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(54) **PEDICLE SCREW ASSEMBLY**

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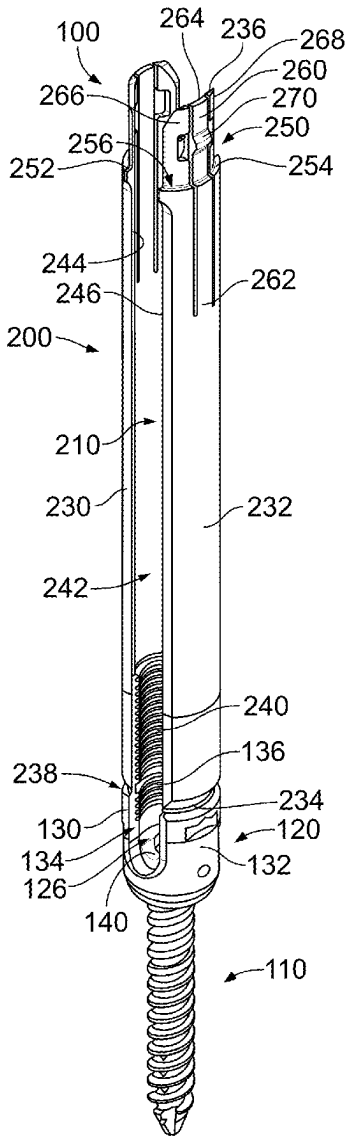
(57) **ABSTRACT**

A pedicle screw assembly includes a tulip having a pocket that receives a head of the screw body. The pedicle screw assembly includes a tulip extension that extends from the tulip including first and second extension tabs extending from first and second side walls of the tulip. The tulip extension has a lumen defined between the first and second extensions and slots defined between the first and second extensions aligned with rod openings of the tulip. The tulip extension includes a deflectable retention spring along at least one of the extension tabs. A support ring is coupled to the extension tabs for support. The retention spring retains the support ring on the extension tabs but is releasable to allow removal of the support ring.



