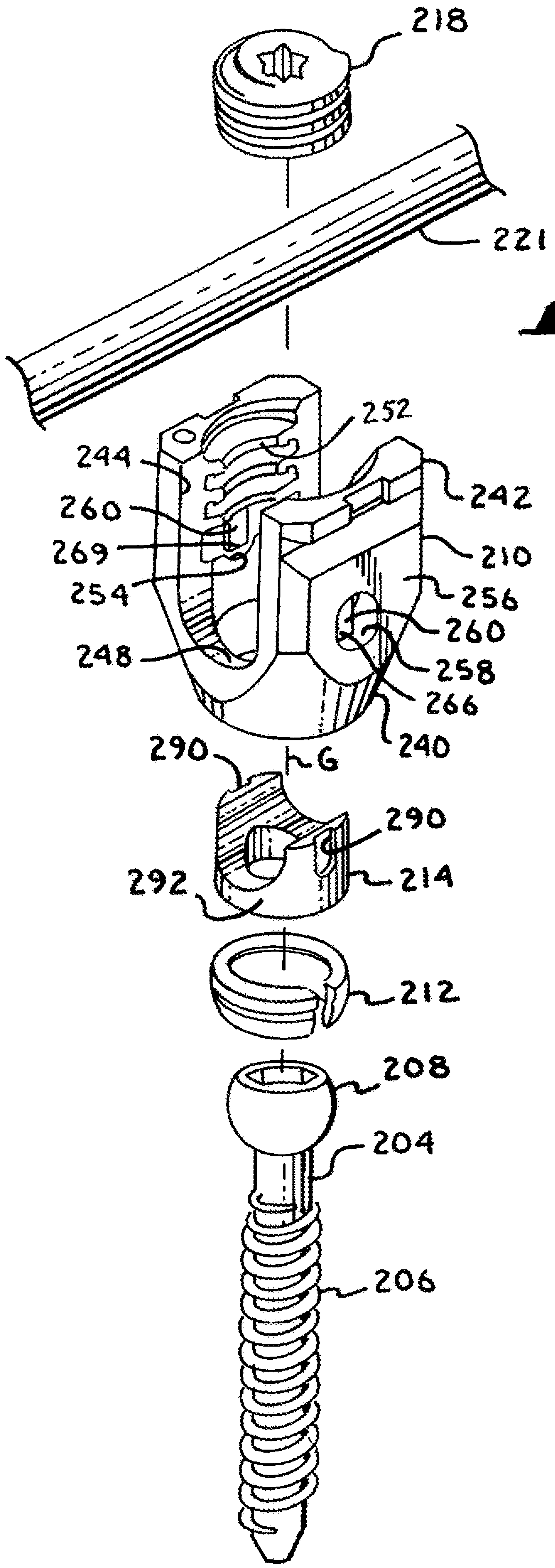
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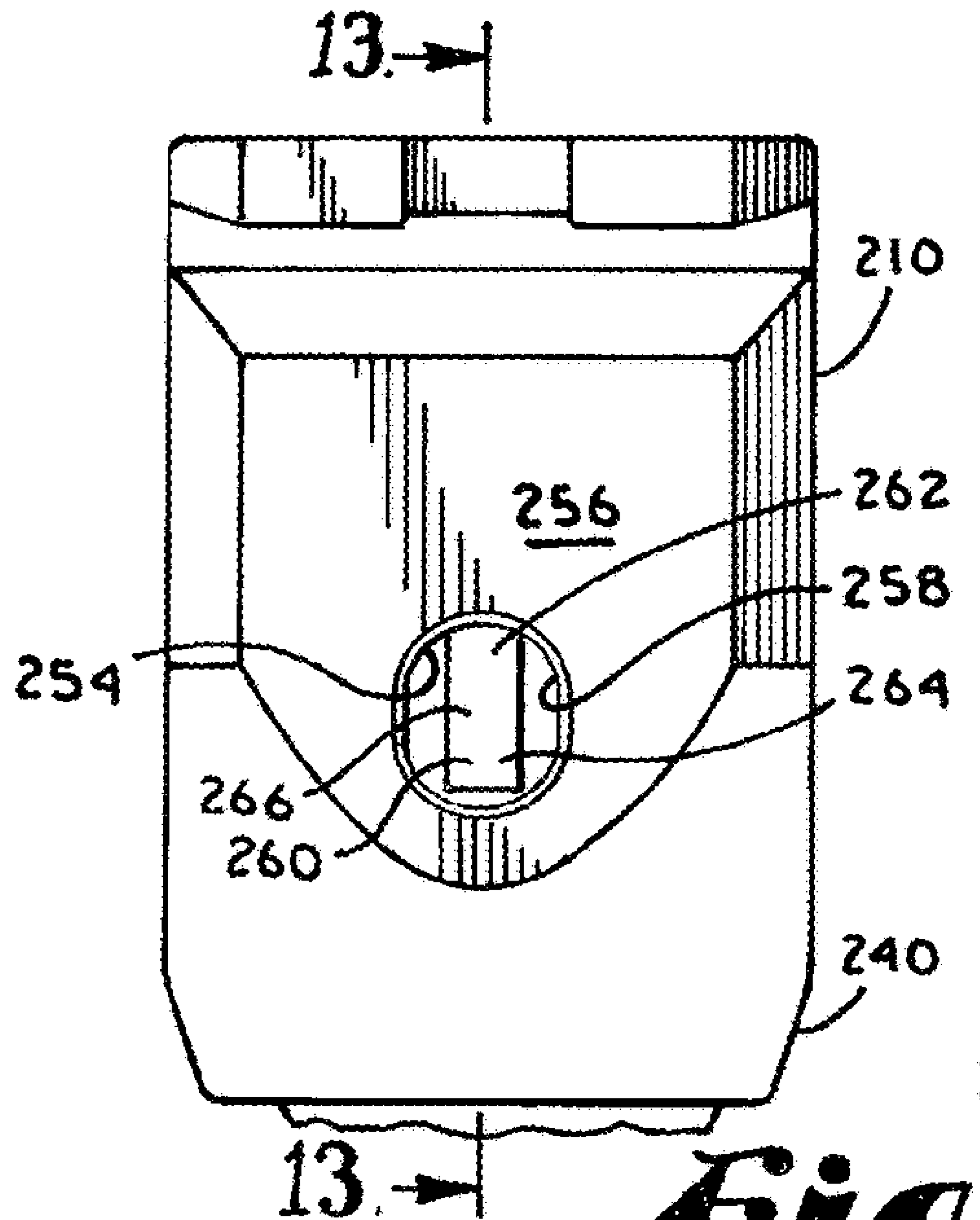
Fig. 11.



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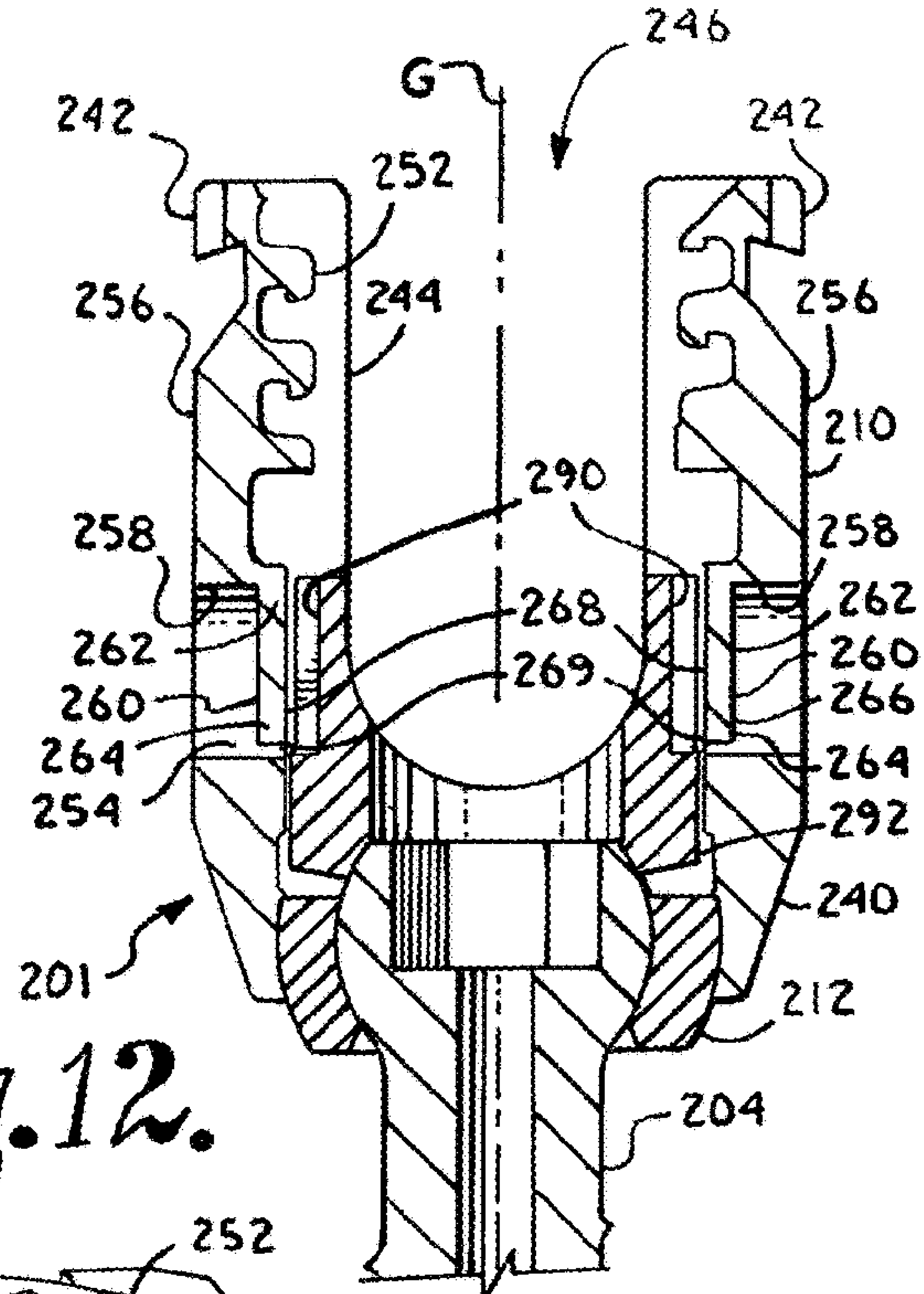