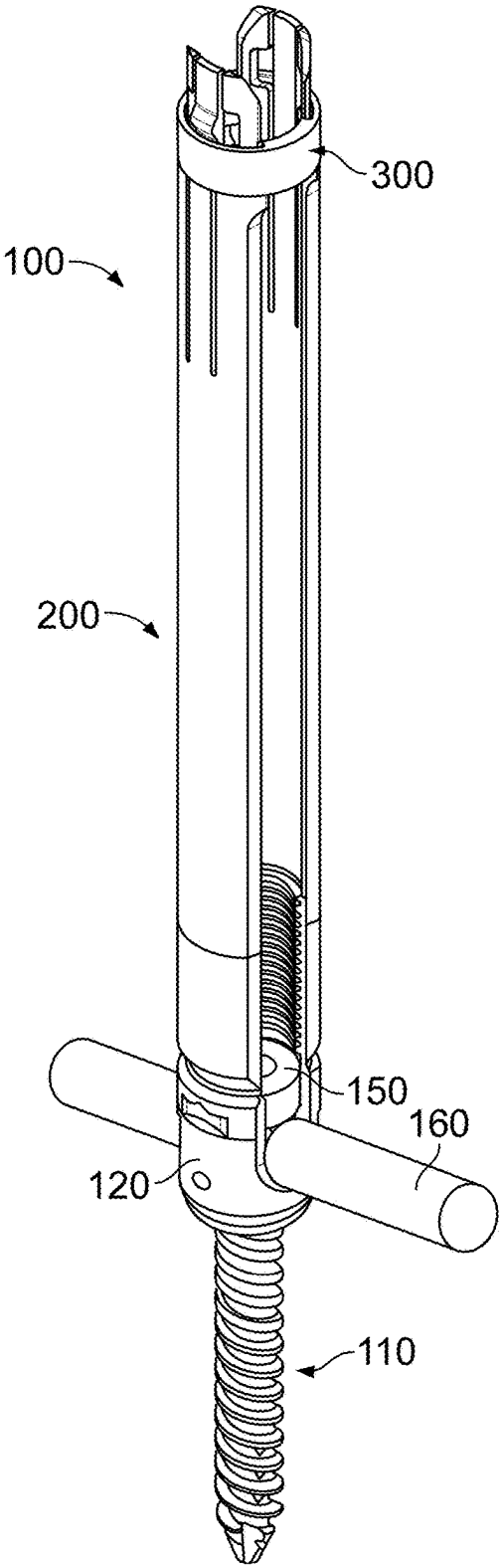


FIG. 1

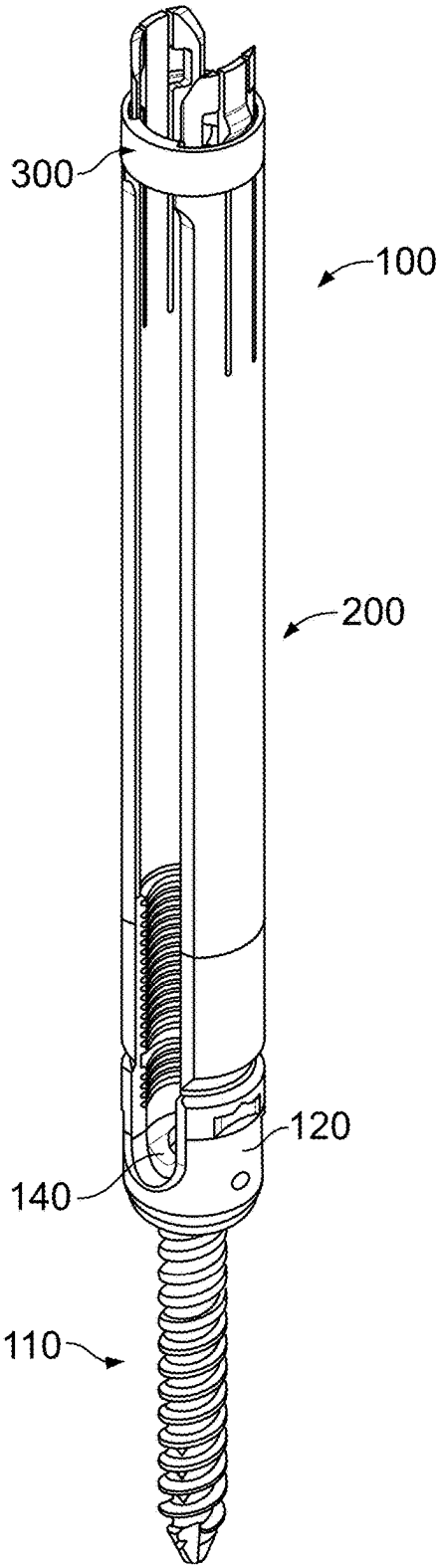


FIG. 2

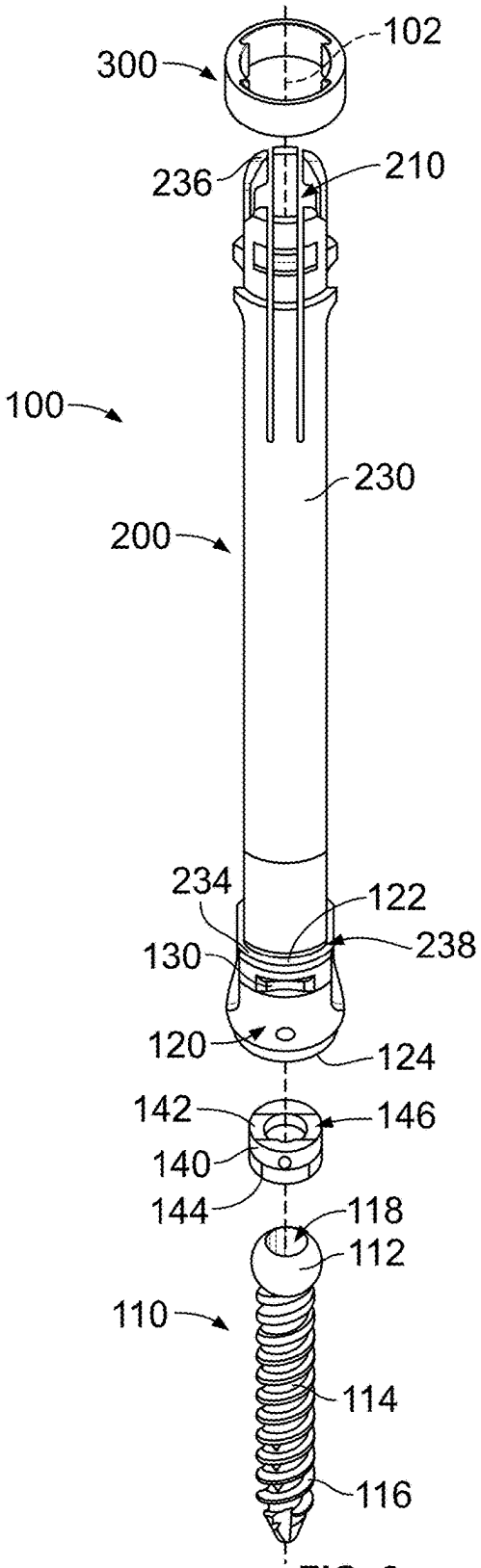

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FIG. 3

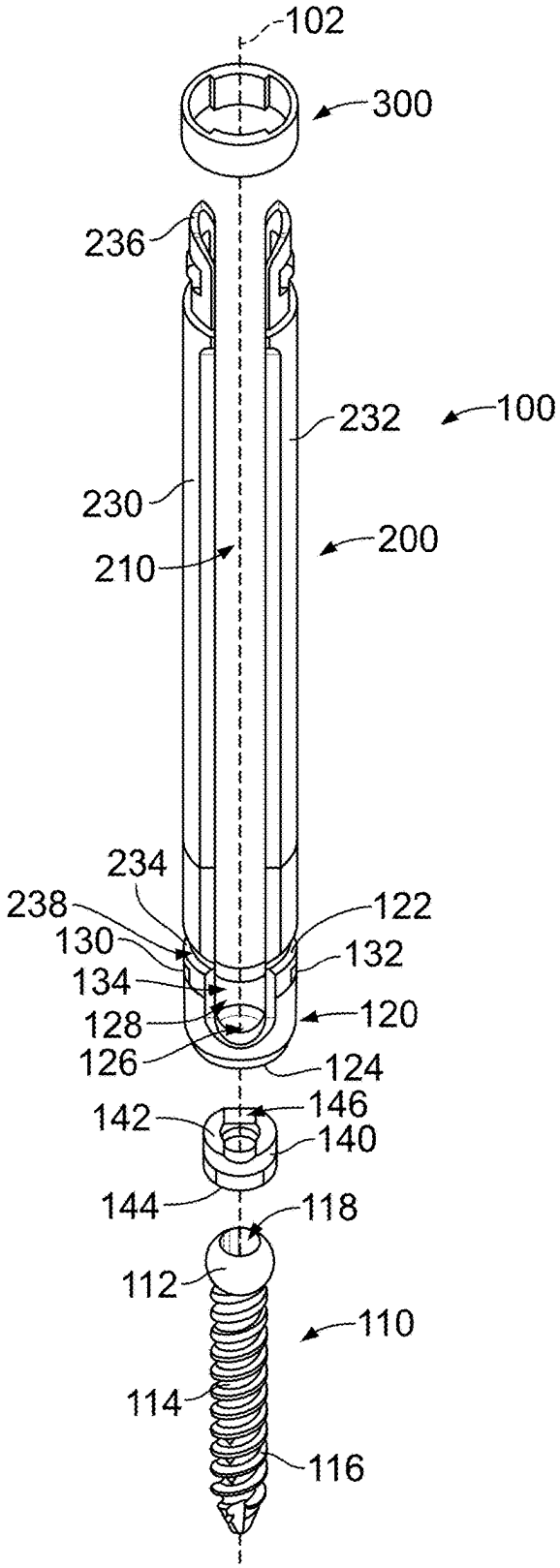
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FIG. 4

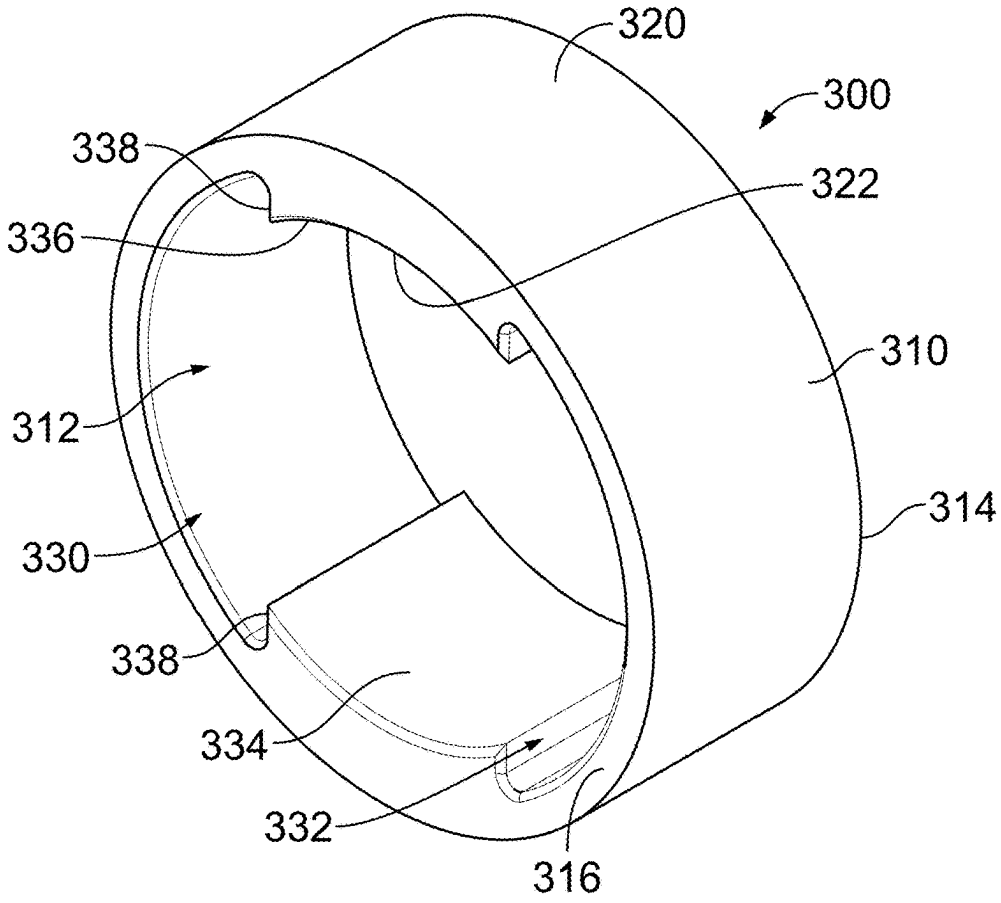
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FIG. 5

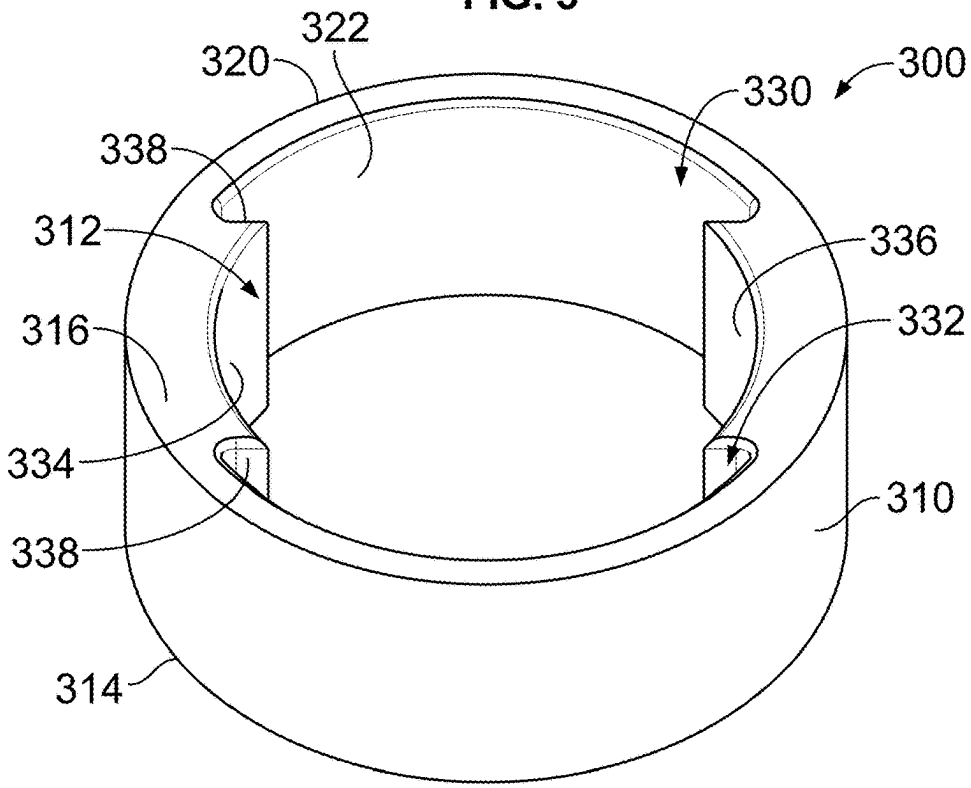
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FIG. 6