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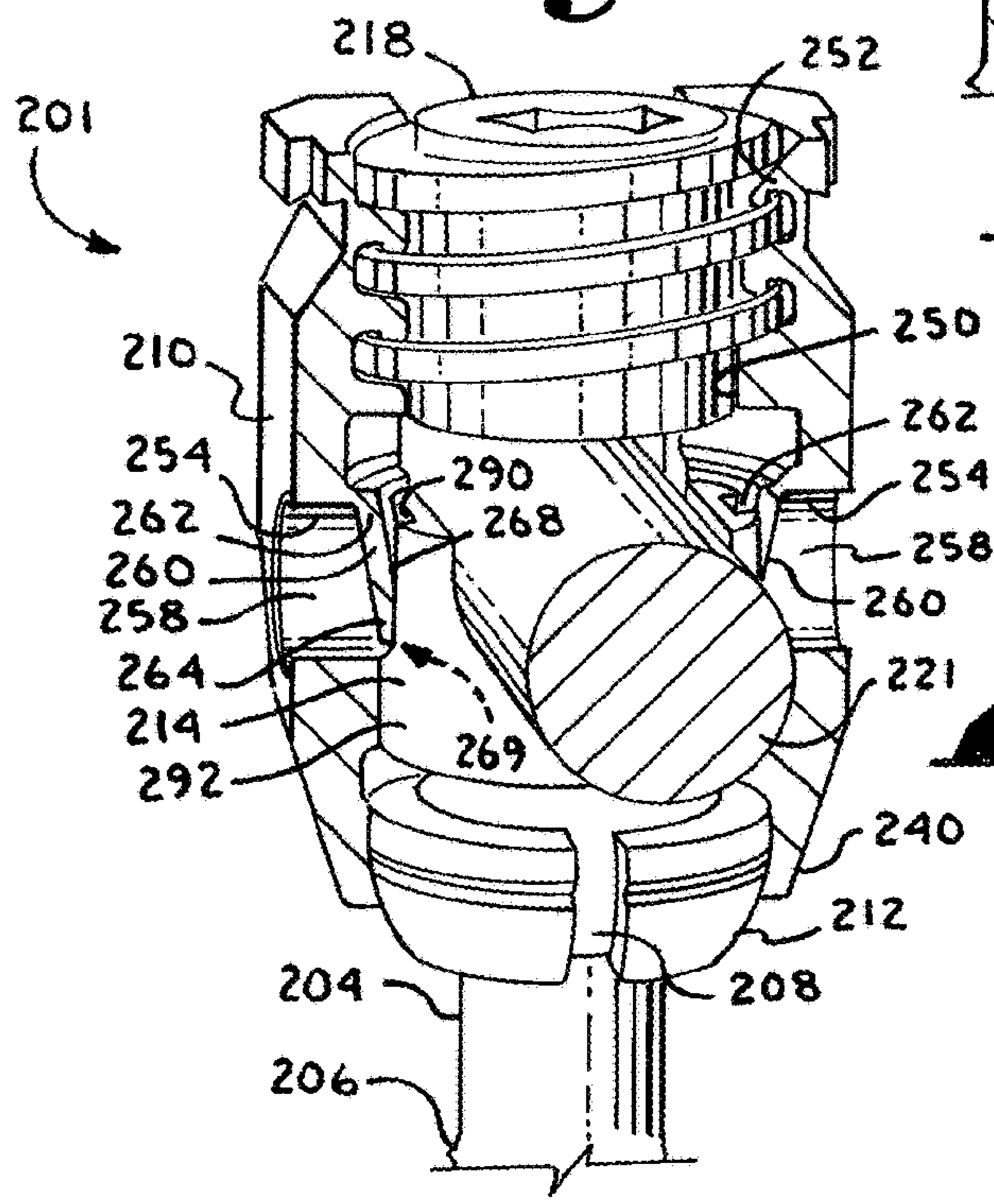
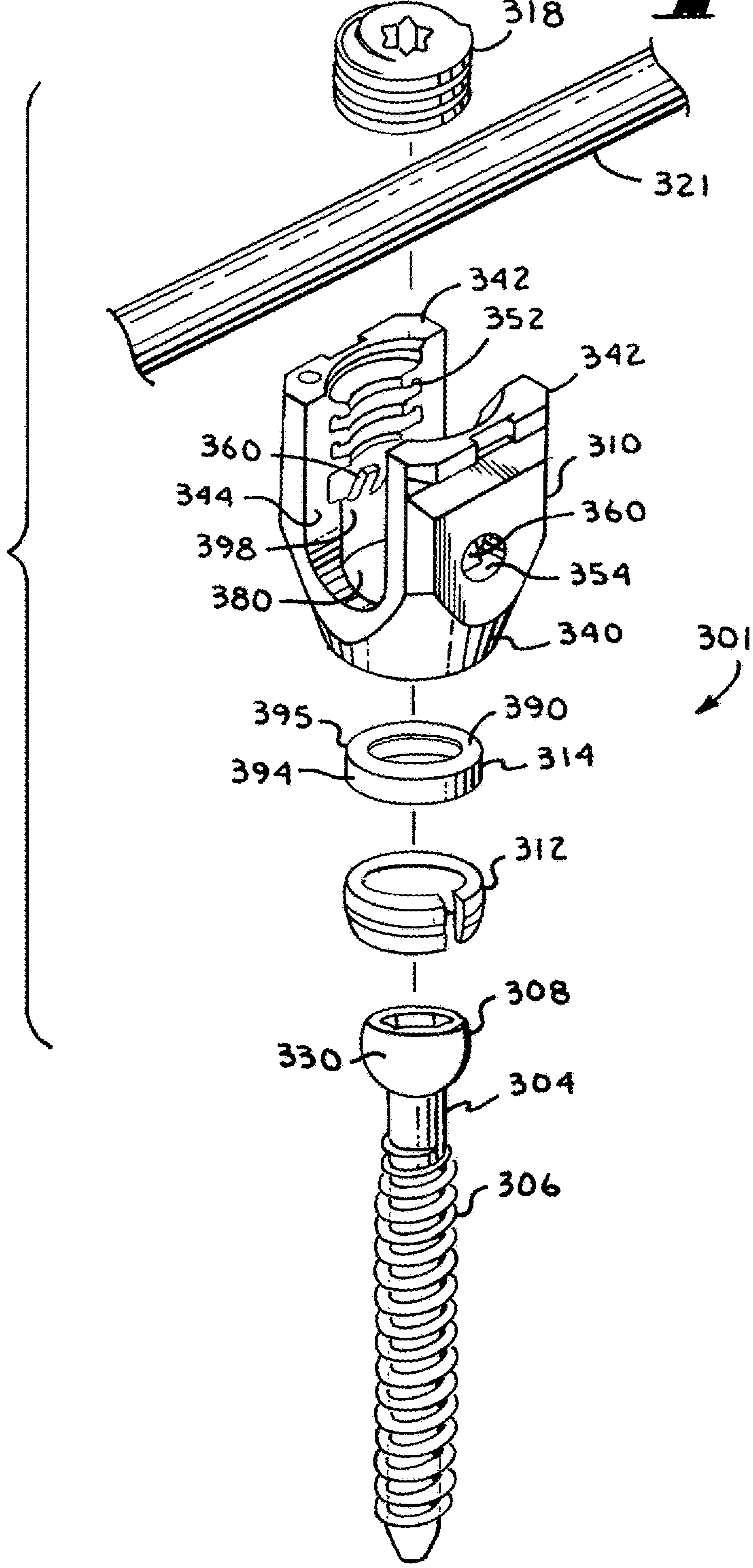


Fig. 14.

Fig. 15.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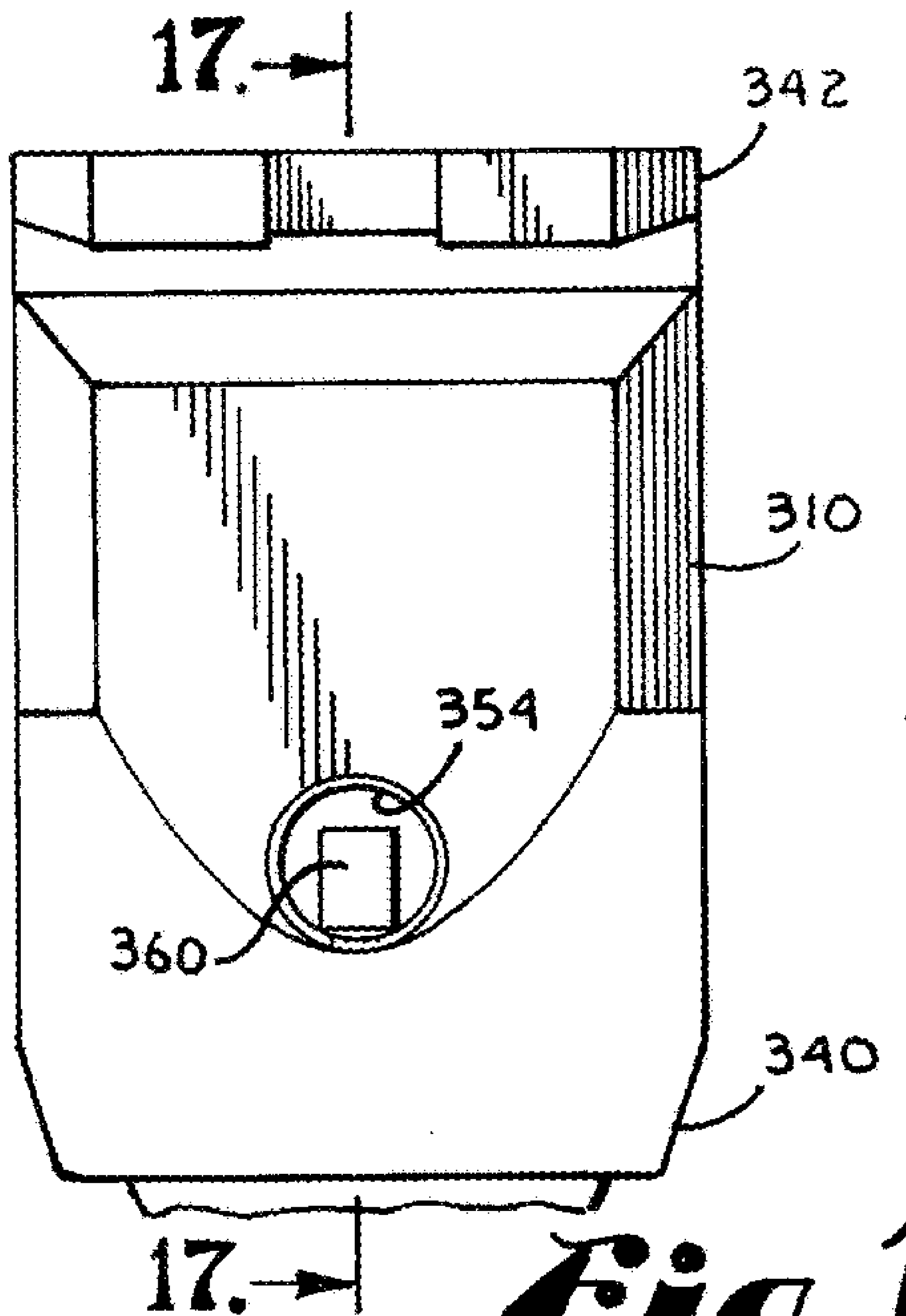

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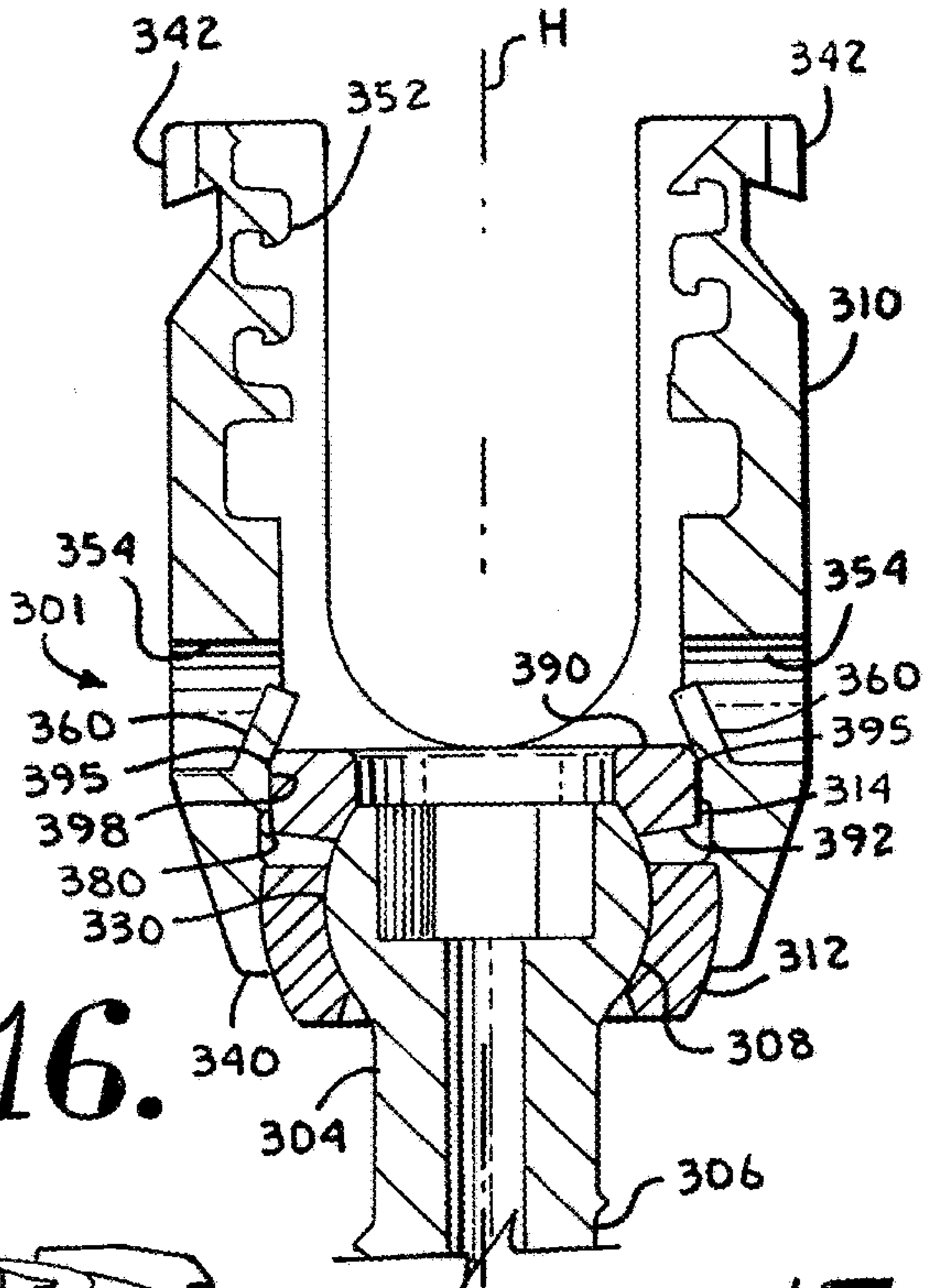