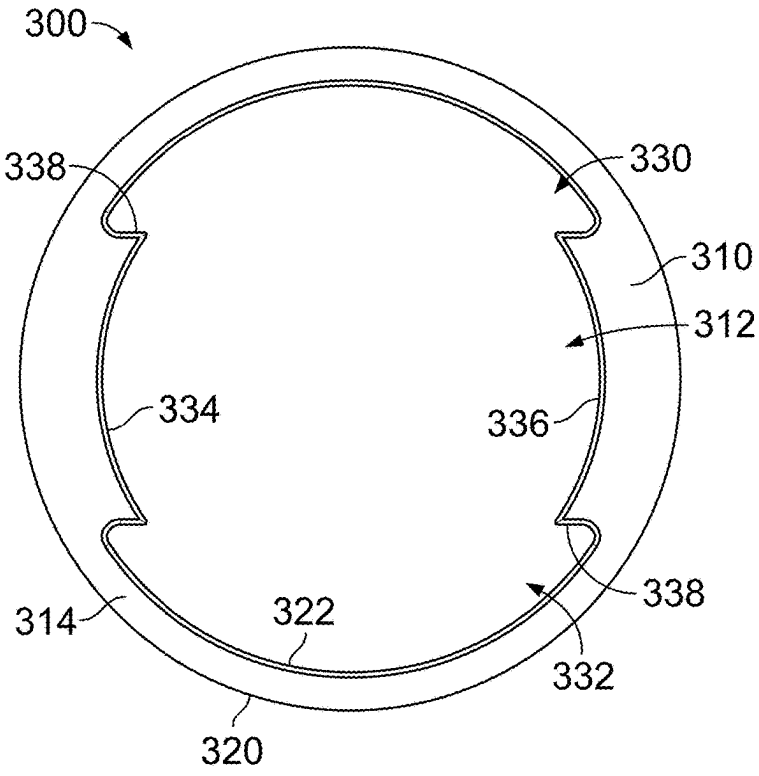
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FIG. 7

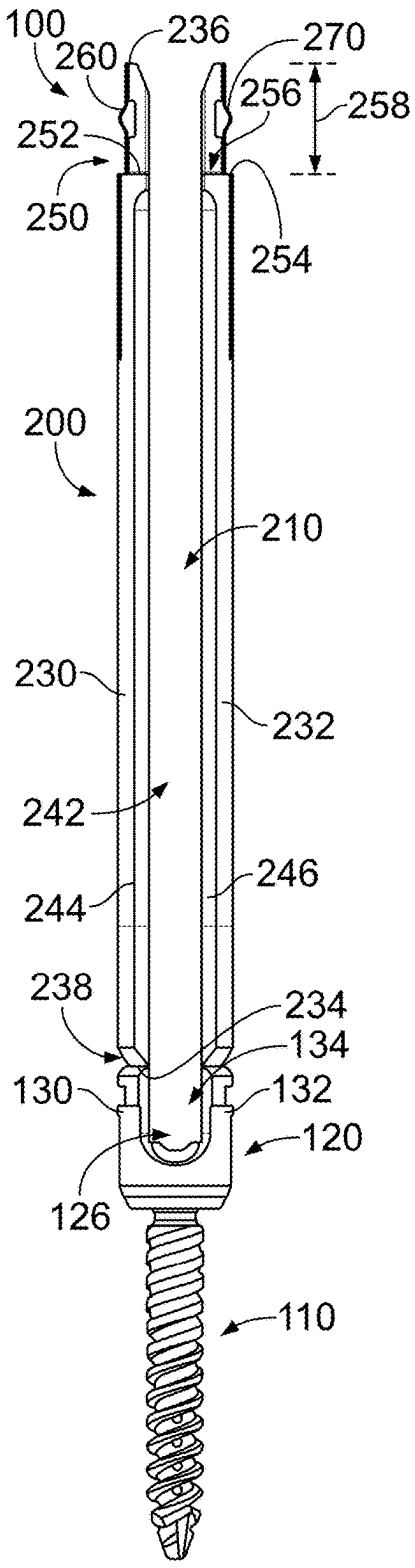
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FIG. 8

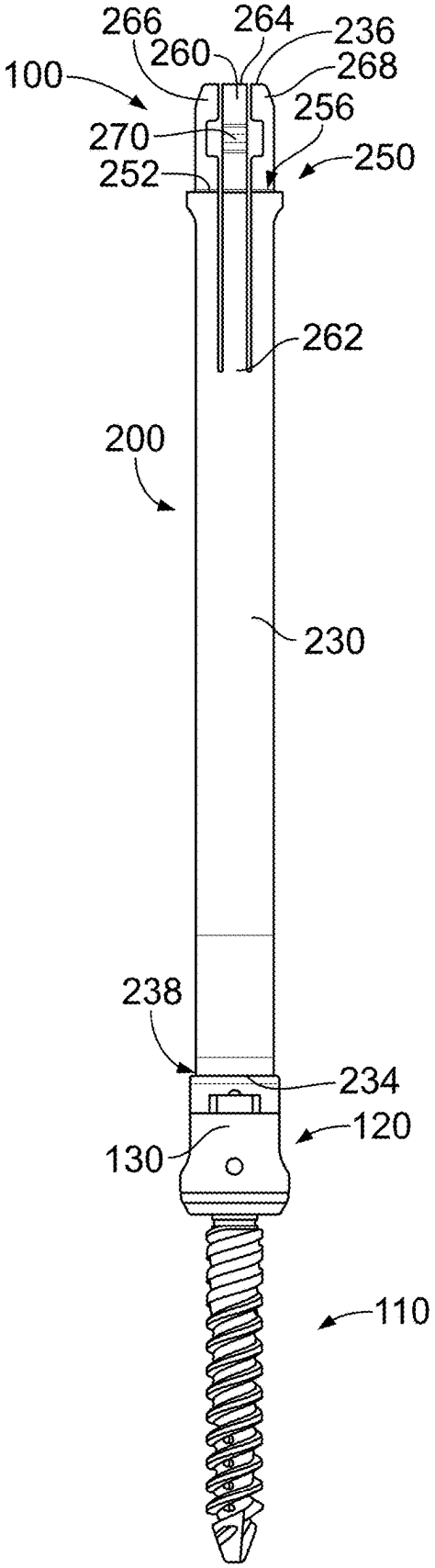
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FIG. 9

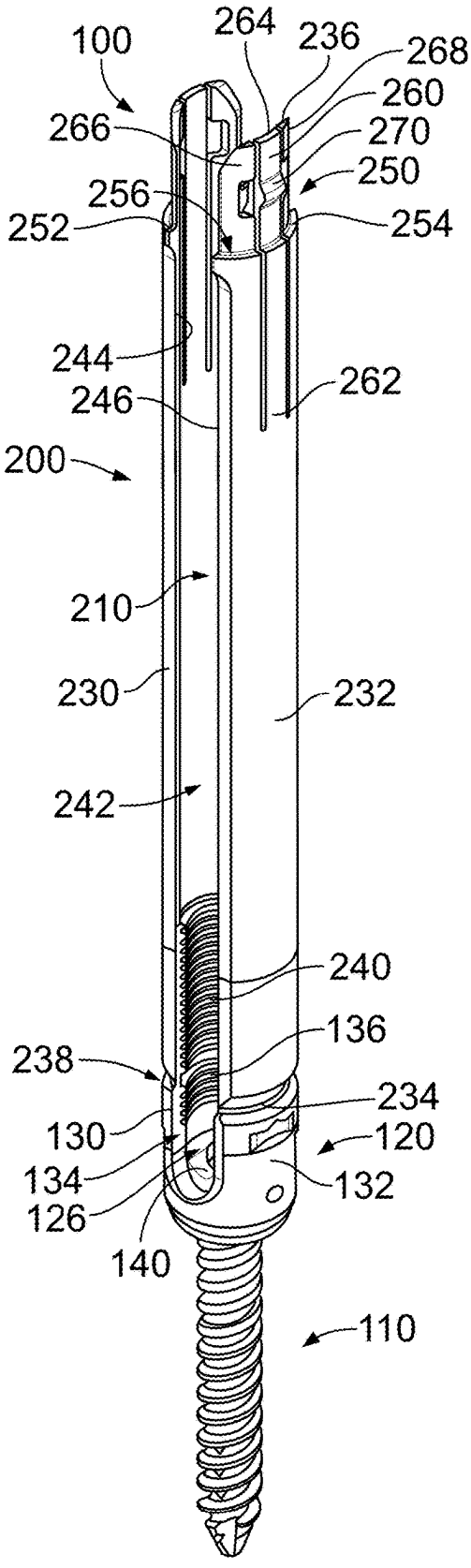
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FIG. 10

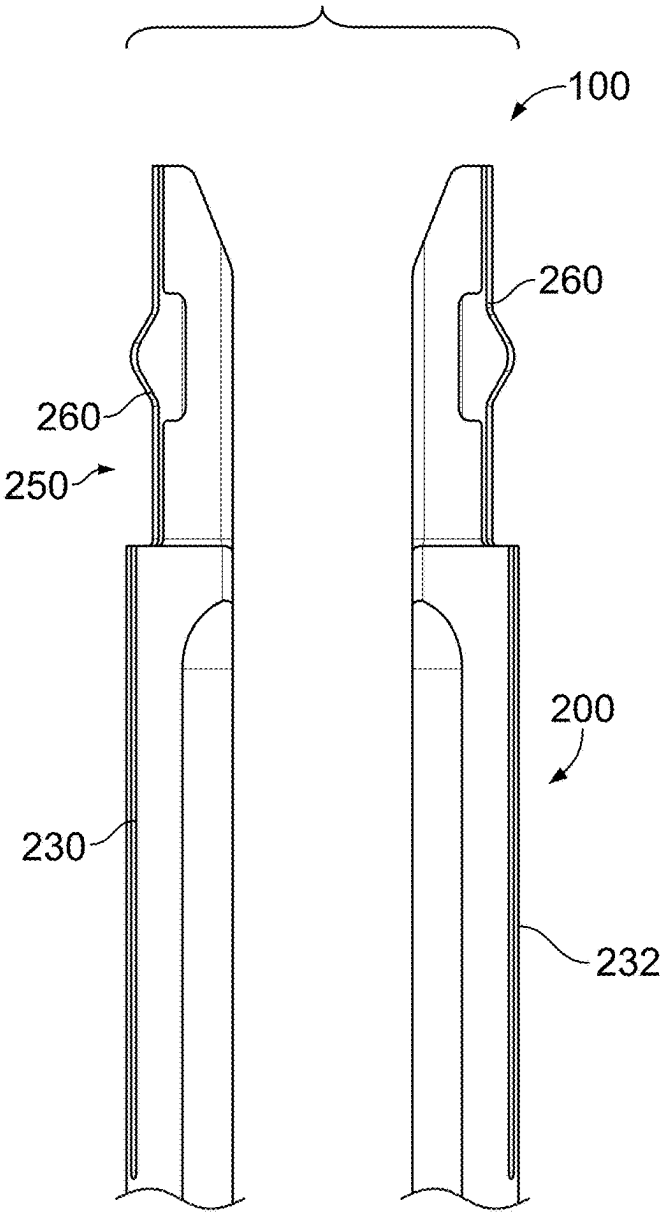

FIG. 11

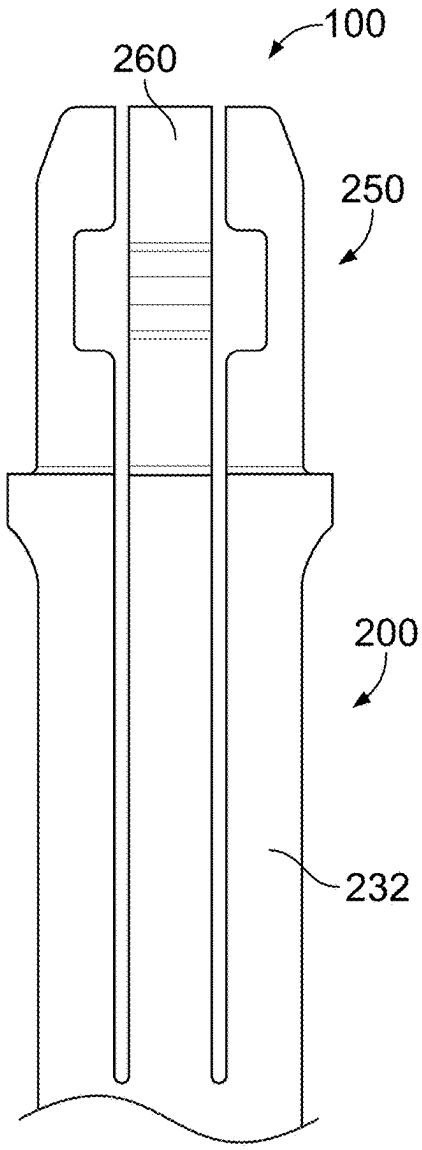

FIG. 12

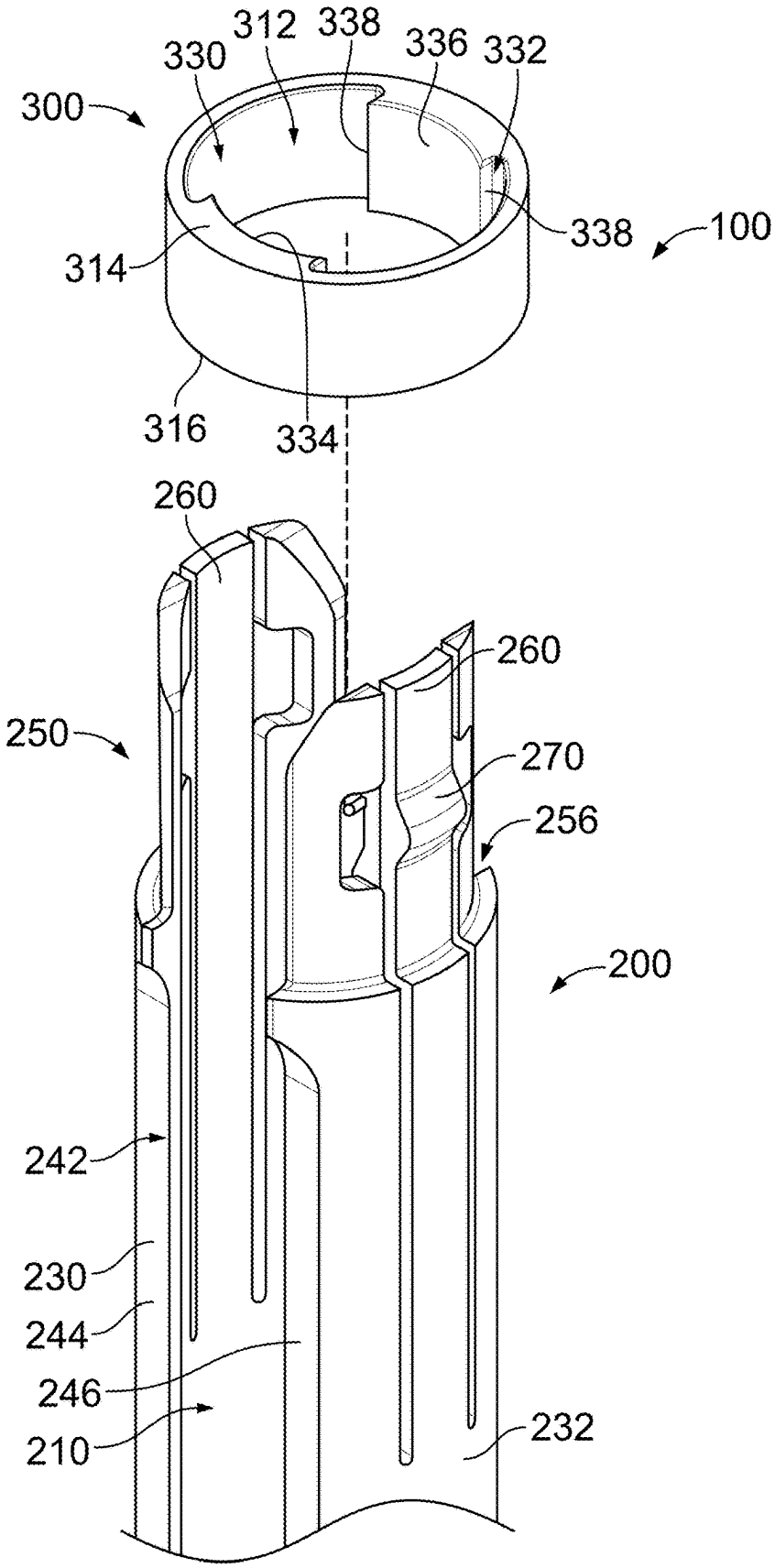
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FIG. 13

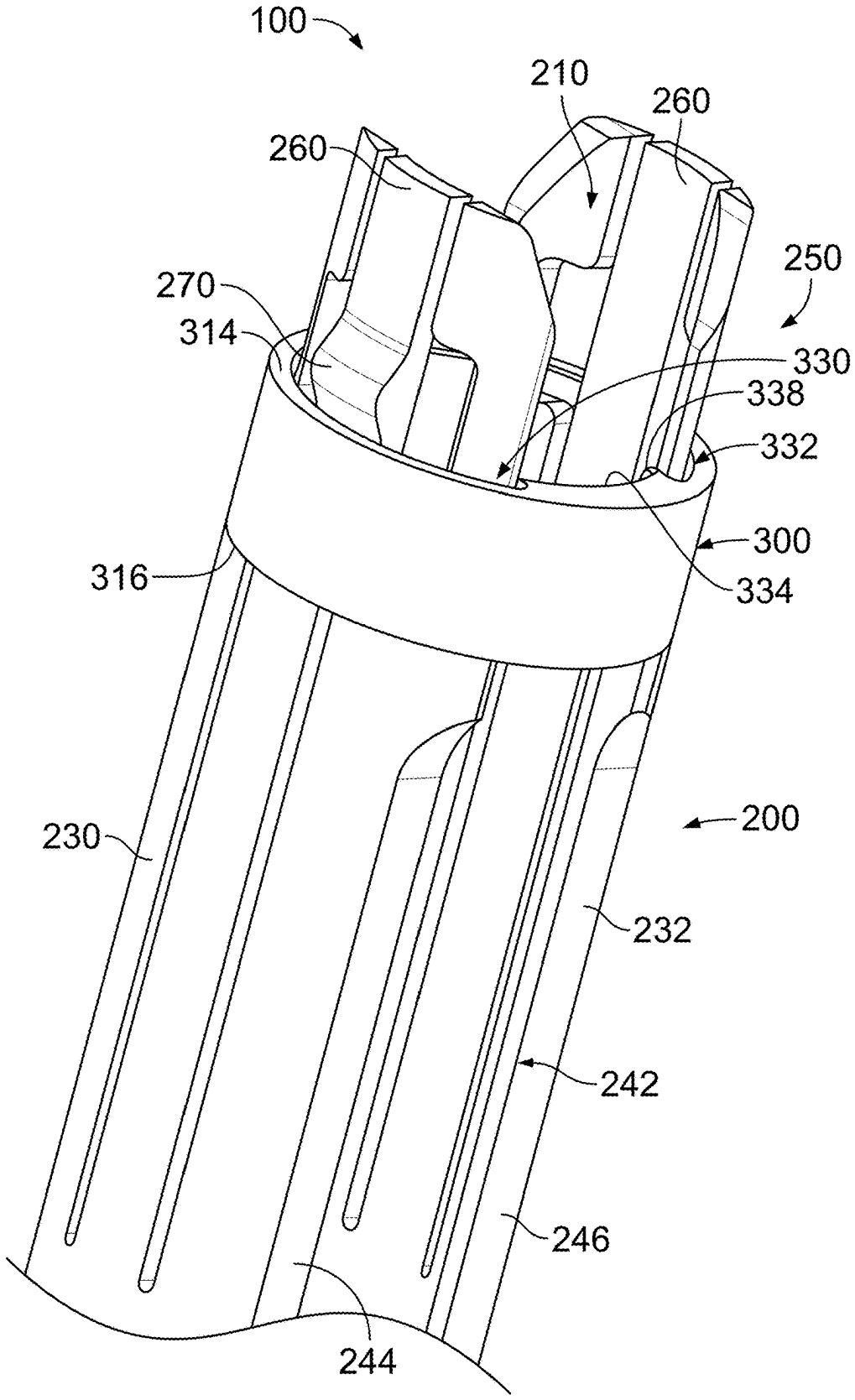
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FIG. 14