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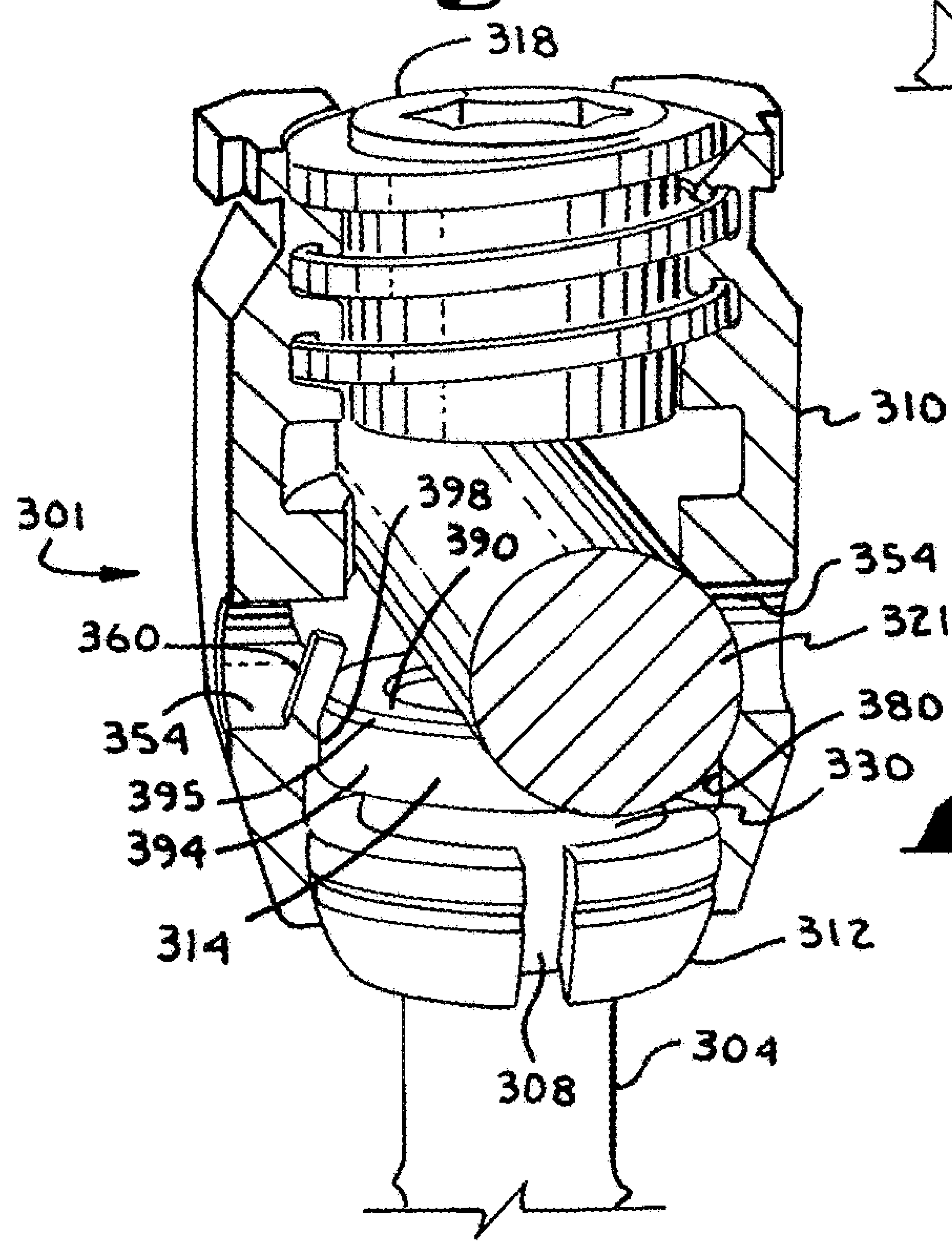
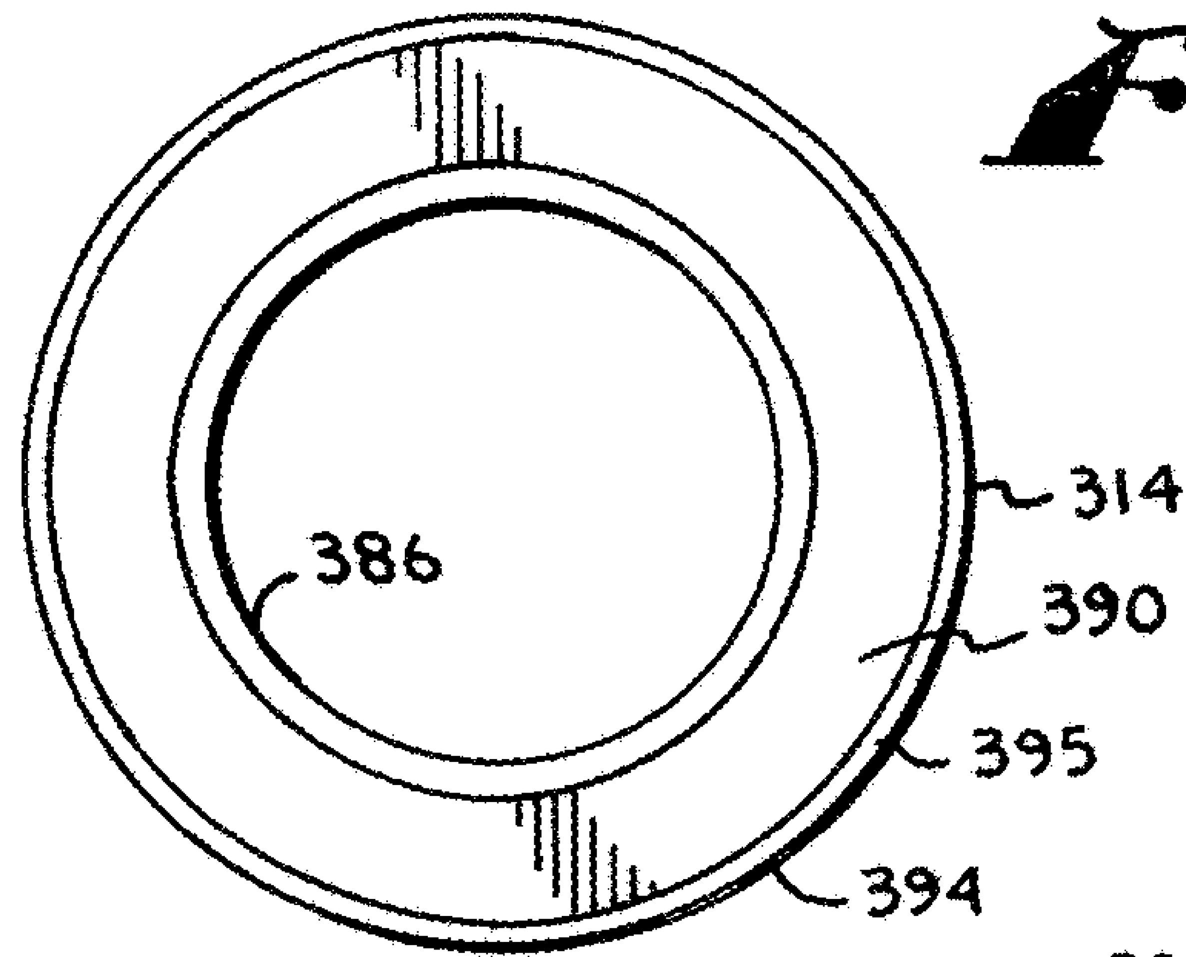


Fig.18.

Fig. 19.



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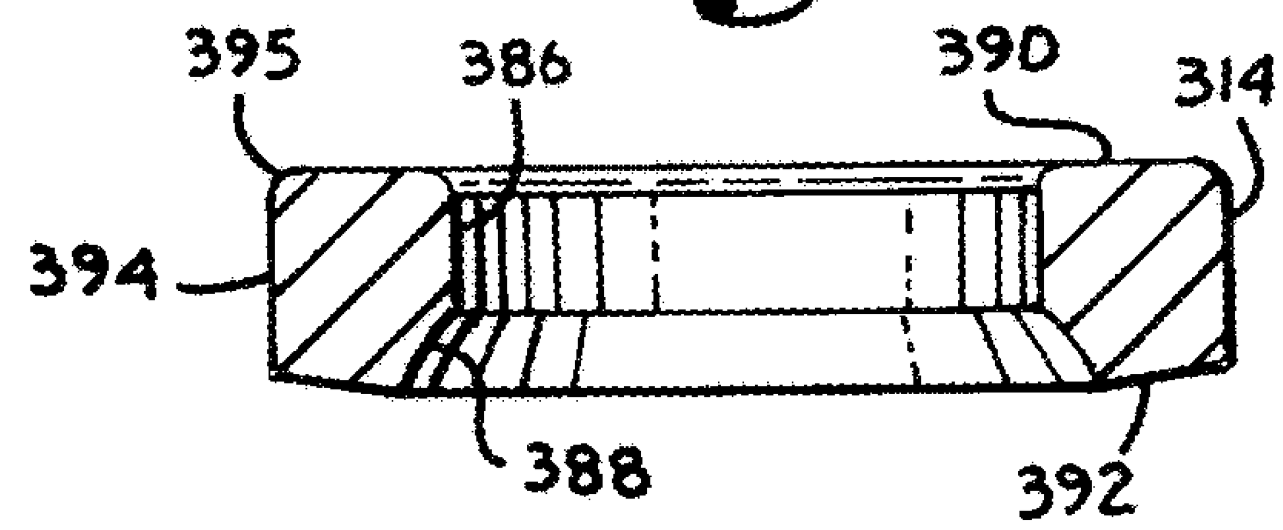

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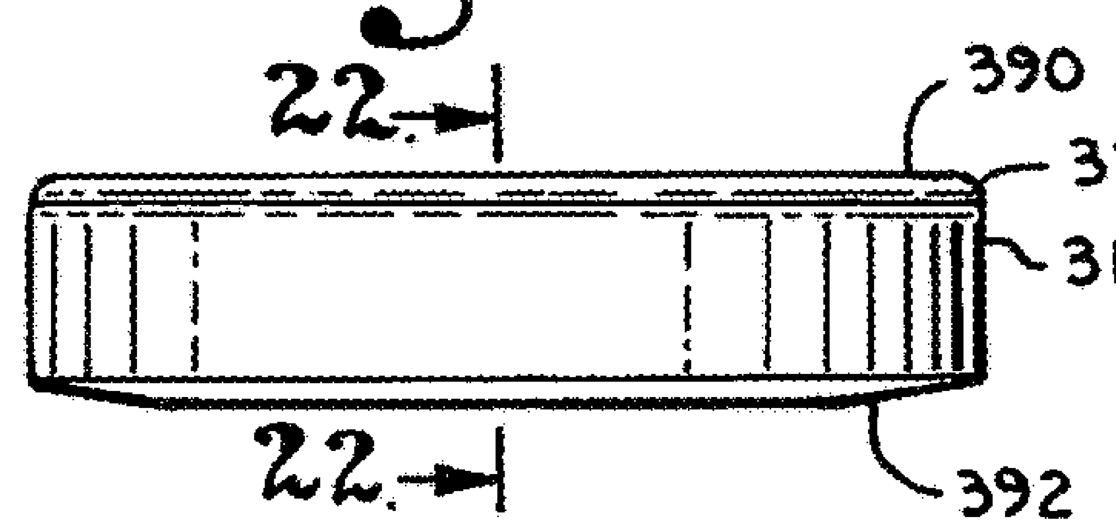

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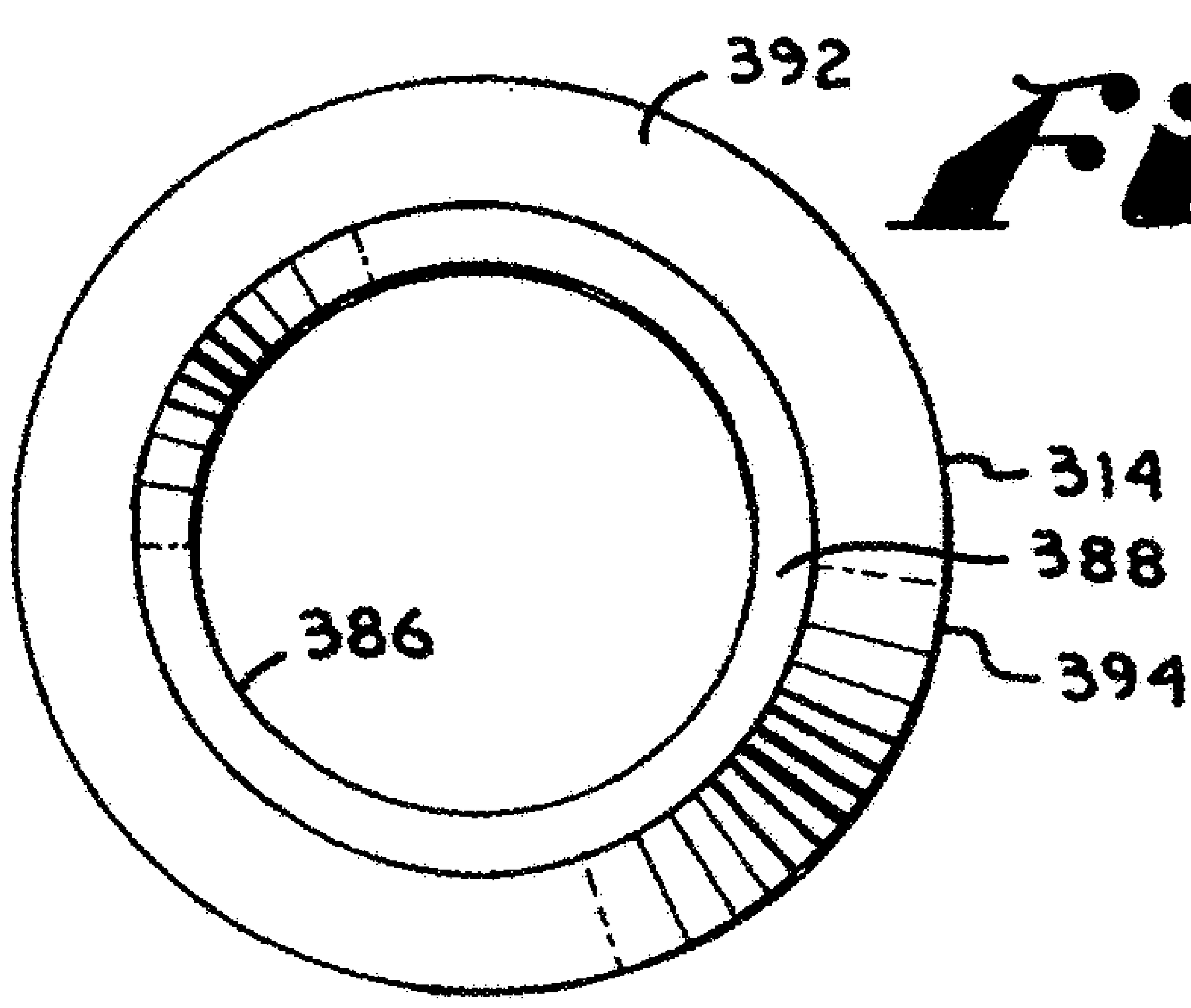