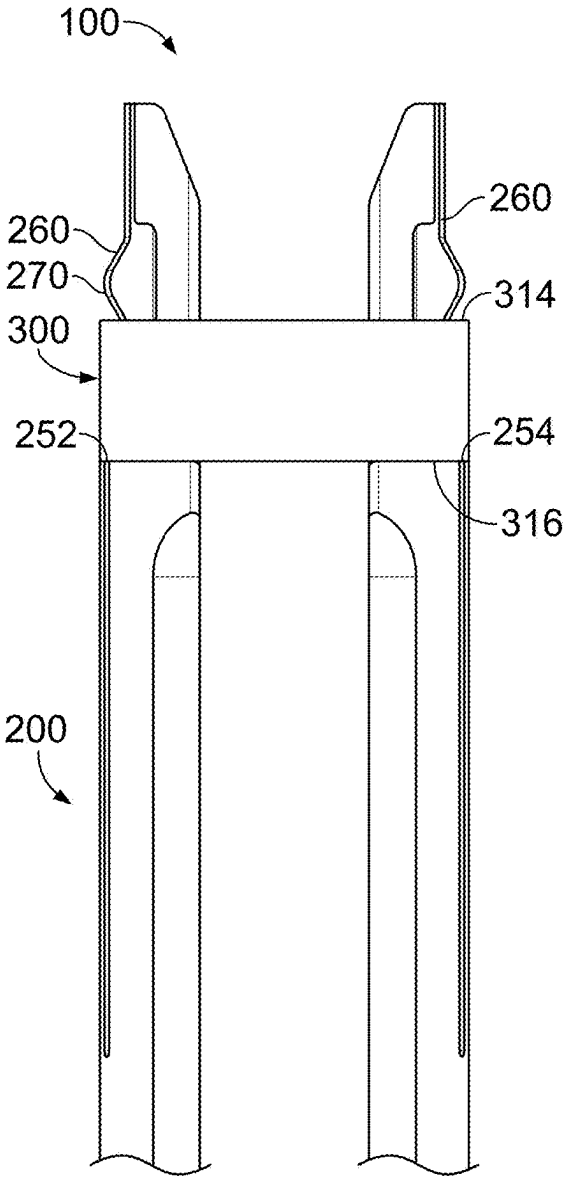
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FIG. 15

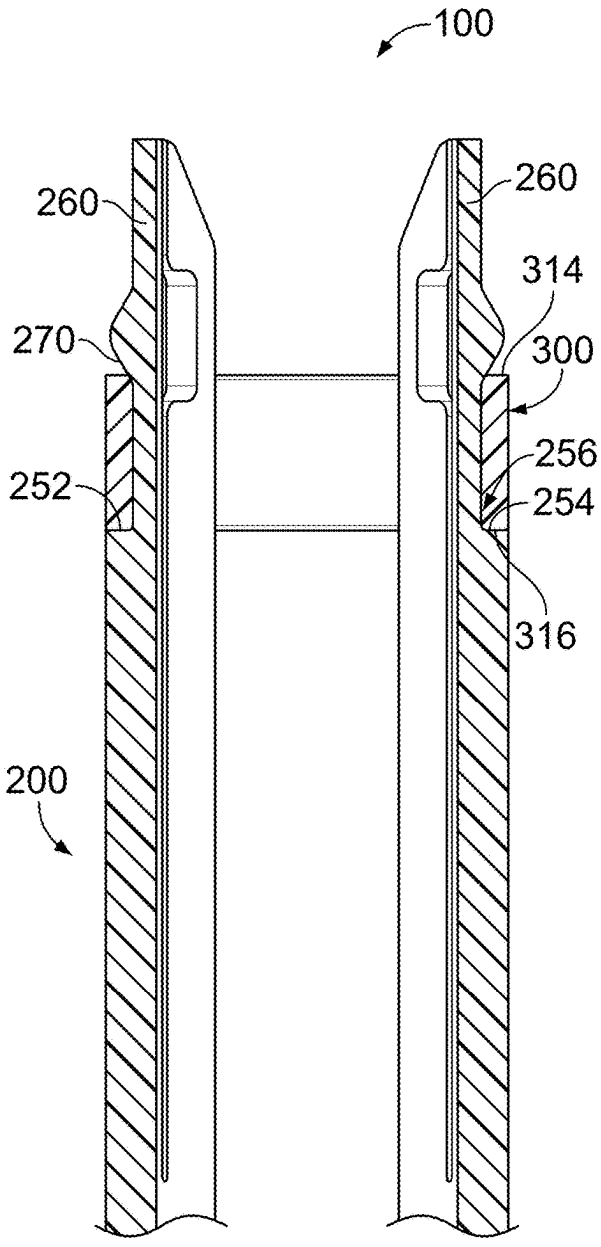
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FIG. 16

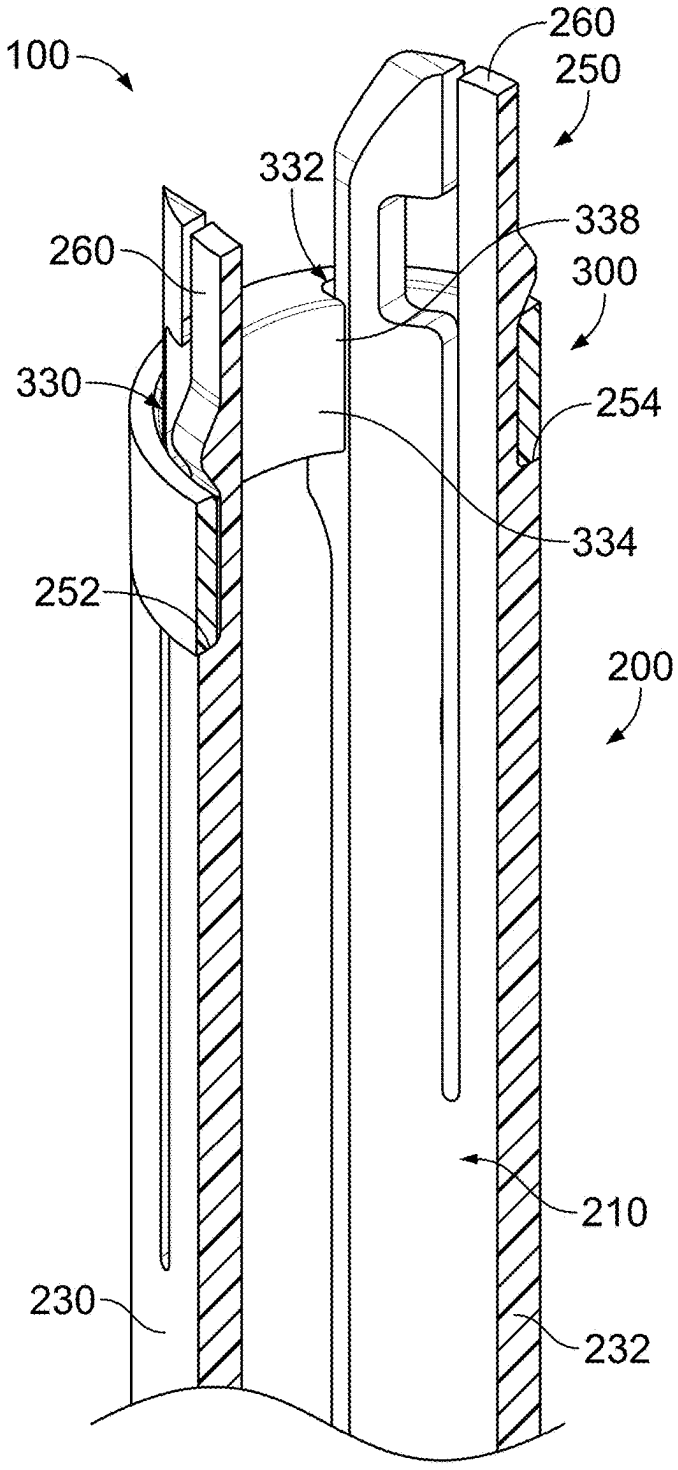
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FIG. 17