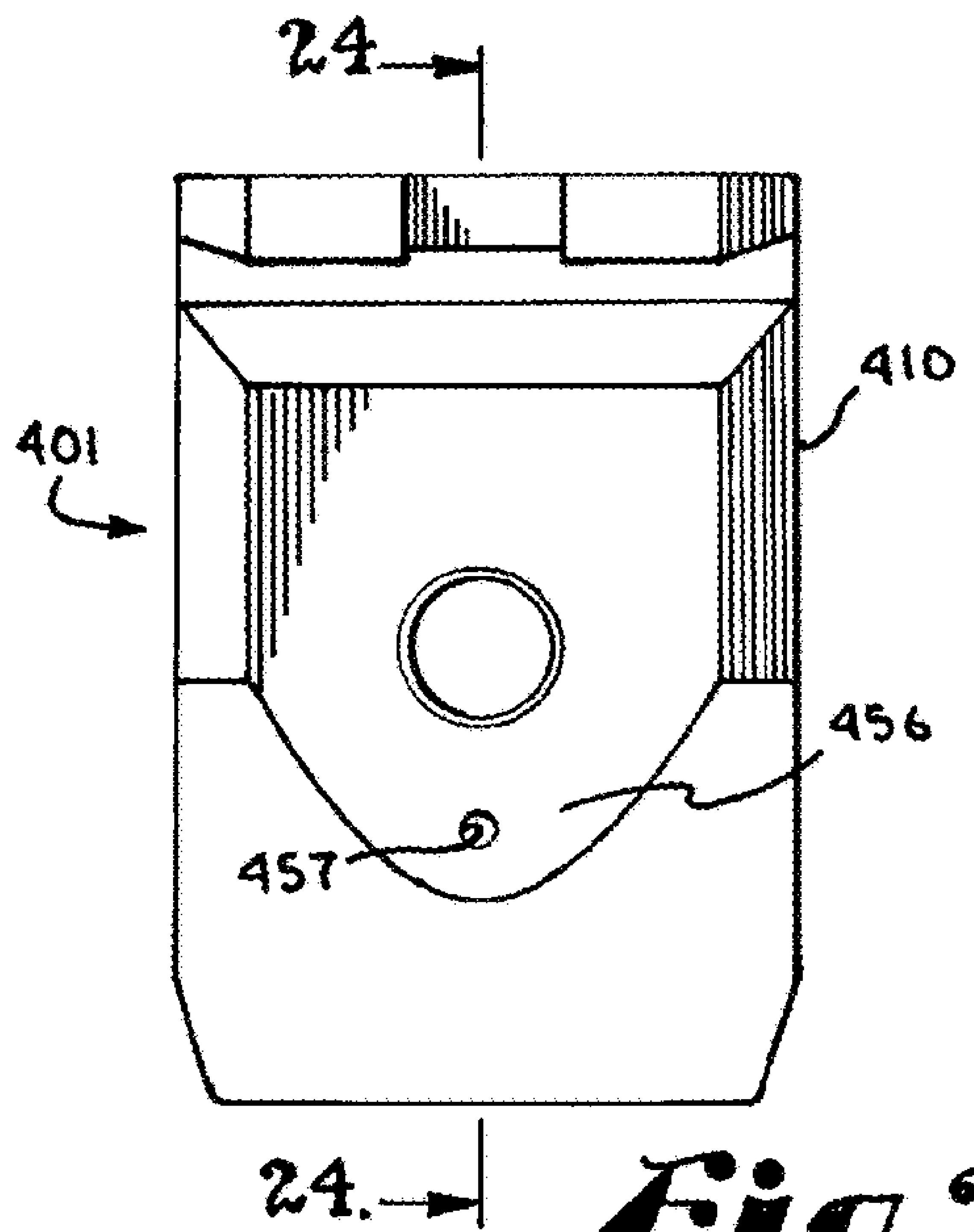

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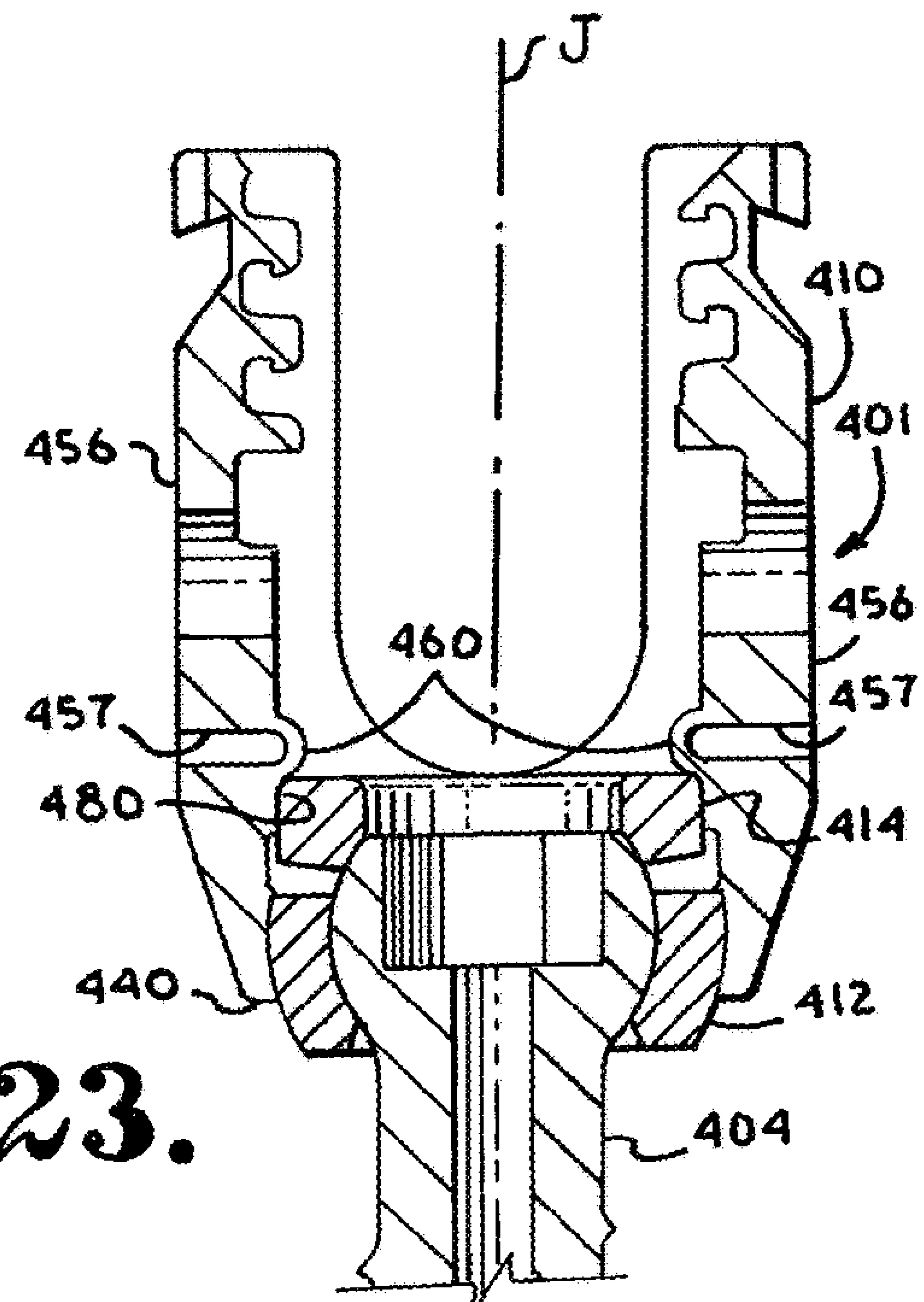
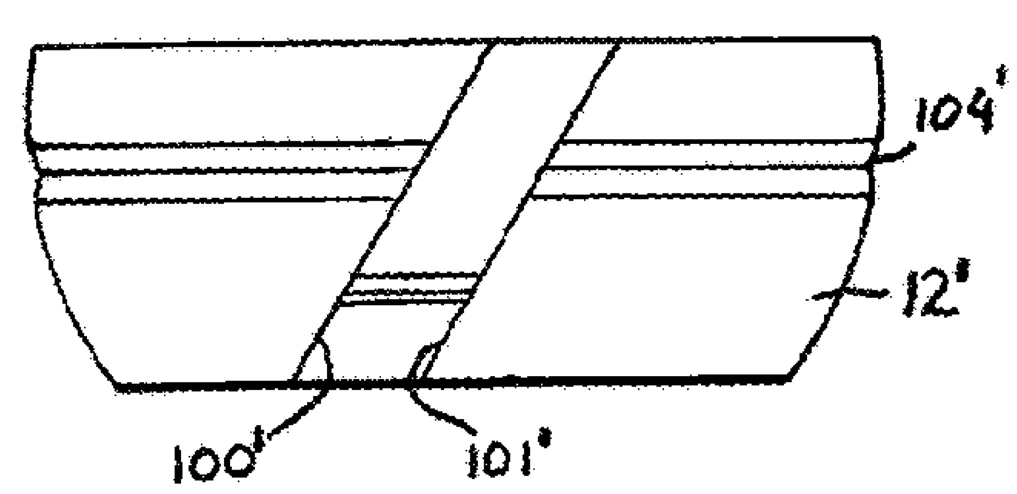


Fig.24.

Fig.25.



POLYAXIAL BONE SCREW WITH SPHERICAL CAPTURE, COMPRESSION INSERT AND ALIGNMENT AND RETENTION STRUCTURES

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

This application Ser. No. 15/902,433, filed on Feb. 22, 2018, is one of two reissue applications of U.S. Pat. No. 9,414,863, with the other reissue application being application Ser. No. 15/902,535 also filed on Feb. 22, 2018.

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent Ser. No. 12/072,354, filed Feb. 26, 2008 that claimed the benefit of U.S. Provisional Application No. 60/905,472 filed Mar. 7, 2007, both of which is incorporated by reference herein. U.S. patent Ser. No. 12/072,354 was also a continuation-in-part of U.S. patent application Ser. No. 11/126,965 filed May 10, 2005 which is incorporated by reference herein. U.S. patent Ser. No. 12/072,354 was also a continuation-in-part of U.S. patent application Ser. No. 12/008,067 filed Jan. 8, 2008 that claimed the benefit of U.S. Provisional Application No. 60/897,723 filed Jan. 26, 2007, all of which are incorporated by reference herein. This application is also a continuation-in-part of U.S. patent application Ser. No. 12/924,260, now U.S. Pat. No. 8,403,962, filed Sep. 23, 2010 that was a continuation-in-part of U.S. patent application Ser. No. 11/385,957, filed Mar. 21, 2006, that was a continuation-in-part of U.S. patent application Ser. No. 11/178,854 filed Jul. 11, 2005, now U.S. Pat. No. 7,789,896, that claimed the benefit of U.S. Provisional Application No. 60/655,239 filed Feb. 22, 2005.

BACKGROUND OF THE INVENTION

The present invention is directed to polyaxial bone screws for use in bone surgery, particularly spinal surgery, and particularly to capture structures and inserts for such screws.

Bone screws are utilized in many types of spinal surgery in order to secure various implants to vertebrae along the spinal column for the purpose of stabilizing and/or adjusting spinal alignment. Although both closed-ended and open-ended bone screws are known, open-ended screws are particularly well suited for connections to rods and connector arms, because such rods or arms do not need to be passed through a closed bore, but rather can be laid or urged into an open channel within a receiver or head of such a screw.

Typical open-ended bone screws include a threaded shank with a pair of parallel projecting branches or arms which form a yoke with a U-shaped slot or channel to receive a rod. Hooks and other types of connectors, as are used in spinal fixation techniques, may also include open ends for receiving rods or portions of other structure.

A common mechanism for providing vertebral support is to implant bone screws into certain bones which then in turn support a longitudinal structure such as a rod, or are supported by such a rod. Bone screws of this type may have a fixed head or receiver relative to a shank thereof. In the fixed bone screws, the rod receiver head cannot be moved relative to the shank and the rod must be favorably positioned in order for it to be placed within the receiver head. This is sometimes very difficult or impossible to do. Therefore, polyaxial bone screws are commonly preferred.

Open-ended polyaxial bone screws allow rotation of the head or receiver about the shank until a desired rotational position of the head is achieved relative to the shank. Thereafter, a rod can be inserted into the head or receiver and eventually the receiver is locked or fixed in a particular position relative to the shank.

During the rod implantation process it is desirable to utilize bone screws or other bone anchors that have components that remain within the bone screw and further remain properly aligned during what is sometimes a very lengthy, difficult procedure. For example, some bone screws desirably include compression inserts or other parts that are designed to securely and fully engage surface portions of a rod or other longitudinal connecting member.

SUMMARY OF THE INVENTION

A polyaxial bone screw assembly according to the invention includes a shank having an upper portion and a body for fixation to a bone; a head or receiver defining an open channel; an articulation structure for retaining the shank upper portion within the receiver; and at least one compression insert. The articulation structure is disposed between the receiver and the shank upper portion and is slidingly mated to both the upper portion and the receiver, allowing for compound articulation of the shank with respect to the receiver. The receiver includes structure cooperating with the compression insert that retain such insert in a desired position and alignment within the receiver. Illustrated embodiments include spring tabs that project into the receiver cavity either upwardly or downwardly and into grooves or slots and/or flat surfaces formed in or on the insert.

OBJECTS AND ADVANTAGES OF THE INVENTION

Therefore, objects of the present invention include: providing an improved spinal implant assembly for implantation into vertebrae of a patient; providing such an assembly that includes an open longitudinal connecting member receiver, a shank pivotally connected to the rod receiving member, a rod or other longitudinal connecting member, and in some instances, an aligned pressure insert disposed between the shank and the rod; providing such an assembly that has a low profile after final installation; and providing such an assembly that is easy to use, especially adapted for the intended use thereof and wherein the implant assembly components are comparatively inexpensive to produce.

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

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

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an enlarged exploded perspective view of a bone screw assembly according to the invention including a shank, a retainer, a compression insert and a receiver and shown with a cooperating longitudinal connecting member and a cooperating closure top.

FIG. **2** is an enlarged and partial side elevational view of the bone screw assembly of FIG. **1**.

FIG. **3** is an enlarged and partial cross-sectional view taken along the line **3-3** of FIG. **2**.