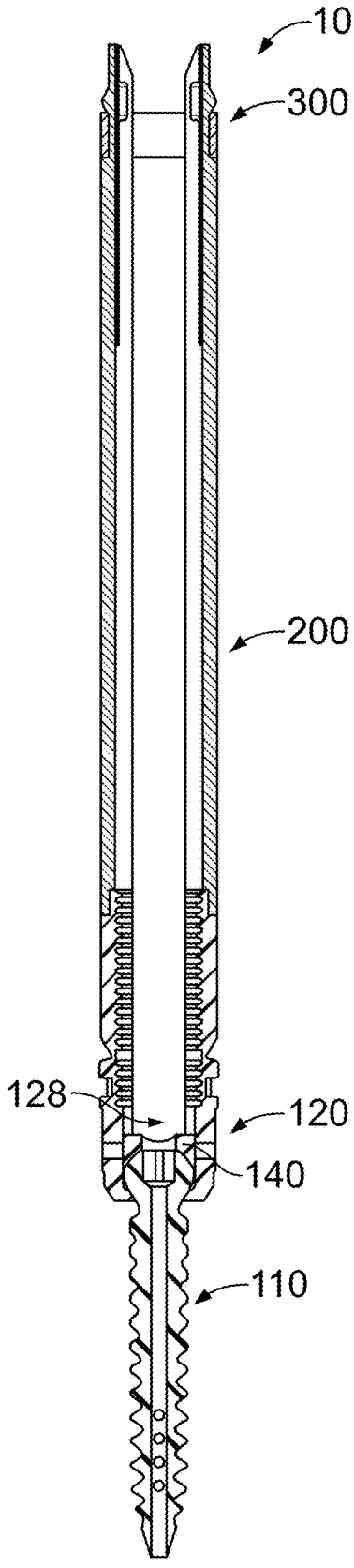
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FIG. 18

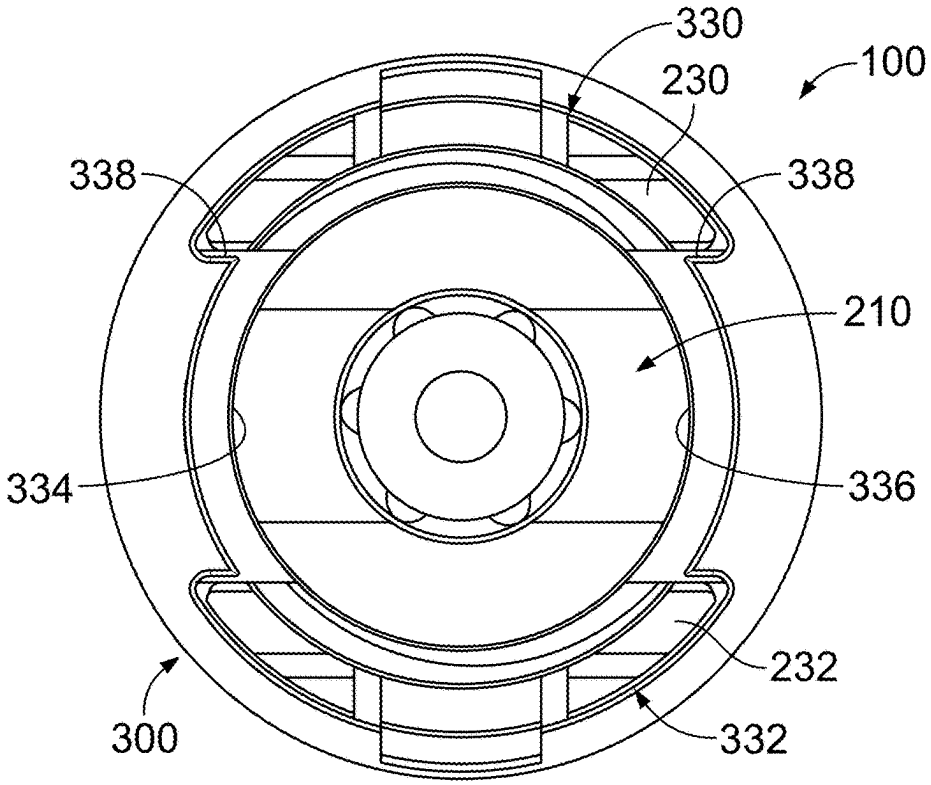
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FIG. 19

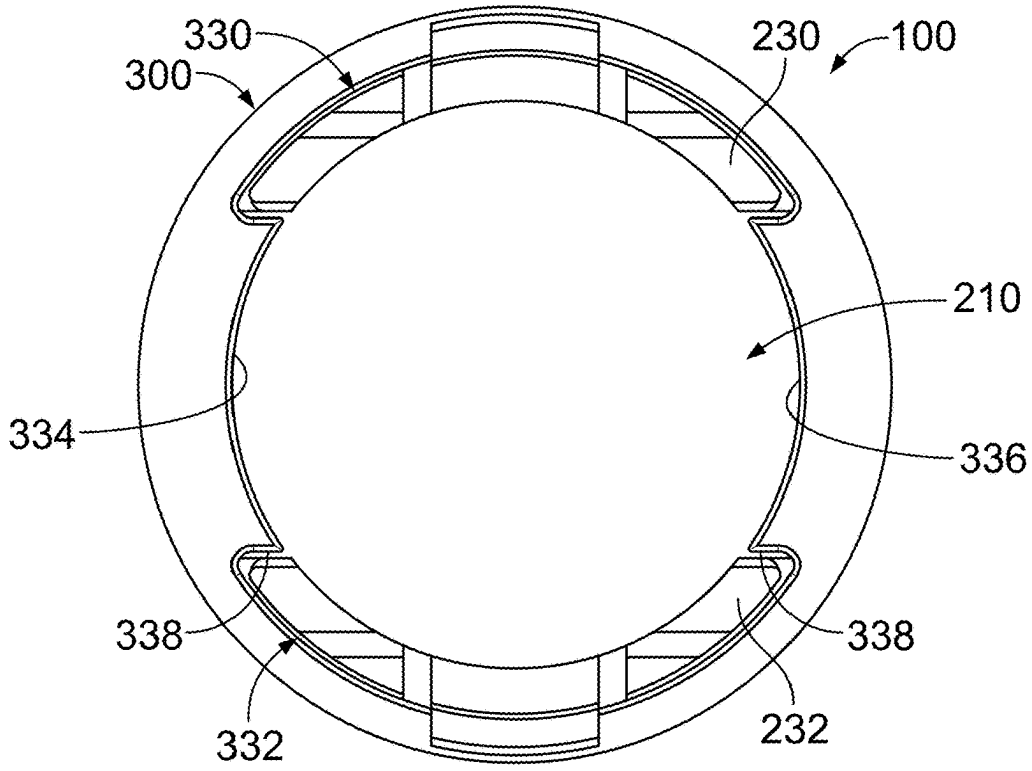
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FIG. 20

PEDICLE SCREW ASSEMBLY

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a claims priority to U.S. Application No. 63/555,732, filed 20 Feb. 2024, the subject matter of which is herein incorporated by reference in its entirety.

BACKGROUND OF THE INVENTION

[0002] The subject matter herein relates generally to pedicle screw assemblies.

[0003] A technique commonly referred to as spinal fixation is employed for fusing together and/or mechanically immobilizing vertebrae of the spine. In spine stabilization procedures, connecting elements, such as rods, plates or wires are placed and fixed between two or more locations of the spine. In some applications, pedicle screws can be inserted into the vertebrae of the spine and connected with the connecting elements to provide immobilization and stabilization of the vertebral column. The pedicle screws used in some surgical procedures utilize tubes or extended tabs extending from the ends of the pedicle screws to access the pedicle screws at locations deep in the patient's body. The extensions provide a slot or channel for insertion of the connecting elements or tools to access the pedicle screw. However, fixation of the extensions may be difficult. If the extensions collapse inward, it is difficult or impossible to load the connecting element or tool into the pedicle screw. If the extensions spread outward, it may be difficult to properly load the connecting element or tool into the pedicle screw. Additionally, opening or closing of the extensions may cause the extensions to be damaged or separate from the pedicle screw.

BRIEF DESCRIPTION OF THE INVENTION

[0004] In one embodiment, a pedicle screw assembly is provided and includes a screw body that has a head and a threaded shaft extends from the head. The pedicle screw assembly includes a tulip that has a pocket that receives the head of the screw body. The tulip has a first side wall and a second side wall on opposite sides of the pocket. The tulip has rod openings defined between the first and second side walls configured to receive a rod. The pedicle screw assembly includes a set screw received in the pocket to secure the rod in the slot. The pedicle screw assembly includes a tulip extension that extends from the tulip. The tulip extension includes a first extension tab that extends from the first side wall and a second extension tab extends from the second side wall. The first and second side walls extend parallel to each other between proximal ends and distal ends of the first and second extension tabs. The tulip extension has a lumen defined between the first and second extensions. The tulip extension has slots defined between the first and second extensions aligned with the rod openings. The tulip extension includes a deflectable retention spring along the first extension tab. The pedicle screw assembly includes a support ring coupled to the distal ends of the first and second extension tabs to support the first and second extension tabs relative to each other. The support ring interfaces with the retention spring to retain the support ring on the first and second extension tabs. The retention spring is releasable from the support ring to allow removal of the support ring from the distal ends of the first and second extension tabs.

[0005] In another embodiment, a pedicle screw assembly is provided and includes a screw body that has a head and a threaded shaft extends from the head. The pedicle screw assembly includes a tulip that has a pocket to receive the head of the screw body. The tulip has a first side wall and a second side wall on opposite sides of the pocket. The tulip has rod openings defined between the first and second side walls configured to receive a rod. The pedicle screw assembly includes a set screw received in the pocket to secure the rod in the slot. The pedicle screw assembly includes a tulip extension that extends from the tulip. The tulip extension includes a first extension tab that extends from the first side wall and a second extension tab extends from the second side wall. The first and second side walls extend parallel to each other between proximal ends and distal ends of the first and second extension tabs. The tulip extension has a lumen defined between the first and second extensions. The tulip extension has slots defined between the first and second extensions aligned with the rod openings. The pedicle screw assembly includes a support ring that includes a ring body surrounding an opening configured to receive the distal ends of the first and second extension tabs. The ring body surrounds the first and second extension tabs to prevent opening of the first and second extension tabs relative to each other. The ring body is coupled to the first and second extension tabs to support the first and second extension tabs and prevent closing of the first and second extension tabs relative to each other.

[0006] In a further embodiment, a pedicle screw assembly is provided and includes a screw body that has a head and a threaded shaft extends from the head. The pedicle screw assembly includes a tulip that has a pocket to receive the head of the screw body. The tulip has a first side wall and a second side wall on opposite sides of the pocket. The tulip has rod openings defined between the first and second side walls configured to receive a rod. The pedicle screw assembly includes a set screw received in the pocket to secure the rod in the slot. The pedicle screw assembly includes a tulip extension extends from the tulip. The tulip extension includes a first extension tab that extends from the first side wall and a second extension tab extends from the second side wall. The first and second side walls extend parallel to each other between proximal ends and distal ends of the first and second extension tabs. The tulip extension has a lumen defined between the first and second extensions. The tulip extension has slots defined between the first and second extensions aligned with the rod openings. The tulip extension includes a deflectable retention spring along the first extension tab. The pedicle screw assembly includes a support ring that includes a ring body surrounding an opening configured to receive the distal ends of the first and second extension tabs. The ring body surrounds the first and second extension tabs to prevent opening of the first and second extension tabs relative to each other. The ring body is coupled to the first and second extension tabs to support the first and second extension tabs and prevent closing of the first and second extension tabs relative to each other. The support ring interfaces with the retention spring to retain the support ring on the first and second extension tabs. The retention spring is releasable from the support ring to allow removal of the support ring from the distal ends of the first and second extension tabs.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. **1** is a front perspective view of a pedicle screw assembly in accordance with an exemplary embodiment.

[0008] FIG. **2** is a rear perspective view of the pedicle screw assembly in accordance with an exemplary embodiment.

[0009] FIG. **3** is a front, exploded perspective view of the pedicle screw assembly in accordance with an exemplary embodiment.

[0010] FIG. **4** is a side, exploded perspective view of the pedicle screw assembly in accordance with an exemplary embodiment.

[0011] FIG. **5** is a bottom perspective view of the support ring in accordance with an exemplary embodiment.

[0012] FIG. **6** is a top perspective view of the support ring in accordance with an exemplary embodiment.

[0013] FIG. **7** is a top view of the support ring in accordance with an exemplary embodiment.

[0014] FIG. **8** is a side view of a portion of the pedicle screw assembly showing the tulip extension in accordance with an exemplary embodiment.

[0015] FIG. **9** is a front view of a portion of the pedicle screw assembly showing the tulip extension in accordance with an exemplary embodiment.

[0016] FIG. **10** is a perspective view of a portion of the pedicle screw assembly showing the tulip extension in accordance with an exemplary embodiment.

[0017] FIG. **11** is a side view of a portion of the pedicle screw assembly showing the top of the tulip extension in accordance with an exemplary embodiment.

[0018] FIG. **12** is a front view of a portion of the pedicle screw assembly showing the top of the tulip extension in accordance with an exemplary embodiment.

[0019] FIG. **13** is an exploded, perspective view of a portion of the pedicle screw assembly showing the support ring poised for loading onto the tulip extension in accordance with an exemplary embodiment.

[0020] FIG. **14** is a perspective view of a portion of the pedicle screw assembly showing the support ring coupled to the tulip extension in accordance with an exemplary embodiment.

[0021] FIG. **15** is a side view of a portion of the pedicle screw assembly showing the support ring on the tulip extension in accordance with an exemplary embodiment.

[0022] FIG. **16** is a cross-sectional view of a portion of the pedicle screw assembly showing the support ring on the tulip extension in accordance with an exemplary embodiment.

[0023] FIG. **17** is a perspective, sectional view of a portion of the pedicle screw assembly showing the support ring on the tulip extension in accordance with an exemplary embodiment.

[0024] FIG. **18** is a cross-sectional view of the pedicle screw assembly in accordance with an exemplary embodiment.

[0025] FIG. **19** is a cross-sectional view of the pedicle screw assembly through the support ring facing downward in accordance with an exemplary embodiment.

[0026] FIG. **20** is a cross-sectional view of the pedicle screw assembly through the support ring facing upward in accordance with an exemplary embodiment.

DETAILED DESCRIPTION OF THE INVENTION

[0027] FIG. **1** is a front perspective view of a pedicle screw assembly **100** in accordance with an exemplary embodiment. FIG. **2** is a rear perspective view of the pedicle screw assembly **100** in accordance with an exemplary embodiment. The pedicle screw assembly **100** includes a screw body **110**, a tulip **120**, a clamping plate **140** and a set screw **150** (FIG. **1**) used to secure a connecting element **160** (FIG. **1**), such as a rod, in the tulip **120**. The pedicle screw assembly **100** includes a tulip extension **200** extending from the tulip **120** and a support ring **300** used to support the tulip extension **200**.

[0028] FIG. **3** is a front, exploded perspective view of the pedicle screw assembly **100** in accordance with an exemplary embodiment. FIG. **4** is a side, exploded perspective view of the pedicle screw assembly **100** in accordance with an exemplary embodiment. FIGS. **3** and **4** illustrate the screw body **110**, the tulip **120**, the clamping plate **140**, the tulip extension **200**, and the support ring **300** axially aligned along a longitudinal axis **102** of the pedicle screw assembly **100**.

[0029] The screw body **110** includes a head **112** and a threaded shaft **114** extending from the head **112**. The threaded shaft **114** includes helical threads **116** around the exterior of the threaded shaft **114**. The threaded shaft **114** is configured to be screwed into a bone of the patient. In an exemplary embodiment, the head **112** includes a drive element **118** is configured to interface with a drive tool to screw the threaded shaft **114** into the bone of the patient. In the illustrated embodiment, the drive element **118** is an opening, such as a hexagonal opening, configured to receive an end of a drive tool. In the illustrated embodiment, the head **112** is spherical to allow multiaxial orientation of the screw body **110** relative to the tulip **120**. The clamping plate **140** is used to secure the axial orientation of the screw body **110** relative to the tulip **120**, such as in a direction that is nonparallel to the longitudinal axis **102**.

[0030] The clamping plate **140** includes an upper surface **142** and a lower surface **144**. The lower surface **144** is configured to engage the head **112** of the screw body **110** to fix the orientation of the screw body **110** relative to the tulip **120**. The lower surface **144** may include a concave pocket that receives the head **112**. In an exemplary embodiment, the upper surface **142** includes a pocket **146** that is configured to receive the connecting element **160** (FIG. **1**).

[0031] The tulip **120** extends between a top **122** and a bottom **124**. The tulip **120** has a cavity **126** between the top **122** and the bottom **124**. The cavity **126** receives the screw body **110**, the clamping plate **140**, and the set screw **150** (FIG. **1**). In an exemplary embodiment, the tulip **120** includes a pocket **128** at the bottom of the cavity **126**. The pocket **128** receives the head **112** of the screw body **110**. The pocket **128** may have a complementary shape as the head **112** to allow multiaxial rotation of the head **112** within the pocket **128**.