FIG. **4** is an enlarged and partial perspective view of the bone screw assembly of FIG. **1** with portions broken away to show the detail thereof.

FIG. **5** is an enlarged front elevational view of the compression insert of FIG. **1**.

FIG. **6** is an enlarged side elevational view of the compression insert of FIG. **1**.

FIG. **7** is a cross-sectional view taken along the line **7-7** of FIG. **5**.

FIG. **8** is an enlarged front elevational view of the retainer of FIG. **1**.

FIG. **9** is an enlarged rear elevational view of the retainer of FIG. **1**.

FIG. **10** is an enlarged front elevational view, similar to FIG. **8** with portions broken away to show the detail thereof.

FIG. **11** is an enlarged exploded perspective view of a second embodiment of a bone screw assembly according to the invention including a shank, a retainer, a compression insert and a receiver and shown with a cooperating longitudinal connecting member and a cooperating closure top.

FIG. **12** is an enlarged and partial side elevational view of the bone screw assembly of FIG. **11**.

FIG. **13** is an enlarged and partial cross-sectional view taken along the line **13-13** of FIG. **12**.

FIG. **14** is an enlarged and partial perspective view of the bone screw assembly of FIG. **11** with portions broken away to show the detail thereof.

FIG. **15** is an enlarged exploded perspective view of a third embodiment of a bone screw assembly according to the invention including a shank, a retainer, a compression insert and a receiver and shown with a cooperating longitudinal connecting member and a cooperating closure top.

FIG. **16** is an enlarged and partial side elevational view of the bone screw assembly of FIG. **15**.

FIG. **17** is an enlarged and partial cross-sectional view taken along the line **17-17** of FIG. **16**.

FIG. **18** is an enlarged and partial perspective view of the bone screw assembly of FIG. **15** with portions broken away to show the detail thereof.

FIG. **19** is an enlarged top plan view of the compression insert of FIG. **15**.

FIG. **20** is an enlarged front elevational view of the compression insert of FIG. **15**.

FIG. **21** is an enlarged bottom plan view of the compression insert of FIG. **15**.

FIG. **22** is a cross-sectional view taken along the line **22-22** of FIG. **20**.

FIG. **23** is an enlarged and partial side elevational view of a fourth embodiment of a bone screw assembly according to the invention.

FIG. **24** is an enlarged and partial cross-sectional view taken along the line **24-24** of FIG. **23** showing a shank, a retainer, a compression insert and a receiver of the assembly of FIG. **23**.

FIG. **25** is an enlarged rear elevational view of an alternative embodiment of the retainer of FIG. **1** shown in FIG. **9**.

DETAILED DESCRIPTION OF THE INVENTION

As required, detailed embodiments of the present invention are disclosed herein; however, it is to be understood that the disclosed embodiments are merely exemplary of the invention, which may be embodied in various forms. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the present invention in virtually any appropriately detailed structure. It is also noted that any reference to the words top, bottom, up and down, and the like, in this application refers to the alignment shown in the various drawings, as well as the normal connotations applied to such devices, and is not intended to restrict positioning of the bone attachment structures in actual use.

With reference to FIGS. **1-10**, the reference numeral **1** generally designates a polyaxial bone screw assembly according to the present invention. The assembly **1** includes a shank **4** that further includes a body **6** integral with an upper portion or capture structure **8**; a head or receiver **10**; a retainer **12** illustrated as an open collar-like retaining and articulating structure; and a compression insert **14**. The shank **4**, head or receiver **10**, retainer **12** and insert **14** are assembled prior to implantation of the shank body **6** into a vertebra **15**.

FIG. **1** also shows a closure structure or top **18** for capturing a longitudinal connecting member within the head or receiver **10**, such as a rod **21** having an outer cylindrical surface **22**. Upon installation, which will be described in detail below, the closure top **18** presses against the rod **21** that in turn presses against the insert **14** that presses against the shank upper portion **8** which presses the retainer **12** into fixed frictional contact with the receiver **10**, so as to fix the rod **21** relative to the bone screw **1** and thus to adjacent vertebrae. The receiver **10** and shank **4** cooperate in such a manner that the receiver **10** and shank **4** can be secured at any of a plurality of angles, articulations or rotational alignments relative to one another and within a selected range of angles both from side to side and from front to rear, to enable flexible or articulated engagement of the receiver **10** with the shank **4** until both are locked or fixed relative to each other.

The bone screw shank **4**, best illustrated in FIGS. **1** and **3**, is elongate, with the shank body **6** having a helically wound bone implantable thread **25** extending from near a neck **26** located adjacent to the upper portion **8** to near a tip **28** of the body **6** and extending radially outwardly therefrom. During use, the body **6** utilizing the thread **25** for gripping and advancement is implanted into a vertebra (not shown) leading with the tip **28** and driven down into the vertebra with an installation or driving tool (not shown), so as to be implanted in the vertebra to near the neck **26**. The shank **4** has an elongate axis of rotation generally identified by the reference letter A.

The neck **26** extends axially upwardly from the shank body **6**. Further extending axially from the neck **26** is the shank upper portion or capture structure **8** that provides a connective or capture apparatus disposed at a distance from the thread **25** and thus at a distance from the vertebra (not shown) when the body **6** is implanted in such vertebra. The shank upper portion **8** is configured for connecting the shank **4** to the receiver **10** and capturing the shank **4** in the receiver **10**. The shank upper portion **8** has an outer, convex and substantially spherical surface **30** that extends outwardly and upwardly from the neck **26** and terminates at a top **32**. The illustrated top **32** is substantially planar and disposed perpendicular to the axis A. The spherical surface **30** has an outer radius configured for sliding cooperation and ultimate frictional mating with a concave surface of the retainer **12** that has a substantially similar radius. The spherical surface **30** is smooth, but it is foreseen that such surface may include a roughened or textured surface or surface finish, or may be scored, knurled, or the like, for enhancing frictional engagement with the retainer **12**. A counter sunk drive feature **34** is formed in the top **32** (shown as a hexagonal aperture). In operation, a driving tool (not shown) engages the feature **34** for driving the shank body **6** into bone. The drive feature **34** may take a variety of tool-engaging forms and may include one or more apertures or imprints of various shapes, such as a pair of spaced apart apertures or a multi-lobular aperture, such as those sold under the trademark TORX or the like. It is foreseen that in some embodiments, the bone screw shank upper portion may have an external tool engagement structure.

The illustrated shank **4** is cannulated, having a small central bore **35** extending an entire length of the shank **4** along the axis A, coaxial with the threaded body **6**. The bore **35** has a first circular opening at the shank tip **28** and a second circular opening at the drive feature **34**. The bore **35** provides a passage through the shank **4** interior for a length of wire (not shown) inserted into a vertebra (not shown) prior to the insertion of the shank body **6**, the wire providing a guide for insertion of the shank body **6** into the vertebra.

To provide a biologically active interface with the bone, the threaded shank body **6** may be coated, perforated, made porous or otherwise treated. The treatment may include, but is not limited to a plasma spray coating or other type of coating of a metal or, for example, a calcium phosphate; or a roughening, perforation or indentation in the shank surface, such as by sputtering, sand blasting or acid etching, that allows for bony ingrowth or ongrowth. Certain metal coatings act as a scaffold for bone ingrowth. Bio-ceramic calcium phosphate coatings include, but are not limited to: alpha-tri-calcium phosphate and beta-tri-calcium phosphate $(Ca_3(PO_4)_2$, tetra-calcium phosphate $(Ca_4P_2O_9)$, amorphous calcium phosphate and hydroxyapatite $(Ca_{10}(PO_4)_6(OH)_2)$. Coating with hydroxyapatite, for example, is desirable as hydroxyapatite is chemically similar to bone with respect to mineral content and has been identified as being bioactive and thus not only supportive of bone ingrowth, but actively taking part in bone bonding.

With reference to FIGS. **1-4**, the receiver **10** has a generally U-shaped appearance with a discontinuous partially cylindrical and partially spherical inner profile and a partially curved and partially faceted outer profile. The receiver has an axis of rotation B that is shown in FIG. **1** as being aligned with and the same as the axis of rotation A of the shank **4**, such orientation being desirable during assembly of the receiver **10** with the shank **4**, the retainer **12** and the insert **14**. After the receiver **10** is pivotally attached to the shank **4**, and the assembly **1** is implanted in a vertebra (not shown), the axis B is typically disposed at an angle with respect to the axis A.

The receiver **10** includes a base **40** integral with a pair of opposed upstanding arms **42** forming a cradle and defining a U-shaped channel **44** between the arms **42** with an upper opening **46** and a lower seat **48**, the channel **44** having a width for receiving the rod **21**, for operably snugly receiving the rod **21** between the arms **42**. Each of the arms **42** has an interior surface **50** that defines the inner cylindrical profile and includes a partial helically wound guide and advancement structure **52**. In the illustrated embodiment, the guide and advancement structure **52** is a partial helically wound interlocking flangeform configured to mate under rotation with a similar structure on the closure structure **18**, as described more fully below. However, it is foreseen that the guide and advancement structure **52** could alternatively be a square-shaped thread, a buttress thread, a reverse angle thread or other thread like or non-thread like helically wound discontinuous advancement structure for operably guiding under rotation and advancing the closure structure **18** downward between the arms **42**, as well as eventual torquing when the closure structure **18** abuts against the rod **21**.

An opposed pair of tool receiving and engaging apertures **54** are formed on outer surfaces **56** of the arms **42**. A pair of substantially cylindrical inner surfaces **58** define the apertures **54**, with a portion of each of the apertures **54** extending through the arms **42** as best illustrated in FIG. **2**. With particular reference to FIGS. **3** and **4**, a pair of tabs **60**, each having a lower end or body portion **62** integral with a respective arm **42** at a lower portion of one of the cylindrical surfaces **58**, and an upper end **64** extending upwardly and inwardly from the respective lower body portion **62**, the tab **60** generally directed towards the guide and advancement structure **52** of the respective arm **42** and also toward the axis B. As shown in FIGS. **1**, **3** and **4**, an operational orientation of each of the tabs **60** is angled toward the axis B with an inner surface **68** or edge **69** of the upper end **64** in sliding engagement with a slot in the cooperating insert **14** as will be described in greater detail below. The tabs **60** are typically initially disposed parallel to the axis B and then a tool (not shown) is inserted into the aperture **54** from the outside surface **56** and engages and pushes a surface **66** of the tab **60** and bends the tab **60** inwardly in a direction toward the axis B until the tab **60** is at the illustrated desired angular position. Such bending of the tabs **60** may be performed either prior to or after assembly of the receiver **10** with the insert **14**, the shank **4** and the retainer **12**. It is also foreseen that the tabs **60** may be machined or otherwise pre-fabricated to be angled or directed toward the axis B as is shown in the drawing figures. The illustrated tabs **60** are resilient, having a spring-like nature. Thus, when operatively cooperating with the insert **14**, the tabs **60** bias against the insert **14**, holding such insert in a desired position and yet the tabs **60** are flexible enough to allow a user to make desired adjustments of the position of the insert **14** within the receiver **10**.

Each of the illustrated receiver arms **42** also includes a V-shaped or undercut tool engagement groove **76**, formed on outer surfaces thereof which may be used for holding the receiver **10** with a holding tool (not shown) having projections that are received within the grooves **76** during implantation of the shank body **6** and/or during subsequent installation of the rod **21** or other longitudinal connecting member and the closure structure **18**. It is foreseen that tool receiving grooves or apertures may be configured in a variety of shapes and sizes and be disposed at other locations on the receiver arms **42**.

Communicating with the U-shaped channel **44** of the receiver **10** is a chamber or cavity **80** defined in part by a substantially cylindrical upper portion **82** and by a lower inner substantially spherical seating surface **84** of the base **40**. The upper portion **82** is located below the guide and advancement structures **52** and may include one or more cylindrical surfaces for sliding cooperation with an insert or inserts. As illustrated in FIG. **3**, the cylindrical upper portion **82** may include a lower section or portion **85** having a larger diameter than a remainder of the portion **82**, the portion **85** located adjacent to the spherical seat **84** and providing clearance for movement of the retainer **12**, including an expanding or spreading movement thereof during attachment with the shank upper portion **8** and for swiveling the retainer **12** to a desired orientation after assembly of the bone screw **1**. The apertures **54** and the tabs **60** communicate with the cylindrical upper portion **82**. The seating surface **84** is near or adjacent to the cylindrical portion **82**. The seating surface **84** is sized and shaped for slidable mating and eventual frictional engagement with the retainer **12**, as described more fully below. The cavity **80** opens into the U-shaped channel **44** and also to a lower neck **86** defining a bore or circular opening that communicates with a lower exterior **88** of the base **40**. The circular neck **86** is coaxially aligned with the rotational axis B of the receiver **10**. The neck **86** is sized and shaped to be smaller than an outer radial dimension of the open, uncompressed retainer **12**, as will be discussed further below, so as to form a restriction at the location of the neck relative to the retainer **12**, to prevent the uncompressed retainer **12** from passing from the cavity **80** and out to the lower exterior **88** of the receiver **10** when the retainer **12** is seated and loaded.

With reference to FIGS. **1**, **3**, **4** and **8-10**, the partially spherical and discontinuous or open retainer **12** that both retains and articulates is used to hold the spherically surfaced **30** upper portion **8** of the shank **4** within the receiver **10** and is also independently slidably and pivotally engageable with both the shank upper portion **8** at the surface **30** and the receiver **10** at the seating surface **84**. The retainer **12** has an operational central axis C that may be the same or different from the axis A associated with the shank **4**, or the axis B associated with the receiver **10** when the shank upper portion **8** and the retainer **12** are installed within the receiver **10**. The retainer **12** has a central channel or through bore substantially defined by a discontinuous inner partially spherical surface **90**. The surface **90** extends from a substantially planar annular top **92** to an inner neck **94** disposed near a substantially planar annular bottom surface **96**. An inner chamfer **98** runs between the neck **94** and the bottom surface **96**. The inner spherical surface **90** has a radius sized and shaped to cooperate with a radius of the substantially spherical surface **30** of the shank upper portion **8** such that the surface **90** slidingly and pivotally mates with the spherical surface **30**. The surface **90** may include a roughening or surface finish to aid in frictional contact between the surface **90** and the surface **30**, once a desired angle of articulation of the shank **4** with respect to the retainer **12** and also with respect to the receiver **10** is reached.

The resilient retainer **12** includes first and second end surfaces, **100** and **101** disposed in spaced relation to one another and a discontinuous outer partially spherically shaped surface **102**. Both end surfaces **100** and **101** are disposed substantially perpendicular to the top surface **92** and the bottom surface **96**. A width of the space between the surfaces **100** and **101** is determined to provide adequate space for the retainer **12** to be pinched, with the surfaces **100** and **101** compressed toward one another to an almost touching or touching configuration, to an extent that the compressed retainer **12** is up or bottom loadable into the receiver cavity **80** being received within the lower neck **86** opening of the receiver **10** while mounted on the neck **26** of the bone screw shank body **6**. After passing through the bore defined by the lower neck **86** of the receiver **10** simultaneously with the shank upper portion **8**, the retainer **12** expands or springs back to an original uncompressed, rounded or collar-like configuration of FIG. **1** once in the cavity **80**. The retainer **12** is then expanded about the shank upper portion spherical surface **30** as will be described in greater detail below. Then, once the resilient structure **12** returns to an original form, but now surrounding the spherical structure **30**, the engaged structures **8** and **12** are movable together within the cavity **80** at the spherical seat **84** to a variety of positions in which the surface **102** of the retainer **12** is in slidable mating engagement with the seating surface **84** of the receiver **10**.

The illustrated embodiment of the retainer **12** shows the surfaces **100** and **101** as substantially parallel and vertical, however, in other embodiments according to the invention, such as the retainer **12'** shown in FIG. **25**, opposing surfaces **100'** and **101'** are oriented obliquely or at a slight angle with respect to top and bottom surfaces thereof, advantageously allowing for the surfaces **100'** and **101'** to slide and ride up upon one another during assembly with the other components of the assembly **1**, allowing for greater compression of the retainer **12'** without increasing the space between the surfaces **100'** and **101'** when the retainer **12'** is in an uncompressed state. Depending upon the amount of compression desired during loading of the retainer **12'** into the receiver **10**, the oblique angle may be modified. The retainer **12'** is otherwise identical or substantially similar to the retainer **12** in form and function. Furthermore, the illustrated embodiment **12** and **12'** include an outer groove **104** and **104'**, respectively, that may be needed in some instances for clearance within the receiver **10** when the retainer **12** or **12'** is expanded about the spherical surface **30** of the shank upper portion **8**. Also, other embodiments according to the invention, particularly smaller bone screw assemblies, may include retainers small enough to top load into the receiver channel upper opening **46**, rather than loading through the receiver neck **86**.

With reference to FIGS. **1**, **3** and **4**, the compression member or insert **14** is sized and shaped to be received by and uploaded into the receiver **10** at the lower neck **86**. In operation, the insert **14** is disposed between the rod **21** and the upper portion **8** of the bone screw **4** as illustrated for example in FIGS. **3** and **4**. When the closure structure **18** presses upon the rod **21**, the rod **21** operatively presses upon the insert **14** that in turn presses upon the shank upper portion **8** that in turn presses against the retainer **12** that in turn presses against the seating surface **84** of the receiver **10**, resulting in ultimate frictional engagement and locking of the angular position of the bone screw shank **4** with respect to the receiver **10**. The compression insert **14** has an operational central axis D that is the same as the central axis B of the receiver **10**.

With particular reference to FIGS. **5-7**, the compression insert **14** has a central channel or through bore substantially defined by a an inner cylindrical surface **110** and an inner partially spherical surface **112**, both having the central axis D. The compression insert **14** through bore is sized and shaped to receive a driving tool (not shown) therethrough that engages the shank drive feature **34** when the shank body **6** is driven into bone. The surface **112** is sized and shaped to cooperate with the spherical surface **30** of the shank upper portion **8** such that the surface **112** slidingly and pivotally mates with the spherical surface **30**. The surface **112** may include a roughening or surface finish to aid in frictional contact between the surface **112** and the surface **30**, once a desired angle of articulation of the shank **4** with respect to the retainer **12** and the receiver **10** is reached.

The compression insert **14** also includes a pair of arms **114** with a U-shaped surface or saddle **116** formed therebetween. The saddle **116** defines a U-shaped channel that communicates with the bore defined by the cylindrical surface **110** and the spherical surface **112**. The curved surface or saddle **116** is sized and shaped to closely receive the cylindrical rod **21**. With reference to the axis D, the saddle **116** extends from top surfaces **118** of the arms to a curved lower seat **120** near a bottom surface **122** of the insert **114**. In operation, the lower seat **129** (as well as a substantial portion of a remainder of the saddle **116**) frictionally engages the surface **22** of the rod **21**.

A base having a cylindrical surface **124** is disposed between the saddle **116** and the bottom surface **122**. The cylindrical surface **124** also extends about the arms **114**. Formed in the surface **124** and located centrally with respect to each arm **114** is a shallow groove **126**. Each groove **126** is U-shaped and runs from the respective top surface **118** to a curved bottom **128** located approximately centrally between the top surface **118** and the bottom surface **122**. The grooves **126** are sized and shaped to cooperate with the tabs **60** of the receiver **10** as will be described in greater detail below. Thus, although the grooves **126** may be of any shape, the grooves **126** preferably are elongate, running parallel to the axis D and have a width that receives the respective tab **60** within such groove. The bottom surface **122** includes a substantially planar and annular central portion **130** disposed perpendicular to the axis D. The bottom portion **130** extends about the bore defined by the inner spherical surface **112**. The bottom surface **122** further includes an outer planar and annular surface portion **132** disposed at an angle with respect to the surface portion **130**. The surface portion **132** angles upwardly (toward the top surfaces **118**) and outwardly (away from the axis D) from the surface **130**. As shown in FIG. **3**, the surface portion **132** provides clearance for articulated movement of the retainer **12** and the bone screw shank **4**.

The compression or pressure insert **14** ultimately seats on the shank upper portion **8** and is disposed substantially in the upper cylindrical portion **82** of the cavity **80**, with the tabs **60** holding the insert **14** in desired alignment with respect to the rod **21** as will be described in greater detail below. In operation, the insert **14** extends at least partially in the channel **44** such that the saddle **116** surface substantially contacts and engages the outer surface **22** of the rod **21** when such rod is placed in the receiver **10** and the closure structure or top **18** is tightened therein.

With reference to FIGS. **1** and **4**, the closure structure or closure top **18** can be any of a variety of different types of closure structures for use in conjunction with the present invention with suitable mating structure on the upstanding arms **42**. In the embodiment shown, the closure top **18** is rotatably received between the spaced arms **42**, but could be a slide-in closure structure. The illustrated closure structure **18** is substantially cylindrical and includes an outer helically wound guide and advancement structure **142** in the form of a flange form that operably joins with the guide and advancement structure **52** disposed on the arms **42** of the receiver **10**. The flange form utilized in accordance with the present invention may take a variety of forms, including those described in Applicant's U.S. Pat. No. 6,726,689, which is incorporated herein by reference. It is also foreseen that according to the invention the closure structure guide and advancement structure could alternatively be a buttress thread, a square thread, a reverse angle thread or other thread like or non-thread like helically wound advancement structure for operably guiding under rotation and advancing the closure structure **18** downward between the arms **42** and having such a nature as to resist splaying of the arms **42** when the closure structure **18** is advanced into the U-shaped channel **44**. The illustrated closure structure **18** also includes a top surface **144** with an internal drive **146** in the form of an aperture that may be a hex drive, or as illustrated, a star-shaped internal drive, for example, sold under the trademark TORX or other internal drives such as slotted, tri-wing, spanner, two or more apertures of various shapes, and the like. A driving tool (not shown) sized and shaped for engagement with the internal drive **146** is used for both rotatable engagement and, if needed, disengagement of the closure **18** from the receiver arms **42**. It is also foreseen that the closure structure **18** may alternatively include a break-off head designed to allow such a head to break from a base of the closure at a preselected torque, for example, 70 to 140 inch pounds. Such a closure structure would also include a base having an internal drive to be used for closure removal. A bottom surface **148** of the closure may be planar or include a point, points, a rim or roughening for engagement with the surface **22** of the rod **21**. The illustrated closure top **18** further includes a cannulation through bore **150** extending along a central axis thereof and through the top surface **144** and the bottom surface **148**. Such a through bore provides a passage through the closure **18** interior for a length of wire (not shown) inserted therein to provide a guide for insertion of the closure top into the receiver arms **42**.

Prior to the polyaxial bone screw assembly **1** being placed in use according to the invention the tabs **60** of the receiver **10** are preferably bent inwardly toward the axis B as shown in FIGS. **1**, **2** and **4**. This is accomplished by inserting an elongate tool (not shown) into each of the tooling apertures **54** and pressing the respective tab **60** inwardly toward the axis B until the tab end **64** is disposed at least partially within the upper cylindrical portion **82** of the cavity **80**. It is noted that alternatively, in some embodiments according to the invention, the tabs **60** are bent inwardly toward the axis B after the pressure insert **14** is located in the cylindrical portion **82** of the cavity **80**. For example, if the insert **14** is top loaded through the opening **46** of the receiver **10**, it may be desirable to first load the insert **14** into the receiver, align the grooves **126** with the tabs **60** and then press the tabs **60** until such tabs come into frictional engagement with surfaces of the receiver **14** disposed within the shallow grooves **126**.

Also prior to the polyaxial bone screw assembly **1** being placed in use according to the invention, the retainer **12** is first inserted about the neck **26** of the shank body **6** by inserting the shank tip **28** into the retainer **12** through bore defined by the inner surface **90** and feeding the shank body **6** therethrough until the retainer **12** is located at the neck **26**. Alternatively, in certain embodiments, the retainer **12** is placed near the neck **26** and the end surfaces **100** and **101** are pulled away from one another and pressed against and about the neck **26** until the surfaces **100** and **101** expand around the neck **26** and then spring back into an original or first position with the inner surface **90** disposed adjacent to the neck **26** and the top surface **92** facing toward the spherical surface **30** of the shank upper portion **8**.

In the illustrated embodiment, prior to inserting the shank **4** and connected retainer **12** into the receiver **10**, the compression insert **14** is up or bottom loaded into the receiver **10** through the lower neck **86** with the saddle **116** facing the neck **86** and the arms **114** aligned with the tabs **60**. The insert **14** is then moved upwardly through the lower seat **84** of the receiver **10** and into the cylindrical portion **82** of the cavity **80**. As the insert **14** is moved upwardly into the cylindrical portion **82**, each of the tabs **60** are received in a groove **126**. The tabs **60** press against the insert **14** at the grooves **126**, allowing for some upward and downward adjustment of the insert **14**. However, rotation of the insert **14** about the axis B is prohibited by the tabs **60** abutting against surfaces forming the grooves **126**. Surfaces defining the lower curved portion **128** of the grooves **126** also prohibit the tabs **60** from sliding along the outer cylindrical surface **124** of the insert **14**, thus resisting upward movement of the insert **14** out of the receiver **10**.

In certain embodiments, it may be desirable to place the compression insert **14** on the shank upper portion **8** with the spherical surface **112** seated on the surface **30** of the shank upper portion **8** and then upload the insert **14** simultaneously with the shank upper portion **8** and the retainer **12**. The upper portion **8** and the connected retainer **12** are simultaneously up or bottom-loaded into the receiver cavity **80** by inserting the upper portion **8** through the lower neck **86** and into the cavity **80** lower seat portion **84** and manually compressing the retainer **12** by pinching the surfaces **100** and **101** toward one another and inserting the neck **26** and the compressed retainer **12** into the bore formed by the lower neck **86** of the receiver **10**. After the retainer **12** moves beyond the neck **86**, the compressive force is removed and the retainer **12** resiliently springs back and returns to the original ring-like or collar-like orientation, capturing the shank upper portion **8** within the receiver **10**. Then, the shank body **6** is pulled downwardly away from the base **40** of the receiver **10**, forcing the retainer **12** to temporarily expand as the retainer **12** moves along the spherical surface **30** of the shank upper portion **8** with the end surfaces **100** and **101** moving away from one another. Such an expansion of the retainer **12** allows the spherical surface **30** to slide or snap into the retainer **12** with the spherical surfaces **30** and **90** becoming aligned and the shank upper portion **8** ultimately in sliding cooperation with the inner surface **90** of the retainer **12**. The retainer **12** thus resiliently returns to the original ring-link orientation, with the spherical surface **90** capturing the shank upper portion **8** at the spherical surface **30**, but allowing for pivotal movement or articulation of the shank upper portion **8** with respect to the retainer **12**. Once the retainer **12** returns to the original orientation, both the connected structures **8** and **12** drop down to a seated position at the spherical surface **84** of the receiver **10**, with the retainer **12** being independently slidable with respect to both the shank upper portion **8** and the receiver **10**, forming a multi- or compound articulation or joint between the shank **4** and the receiver **10**. The compression insert **14** may then be pressed downwardly and into full contact with the surface **30**.

The retainer **12** and the attached shank upper portion **8** may then be manipulated into a substantially coaxial position with the insert **14** in readiness for bone implantation. The assembly **1** is typically screwed into a bone, such as a vertebra (not shown), by rotation of the shank **4** using a driving tool (not shown) that operably drives and rotates the shank **4** by engagement thereof with the drive feature **34**.

Typically, the receiver **10**, the compression or pressure insert **14**, and the retainer **12** are assembled on the shank **4** before inserting the shank body **6** into a vertebra. However, in certain circumstances, such as when a small bone screw is utilized and the retainer is top loadable, the shank body **6** can be first partially implanted with the shank upper portion **8** extending proud to allow assembly with the receiver **10**, followed by assembly with a top loaded retainer **12** and a top loaded compression insert **14**. Then the shank body **6** can be further driven into the vertebra.

The vertebra (not shown) may be pre-drilled to minimize stressing the bone and have a guide wire (not shown) inserted to provide a guide for the placement and angle of the shank **4** with respect to the vertebra. A further tap hole may be made using a tap with the guide wire as a guide. Then, the bone screw assembly **1** or the solitary shank **4**, is threaded onto the guide wire utilizing the cannulation bore **35** by first threading the wire into the opening at the bottom **28** and then out of the top opening at the drive feature **34**. The shank **4** is then driven into the vertebra using the wire as a placement guide. It is foreseen that the bone screw assemblies **1**, the rod **21** (also having a central lumen in some embodiments) and the closure top **18** can be inserted in a percutaneous or minimally invasive surgical manner, utilizing guide wires.

With reference to FIG. **4**, the rod **21** is eventually positioned in an open or percutaneous manner in cooperation with the at least two bone screw assemblies **1**. Alignment of the rod surface **22** with the saddle **116** of the insert **14** is initially provided and then maintained by pressure placed at the insert grooves **126** by the tabs **60**. A closure structure **18** is then inserted into and advanced between the arms **42** of each of the bone screw assemblies **1**. The closure structure **18** is rotated, using a tool engaged with the inner drive **146** until a selected pressure is reached at which point the rod **21** engages the saddle **116** and the rod is urged toward, but not in contact with the lower seat **48** of the receiver **10** that defines the U-shaped channel **44**. For example, about 80 to about 120 inch pounds pressure may be required for fixing each bone screw shank **7** with respect to the receiver **10**.

As each closure structure **18** rotates and moves downwardly into the respective receiver **10**, the bottom surface **148** presses against the rod surface **22**, biasing the rod into engagement with the compression insert **14** that operably produces a frictional engagement between the insert surface **112** and the shank surface **30** and also urges the shank upper portion **8** toward the retainer **12** and, in turn, the structure **12** in a direction toward the base **40** of the receiver **10**, so as to frictionally seat the spherical surface **30** against the inner spherical surface **90** of the retainer **12** and the outer spherical surface **102** of the retainer **12** against the internal spherical seating surface **84** of the receiver **10**, also fixing the shank **4** and the retainer **12** in a selected, rigid position relative to the receiver **10**. At this time it is also possible for the retainer **12** to expand somewhat for an even tighter fit in the receiver cavity lower seat **84**.

If removal of the rod **21** from any of the bone screw assemblies **1** is necessary, or if it is desired to release the rod **21** at a particular location, disassembly is accomplished by using the driving tool (not shown) that mates with the internal drive **146** on the closure structure **18** to rotate and remove the closure structure **18** from the cooperating receiver **10**. Disassembly is then accomplished in reverse order to the procedure described previously herein for assembly.

With reference to FIGS. **11-14**, an alternative bone screw assembly of the invention, generally **201** includes a shank **204** that further includes a body **206** integral with an upper portion or capture structure **208**; a head or receiver **210**; a retainer **212** illustrated as an open collar-like retaining and articulating structure; and a compression insert **214**. The shank **204**, the retainer **212** and the insert **214** are identical or substantially similar to the respective shank **4**, retainer **12** and insert **14** previously described herein. The assembly **201** also cooperates with the rod **221** and a closure top **218** that are the same or similar to the respective rod **21** and closure top **18** previously described herein. The receiver **210** is substantially similar to the receiver **10** with the exception of the orientation of spring tabs **260** that are otherwise substantially similar to the tabs **60** previously described herein with respect to the assembly **1**. Similar to the previous discussion with respect to the assembly **1**, the tabs **260** of the receiver **210**, like the tabs **60** of the receiver **10**, press against shallow grooves formed on an outside surface of the insert

214, keeping a saddle or curved surface of the insert **212** in a desired alignment to receive and ultimately frictionally engage the rod **221** along a substantial surface of the saddle. The insert may also have a flat outer surface instead of shallow grooves.

Because the illustrated assembly **201** only differs from the assembly **1** with respect to the tabs **260** of the receiver **210**, only relevant portions of the receiver **210** will be described in greater detail here: The receiver **210** includes a base **240** integral with a pair of opposed upstanding arms **242** forming a cradle and defining a U-shaped channel **244** between the arms **242** with an upper opening **246** and a lower seat **248**, the channel **244** having a width for receiving the rod **221**, for operably receiving the rod **221** between the arms **242**. Each of the arms **242** has an interior surface **250** that defines the inner cylindrical profile disposed about a central axis G and includes a partial helically wound guide and advancement structure **252**. In the illustrated embodiment, the guide and advancement structure **252** is a partial helically wound interlocking flangeform configured to mate under rotation with a similar structure on the closure structure **218**. However, it is foreseen that the guide and advancement structure **252** could alternatively be a square-shaped thread, a buttress thread, a reverse angle thread or other thread like or non-thread like helically wound discontinuous advancement structure for operably guiding under rotation and advancing the closure structure **218** downward between the arms **242**, as well as eventual torquing when the closure structure **218** abuts against the rod **221**.

An opposed pair of tool receiving and engaging apertures **254** are formed on outer surfaces **256** of the arms **242**. A pair of substantially cylindrical inner surfaces **258** define the apertures **254**, with a portion of each of the apertures **254** extending through the arms **242** as best illustrated in FIG. **12**. With particular reference to FIGS. **11**, **13** and **14**, the pair of tabs **260**, each having an upper end or body portion **262** integral with a respective arm **242** at an upper portion of one of the cylindrical surfaces **258**, and a lower end **264** extending downwardly and eventually inwardly from the respective upper body portion **262** toward the central axis G of the receiver **210**. As shown in FIG. **14**, an operational orientation of each of the tabs **260** is angled toward the central axis G of the receiver with an inner surface **268** or edge **269** of the lower end **264** in sliding engagement with a slot **290** in the cooperating insert **214**. As illustrated in FIGS. **11** and **13**, the tabs **260** are typically initially disposed parallel to the central axis of the receiver **210**. In the illustrated embodiment, the pressure insert **214**, retainer **212** and bone screw shank **204** are first bottom loaded (or may be top loaded) into the receiver **210** in a manner as previously described herein with respect to the assembly **1** and then a tool (not shown) is inserted into each aperture **254** from the outside surface **256** and engages and pushes a surface **266** of the tab **260** and bends the tab **260** inwardly in a direction toward the receiver central axis G until the tab **260** is at the illustrated desired angular position. Such bending of the tabs **260** may also be performed prior to assembly of the receiver **210** with the insert **214**, shank **204** and retainer **212**. In such an arrangement, the insert **214** may be uploaded or downloaded into the receiver **210** with the saddle portion thereof in alignment with the tabs **260**. After the insert **214** is in a desired axial position, the insert **214** is rotated about the axis G with the tabs **260** being manipulated to press against the surface **292**. The insert **214** is rotated about the central axis G until the tabs **260** snap into the grooves or depressions **290** (or engage flat surfaces).

It is foreseen that in another embodiment according to the invention, the insert **214** is sized and shaped for top loading into the opening **246** of the receiver **210** and the tabs **260** are bent inwardly toward the axis G prior to assembly of the receiver **210** with the insert **214** and the other bone screw components. During assembly, after the insert **214** is lowered into the receiver **210** and moved past the guide and advancement structure **252**, the outer surface **292** presses against the tabs **260**, moving the tabs **260** outwardly and away from one another. Then, when the edges **269** of the tabs **260** come into contact with the surface of the grooves **290**, the resilient tabs **260** snap into such grooves, maintaining alignment of the insert **214** and resisting any rotational movement of the insert **214** as the insert **214** is lowered into place over the upper portion **208** of the bone screw shank **204**.

It is also foreseen that the tabs **260** may be machined or otherwise pre-fabricated to be angled or directed toward the receiver central axis G. As indicated above, the illustrated tabs **260** are resilient, having a spring-like nature. Thus, when operatively cooperating with the insert **214**, the tabs **260** bias against the insert **214**, holding such insert in a desired position. However, the tabs **260** are flexible enough to allow a user to make desired upward and downward adjustments of the position of the insert **214** within the receiver **210** with respect to the axis G.

With reference to FIGS. **15-21**, a third embodiment of a bone screw assembly of the invention, generally **301** includes a shank **304** that further includes a body **306** integral with an upper portion or capture structure **308**; a head or receiver **310**; a retainer **312** illustrated as an open collar-like retaining and articulating structure; and a compression insert **314**. The shank **304**, the receiver **310** and the retainer **312** are substantially similar to the respective shank **4**, receiver **10** and retainer **12** previously described herein with respect to the assembly **1**. The receiver **310** is sized and proportioned slightly differently than the receiver **12** to cooperate with the insert **314**. However, the receiver **310** otherwise includes the same component parts previously described herein with respect to the receiver **10**. In particular, the receiver **310** includes a central axis H, a base **340**, arms **342**, a U-shaped channel **344**, an interior surface with a guide and advancement structure **352**, a pair of opposed apertures **354** upwardly and inwardly extending spring tabs **360**, and an inner cavity **380** identical or substantially similar to the respective central axis B, base **40**, arms **42**, U-shaped channel **44**, interior surface with a guide and advancement structure **52**, apertures **54**, upwardly and inwardly extending spring tabs **60** and inner cavity **80** of the receiver **10** of the assembly **1**. The assembly **301** also cooperates with the rod **321** and a closure top **318** that are the same or similar to the respective rod **21** and closure top **18** previously described herein.

The compression or pressure insert **314** functions substantially similarly to the insert **14** previously described herein; however the insert **314** is of a different shape than the insert **14** and thus shall be described in detail herein.

The compression insert **314** is sized and shaped to be received by and uploaded into the receiver **310** at an opening into the cavity **380** at the base **340**. In operation, the insert **314** is disposed between the rod **321** and the upper portion **308** of the bone screw shank **304**. When the closure structure **318** presses upon the rod **321**, the rod operatively presses upon the compression member **314** that in turn presses on the shank upper portion **308**, but unlike the assemblies **1** and **101**, the member **314** does not include a saddle. Therefore, rotational alignment of the rod **321** with the insert **314** is not necessary. However, because of the compact cylindrical shape of the insert **314**, there is a possibility of the insert **314** becoming dislodged from a remainder of the assembly and undesirably moving up into the U-shaped channel **344** and out of the top of the receiver **310**. Therefore, the receiver **310** equipped with spring tabs **360** prohibit undesirable upward movement of the insert **314** out of the receiver **310**.

With particular reference to FIGS. **19-21**, the compression insert **314** has an operational central axis that is the same as the central axis H of the receiver **310**. The compression insert **314** has a central channel or through bore substantially defined by a an inner cylindrical surface **386** and an inner partially spherical surface **388**. The insert through bore is sized and shaped to receive a driving tool (not shown) therethrough that engages a shank internal drive feature formed in the upper portion **308** when the shank is driven into bone. The surface **388** is sized and shaped to cooperate and mate with the spherical surface **330** of the shank upper portion **308** such that the surface **388** slidingly and pivotally mates with the spherical surface **330**. The surface **388** may include a roughening or surface finish to aid in frictional contact between the surface **388** and the surface **330**, once a desired angle of articulation of the shank **304** with respect to the retainer **312** and the receiver **310** is reached.

The compression insert **314** also includes a substantially planar top surface **390**, a bottom surface **392** and an outer cylindrical surface **394**. An outer angled surface or chamfer **395** is disposed between and connects the top surface **390** with the outer cylindrical surface **394**. The cylindrical surface **394** is sized to be received within the cavity **380** of the receiver **310** and slidingly mate with a cylindrical inner surface **398** partially defining the cavity **380**. The inner surface **398** is disposed directly below and adjacent to the spring tabs **360**. Thus, the compression insert **314** ultimately seats on the shank upper portion **308** and is disposed at least partially in the channel **344** such that the compression insert **314** top surface **390** substantially contacts the rod **321** when the rod is placed in the receiver **310** and the closure structure **318** is tightened therein. With particular reference to FIG. **17**, similar to the bottom surface **132** of the previously described insert **14**, the bottom surface **392** of the insert **314** is sloped or angled to provide clearance for pivoting movement of the shank upper portion **308** and the retainer **312**.

In operation, the tabs **360** may be bent inwardly toward the axis H before or after insertion of the insert **314** into the cavity **380**, either by top or bottom loading. Preferably, the tabs **360** are initially bent inwardly toward the axis H, followed by bottom loading of the insert **314** into the cavity **380** at the cavity opening at the base **340**. The shank **304** and the retainer **312** are then bottom loaded in a manner similar to what has been previously described herein with respect to the assembly **1**. As best illustrated in FIG. **18**, the tabs **360** engage the insert **314** at or near the chamfer **395**, prohibiting further upward movement of the insert **314** into a remainder of the cavity **380**. Eventually, the rod **321** and the closure top **318** are assembled with the receiver **310** in the manner described previously herein with respect to the receiver **10**, rod **21** and closure top **18**.

With reference to FIGS. **23** and **24**, in a fourth embodiment according to the invention, generally **401**, a receiver **410** is substantially identical to the receiver **310** of the assembly **301** with the exception that the spring tabs **360** are removed and replaced with a deformable material portion **460**. The assembly **401** otherwise includes a shank **404**, a retainer **412** and a compression insert **414** identical or substantially similar to the shank **304**, retainer **312** and compression insert **314** previously described herein with respect to the assembly **301**. Formed on outside surfaces **456** of the receiver **410** are a pair of opposed apertures **457**. Each deformable portion or wall **460** partially defines the respective aperture **457**. A tool (not shown) is inserted into the aperture and is pressed against the deformable portion **460**, causing the portion **460** to extend into a cavity **480** of the receiver **410** in a direction towards a central axis J. Similar to the spring tabs **360**, the now deformed wall portions **460** abut against and prohibit upward movement of the insert **414** and thus desirably retain the insert **414** in the cavity **480**. If, as illustrated, the insert **414** is uploadable into the cavity **480** from an opening in the base **440** thereof, the portions **480** are preferably deformed prior to insertion of the insert **414** into the receiver **410**. It is foreseen that in downloaded embodiments, the portions **480** may be deformed after downloading of the insert **414** into the cavity **480**.

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

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

1. A polyaxial bone screw assembly comprising:
- a) a bone screw shank having an upper portion;
- b) a receiver having a cavity, the bone screw upper portion being receivable in the cavity;
- c) a retaining and articulating structure receivable in the cavity between the shank upper portion and the receiver, the retaining and articulating structure being unattached to both the shank and the receiver so as to be freely movable relative to both the shank and the receiver during positioning of the shank relative to the receiver;
- d) a compression insert disposed in the receiver during final positioning of the shank to lock the shank in place, the insert having a depression formed in an outer surface thereof and having a mating surface exclusively frictionally engageable with the bone screw upper portion, wherein the insert is spaced from the retaining and articulating structure; and
- e) resilient structure extending from the receiver and biasing against the compression insert at the depression thereof, the resilient structure resisting rotational movement of the compression insert within the receiver to maintain a desired alignment of the insert with the receiver, while allowing for upward and downward movement of the insert with respect to the receiver.

2. The assembly of claim **1** wherein the compression insert mating surface is concave and the bone screw upper portion is convex.

3. The assembly of claim **1** wherein the shank upper portion has a convex surface and the retaining and articulating structure has a concave surface in slidable mating engagement with the convex surface.

4. The assembly of claim **3** wherein the concave and convex surfaces are substantially spherical.

5. The assembly of claim **1** wherein the retaining and articulating structure has a convex surface and the receiver has a concave surface in slidable mating engagement with the convex surface.

6. The assembly of claim **5** wherein the concave and convex surfaces are substantially spherical.

7. The assembly of claim **1** wherein the shank upper portion has a tool engagement formation formed thereon adapted for non-slip engagement by a tool for driving the bone screw shank into bone.

8. The assembly of claim **7** wherein the tool engagement formation is a substantially hex shaped inner drive.

9. The assembly of claim **1** wherein the retaining and articulating structure is sized and shaped to be at least one of top-loadable and bottom-loadable into the receiver.

10. The assembly of claim **1** wherein the retaining and articulating structure further comprises first and second spaced ends, the retaining and articulating structure being compressible and [expandible] *expandable* with the first and second ends being movable toward and away from one another.

11. The assembly of claim **10** wherein the retaining and articulating structure has a central axis, the first and second ends each being substantially planar surfaces running substantially parallel to the axis.

12. The assembly of claim **10** wherein the retaining and articulating structure has a central axis, the first and second ends each being substantially planar surfaces running at an angle oblique to the axis.

13. The assembly of claim **1** wherein the bone screw shank is cannulated.

14. The assembly of claim **1** wherein

a) the bone screw shank has a body for fixation to bone, the shank body being integral with the shank upper portion; and

b) the assembly further comprising a closure structure insertable into the receiver, the closure structure for operably urging the insert into frictional engagement with the bone screw shank upper portion and moving the shank in a direction to frictionally lock the position of the retaining and articulating structure with respect to the shank upper portion and the receiver, thereby locking the shank body in a selected angle with respect to the receiver.

15. The assembly of claim **14** wherein:

(a) the receiver has upstanding spaced arms defining an open channel, the arms having guide and advancement structures on an inside surface thereof; and

(b) the closure structure is sized and shaped to be positionable between the arms for closing the channel, the closure structure having a closure guide and advancement structure for rotatably mating with the guide and advancement structures on the arms, biasing the closure structure upon advancement rotation against a longitudinal connecting member disposed in the channel.

16. The assembly of claim **1** wherein the resilient structure is a pair of opposed spring tabs attached to the receiver and extending toward a central axis of the receiver.

17. The assembly of claim **16** wherein the spring tabs are integral with the receiver.

18. The assembly of claim **16** wherein the spring tabs are directed upwardly toward a top opening of the receiver.

19. The assembly of claim **16** wherein the spring tabs are directed downwardly toward a base of the receiver.

20. The assembly of claim **1** wherein the insert depression is a shallow groove.

21. The assembly of claim **1** wherein the insert depression is a flat surface.

22. The assembly of claim **1** wherein the insert is one of top and bottom loaded.

23. In a polyaxial bone screw assembly for surgical implantation and including a shank and a threaded body for inserting into a bone and a receiver having a channel for receiving a longitudinal connecting member within the channel, the improvement wherein:

a) the shank has a first curvate surface at an upper end thereof and is pivotally engaged with an interior surface of the receiver; and further comprising:

b) an articulation structure located between the shank upper end and the receiver, the articulation structure having a second curvate surface and an opposed third curvate surface, the articulation structure being in slidable engagement with receiver at the second curvate surface, the articulation structure third curvate surface being in slidable engagement with the shank upper end first curvate surface, the articulation structure being freely movable relative to both the shank and the receiver during positioning of the shank relative to the receiver;

c) a compression insert having a fourth curvate surface in slidable engagement with the shank first curvate surface, the insert being spaced from the articulating structure, and the insert having a depression formed in an outer surface thereof; and

d) resilient structure extending from the receiver and biasing against the compression insert at the depression thereof, the resilient structure resisting rotational movement of the compression insert within the receiver to maintain a desired alignment of the insert with the receiver, while allowing for upward and downward movement of the insert with respect to the receiver.

24. The improvement of claim **23** wherein the shank upper end has a tool engagement formation formed thereon adapted for non-slip engagement by a tool for driving the bone screw shank into bone.

25. The improvement of claim **23** wherein the articulation structure is sized and shaped to be at least one of top-loadable and bottom-loadable into the receiver.

26. The improvement of claim **23** wherein the articulation structure further comprises first and second spaced ends, the articulation structure being compressible and [expandible] *expandable* with the first and second ends being movable toward and away from one another.

27. The improvement of claim **23** wherein the resilient structure is a pair of opposed spring tabs integral with the receiver and extending toward a central axis of the receiver.

28. The improvement of claim **27** wherein the opposed spring tabs face downwardly.

29. The improvement of claim **27** wherein the opposed spring tabs face upwardly.

30. In a bone screw assembly having a receiver pivotally connected to a bone screw shank, the receiver having an opening for receiving a longitudinal connecting member and a compression insert disposed in the receiver for frictional engagement with the longitudinal connection member and having a depression formed in an outer surface thereof, the improvement comprising:

a) resilient structure extending from the receiver and biasing against the compression insert at the depression thereof, the resilient structure resisting rotational movement of the compression insert within the receiver to maintain a desired alignment of the insert with the receiver, while allowing for upward and downward movement of the insert with respect to the receiver; and

b) an articulation structure disposed between the bone screw shank and the receiver, the articulation structure having a first curvate wall in sliding engagement with the receiver and a second curvate wall in sliding engagement with the bone screw shank.

31. The improvement of claim **30** wherein the resilient structure is a pair of opposed spring tabs attached to the receiver and extending toward a central axis of the receiver.

32. The improvement of claim **31** wherein the opposed spring tabs face downwardly.

33. The improvement of claim **31** wherein the opposed spring tabs face upwardly.

34. The improvement of claim **30** wherein the insert depression is a shallow groove.

35. The improvement of claim **30** wherein the insert depression is a flat surface.

36. The improvement of claim **30** wherein the articulation structure further comprises first and second spaced ends, the articulation structure being compressible and [expandible] *expandable* with the first and second ends being movable toward and away from one another.

37. The improvement of claim **30** wherein the articulation structure is freely movable relative to both the shank and the receiver during positioning of the shank relative to the receiver.

[**38**. In a bone screw assembly having a receiver pivotally connected to a bone screw shank, the shank having a lower portion attachable to a bone and an upper head portion, the receiver having an opening for receiving a longitudinal connecting member, the assembly also having a compression insert disposed in the receiver for frictional engagement with the longitudinal connecting member and the shank upper head portion, the improvement wherein the receiver comprises:

a resilient structure integral with the receiver, the structure having a surface projecting inwardly and facing downwardly into the receiver in a direction towards the shank; the structure biasing against the compression insert, holding the insert within the receiver and downwardly against the shank upper head portion, and resisting rotational movement of the insert to maintain a desired alignment of the insert with the receiver, while allowing for upward and downward movement of the insert with respect to the receiver.]

[**39**. The improvement of claim **38** wherein the resilient structure is a first resilient structure; and further comprising a second resilient structure integral with the receiver and located opposite the first resilient structure, the second resilient structure also projecting inwardly and facing downwardly into the receiver in a direction towards the shank.]

[**40**. In a bone screw assembly having a receiver pivotally connected to a bone screw shank, the shank having a lower portion attachable to a bone and an upper head portion, the receiver having an opening for receiving a longitudinal connecting member, the assembly also having a compression insert disposed in the receiver for frictional engagement with the longitudinal connecting member and the shank upper head portion, the improvement wherein the receiver comprises:

a resilient structure integral with the receiver, the structure having a surface projecting inwardly and facing upwardly into the receiver in a direction towards the shank; the structure biasing against the compression insert, holding the insert within the receiver and downwardly against the shank upper head portion, and resisting rotational movement of the insert to maintain a desired alignment of the insert with the receiver, while allowing for upward and downward movement of the insert with respect to the receiver.]

[**41**. The improvement of claim **40**, wherein the resilient structure is a first resilient structure; and further comprising a second resilient structure integral with the receiver and located opposite the first resilient structure, the second resilient structure also projecting inwardly and facing upwardly into the receiver in a direction towards the shank.]

42. In a bone screw assembly having a receiver pivotally connected to a bone screw shank, the receiver having an opening for receiving a longitudinal connecting member and a compression insert disposed in the receiver for frictional engagement with the longitudinal connection member, the improvement comprising:

a) resilient structure extending from the receiver and biasing against the compression insert at a depression formed in a surface of the insert, the resilient structure resisting rotational movement of the compression insert within the receiver to maintain a desired alignment of the insert with the receiver, while allowing for upward and downward movement of the insert with respect to the receiver; and

b) an articulation structure disposed between the bone screw shank and the receiver, the articulation structure having a first curvate wall in sliding engagement with the receiver and a second curvate wall in sliding engagement with the bone screw shank; and

c) the compression insert comprising a top and bottom portion having a bottom surface and a through-bore with an opening on the bottom surface sized and shaped to mate with an upper portion of the bone screw shank.

43. The improvement of claim **42**, wherein the top portion of the through-bore is cylindrical shaped, and the bottom portion of the through-bore is sized and shaped to mate with the upper portion of the bone screw shank.

44. A polyaxial bone screw assembly comprising:

a) a bone screw shank having an upper portion with a top surface;

b) a receiver having an internal cavity with an integral spherical seating surface adjacent a lower opening, the bone screw upper portion receivable in the cavity through the opening;

c) a retaining and articulating structure receivable in the cavity and positioned below the top surface of the shank and between the shank upper portion and the receiver, the retaining and articulating structure having an outer spherical surface for seating against the receiver seating surface and being unattached to both the shank and the receiver so as to be freely movable relative to both the shank and the receiver during positioning of the shank relative to the receiver;

d) a compression insert disposed in the receiver during final positioning of the shank to lock the shank in place, the insert having a lower first mating surface frictionally engageable with the bone screw upper portion and an upper second mating surface to engage a rod; and

e) resilient structure extending from the receiver and biasing against the compression insert at a depression formed in a surface of the insert, the resilient structure resisting rotational movement of the compression insert within the receiver to maintain a desired alignment of the insert with the receiver, while allowing for upward and downward movement of the insert with respect to the receiver.

45. The polyaxial bone screw assembly of claim 44, wherein the receiver internal cavity further comprises an expansion portion above the spherical seating surface, the expansion portion being configured to allow the retaining and articulating structure to expand therein around the shank upper portion during loading of the bone screw shank through the lower opening, and to then snap around the shank upper portion with an inner spherical surface of the retaining and articulating structure in sliding cooperation with an outer spherical surface of the shank upper portion.

46. The polyaxial bone screw assembly of claim 45, further comprising an outer groove formed into the outer spherical surface of the retaining and articulating structure to provide additional clearance for the expansion of the retaining and articulating structure within the expansion portion of the receiver internal cavity.

47. The assembly of claim 1, wherein the receiver cavity further comprises an expansion portion above a spherical seating surface, the expansion portion being configured to allow the retaining and articulating structure to expand therein around the shank upper portion during loading of the bone screw shank into the receiver, and to then snap around the shank upper portion with an inner spherical surface of the retaining and articulating structure in sliding cooperation with an outer spherical surface of the shank upper portion.

48. The assembly of claim 47, further comprising an outer groove formed into the outer spherical surface of the retaining and articulating structure to provide additional clearance for the expansion of the retaining and articulating structure within the expansion portion of the receiver cavity.

49. The improvement of claim 23, wherein the receiver further comprises an expansion portion above the receiver interior surface, the expansion portion being configured to allow the articulation structure to expand therein around the shank upper end during loading of the shank into the receiver and to then snap around the shank upper end with the articulation structure third curvate surface entering into slidable engagement with the shank upper end first curvate surface.

50. The improvement of claim 49, further comprising an outer groove formed into the articulation structure second curvate surface to provide additional clearance for the expansion of the articulation structure within the receiver expansion portion.

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