[0032] In an exemplary embodiment, the tulip **120** includes a first side wall **130** and a second side wall **132** on opposite sides of the cavity **126**. The first and second side walls **130**, **132** extend to the top **122** of the tulip **120**. In various embodiments, the first and second side walls **130**, **132** extend generally parallel to the longitudinal axis **102**. The first and second side walls **130**, **132** are curved or arcuate shape, such as forming portions of the circumference

of the tulip **120**. In an exemplary embodiment, the tulip extension **200** extends from the first and second side walls **130**, **132**. The tulip extension **200** is removable and/or separable from the first and second side walls **130**, **132** after the pedicle screw assembly **100** is fixed to the patient.

[0033] The connecting element/rod **160** (FIG. **1**) is configured be received in the cavity **126** between the first and second side walls **130**, **132**. The tulip **120** includes rod openings **134** at opposite sides of the tulip **120**. The rod openings **134** are open between the first and second side walls **130**, **132**. In the illustrated embodiment, the rod openings **134** are U-shaped. However, the rod openings **134** may have other shapes in alternative embodiments.

[0034] The tulip extension **200** extends from the tulip **120**. The tulip extension **200** forms a lumen **210** aligned with the cavity **126** of the tulip **120**. The lumen **210** is used to guide components into the cavity **126**. For example, when the tulip **120** is located within the patient's body, the tulip extension **200** may extend through an incision to and an exterior of the patient's body. The components may be loaded into the patient's body through the lumen **210**. For example, the screw body **110** and/or the clamping plate **140** and/or the rod **160** and/or the set screw **150** may be loaded into the cavity **126** through the lumen **210**. Tools or other components may additionally be loaded into the cavity **126** through the lumen **210** during the procedure. The tulip extension **200** guides the components and/or the tools into the cavity **126** of the tulip **120**.

[0035] In an exemplary embodiment, the tulip extension **200** includes a first extension tab **230** extending from the first side wall **130** and a second extension tab **232** extending from the second side wall **132**. The first and second extensions tabs **230**, **232** extend parallel to each other, such as parallel to the longitudinal axis **102**. Optionally, the extensions tabs **230**, **232** may be similar to each other, and like components identified with like reference numerals. In various embodiments, the extensions tabs **230**, **232** are identical to each other being oriented on opposite sides of the tulip extension **200**, such as being mirrored halves. In an exemplary embodiment, each extension tab **230**, **232** extends between a proximal end **234** and a distal end **236**. The proximal end **234** of the each extension tab **230**, **232** is connected to the top **122** of the corresponding side wall **130**, **132**. Optionally, a score line or cut line **238** is provided between the extension tab **230**, **232** and the corresponding side wall **130**, **132** to allow easy separation of the tulip extension **200** from the tulip **120** after the pedicle screw assembly **100** is fixed to the patient's bone. The score line **238** may be provided at the exterior surfaces and/or the interior surfaces.

[0036] The support ring **300** is configured to be coupled to the tulip extension **200**, such as at the distal ends **236** of the extensions tabs **230**, **232**. The support ring **300** is used to hold relative positions of the extensions tabs **230**, **232**. When the support ring **300** is coupled to the tulip extension **200**, the support ring **300** surrounds the first and second extensions tabs **230**, **232** to prevent opening of the first and second extensions tabs **230**, **232** relative to each other. For example, the support ring **300** prevents spreading apart of the extensions tabs **230**, **232**. The support ring **300** supports the first and second extensions tabs **230**, **232** to prevent closing of the first and second extensions tabs **230**, **232** relative to each other. For example, the support ring **300** prevents moving the extensions tabs **230**, **232** toward each other. The support ring **300** holds the extensions tabs **230**, **232** parallel to each other to maintain the relative dimension of the lumen **210** along the tulip extension **200**. In an exemplary embodiment, the tulip extension **200** includes one or more features to position the support ring **300** on the extensions tabs **230**, **232**. In an exemplary embodiment, the tube extensions **200** includes one or more retention features to retain the support ring **300** on the tulip extension **200**. In an exemplary embodiment, the retention features are releasable to allow removal of the support ring **300**, such as for loading components into the lumen **210** and/or to allow separation of the tulip extension **200** from the tulip **120**.

[0037] FIG. **5** is a bottom perspective view of the support ring **300** in accordance with an exemplary embodiment. FIG. **6** is a top perspective view of the support ring **300** in accordance with an exemplary embodiment. FIG. **7** is a top view of the support ring **300** in accordance with an exemplary embodiment.

[0038] The support ring **300** includes a ring body **310** surrounding an opening **312**. The support ring **300** extends between a top **314** and a bottom **316**. Optionally, the top **314** and/or the bottom **316** may be planar. In various embodiments, the top **314** and the bottom **316** are parallel to each other. The support ring **300** includes an exterior surface **320** extending between the top **314** and the bottom **316**. In an exemplary embodiment, the exterior surface **320** is cylindrical. The support ring **300** has an outer diameter defined by the exterior surface **320**. The support ring **300** includes an interior surface **322** surrounding the opening **312**. The support ring **300** has an inner diameter defined by the interior surface **322**.

[0039] In an exemplary embodiment, the support ring **300** includes a first tab channel **330** along a first side of the opening **312** and a second tab channel **332** along a second side of the opening. The tab channels **330**, **332** are open at the interior surface **322** to the opening **312**. The tab channels **330**, **332** are configured to receive the corresponding extensions tabs **230**, **232** (FIG. **3**). In an exemplary embodiment, the support ring **300** includes support pads **334**, **336** on opposite sides of the opening **312**. The support pads **334**, **336** are located between the tab channels **330**, **332**. The support pads **334**, **336** are used to support the extensions tabs **230**, **232**. In an exemplary embodiment, the support pads **334**, **336** include tab hooks **338** extending along the tab channels **330**, **332**. The tab hooks **338** surrounding pockets that receive portions of the extensions tabs **230**, **232** to interface with the extensions tabs **230**, **232** and hold the extensions tabs **230**, **232** in the tab channels **330**, **332**. The opening **312** has a smaller diameter between the support pads **334**, **336** compared to the tab channels **330**, **332**. The opening **312** has a larger diameter between the tab channels **330**, **332** compared to the support pads **334**, **336**.

[0040] FIG. **8** is a side view of a portion of the pedicle screw assembly **100** showing the tulip extension **200** in accordance with an exemplary embodiment. FIG. **9** is a front view of a portion of the pedicle screw assembly **100** showing the tulip extension **200** in accordance with an exemplary embodiment. FIG. **10** is a perspective view of a portion of the pedicle screw assembly **100** showing the tulip extension **200** in accordance with an exemplary embodiment. The tulip extension **200** extends from the top of the tulip **120**. The screw body **110** and the clamp a plate **140** are shown in FIGS. **8-10**.

[0041] The tulip extension **200** includes the first and second extensions tabs **230**, **232** extending from the first and second side walls **130**, **132** of the tulip **120**. The lumen **210** is defined between the first and second extensions tabs **230**, **232**. The extensions tabs **230**, **232** extend between the proximal ends **234** and the distal ends **236**. The score lines **238** are provided at the proximal ends **234**. In an exemplary embodiment, the side walls **130**, **132** of the tulip **120** include internal threads **136** configured to threadably receive the set screws **150** (FIG. **1**). In an exemplary embodiment, the proximal ends **234** of the extensions tabs **230**, **232** include internal threads **240**. The internal threads **240** aligned with the internal threads **136** to form a continuous threaded portion that receives the set screws **150**. The internal threads **240**, **136** may receive other components, tools, or devices.

[0042] In an exemplary embodiment, the first and second extensions tabs **230**, **232** are separated from each other by slots **242**. The slots **242** are formed between edges **244**, **246** of the extensions tabs **230**, **232**. The slot **242** are arranged on opposite sides of the tulip extension **200**. In an exemplary embodiment, the slots **242** extend the entire height of the tulip extension **200**. For example, the slots **242** are open at the top of the tulip extension **200**, such as to receive the rod **160** (FIG. **1**) or other tools. The slots **242** are aligned with the rod openings **134** to allow the rod **160** to pass from the lumen **210** of the tulip extension **200** into the cavity **126** of the tulip **120**.

[0043] In an exemplary embodiment, the tulip extension **200** includes a collar **250** at the top of the tulip extension **200** that is configured to receive the support ring **300** (FIG. **5**). In an exemplary embodiment, the tulip extension **200** has a reduced diameter at the collar **250** to receive the support ring **300**. The collar **250** includes a first shoulder **252** along the first extension tab **230** and a second shoulder **254** along the second extension tab **232**. The first and second shoulders **252**, **254** form a seat **256** for the support ring **300** to locate the support ring **300** along the first and second extensions tabs **230**, **232**. The seat **256** is located a distance **258** from the distal ends **236** of the extensions tabs **230**, **232**. The seat **256** is located near the top of the tulip extension **200** and is located remote from the tulip **120**.

[0044] In an exemplary embodiment, the tulip extension **200** includes one or more retention springs **260** for retaining the support ring **300** on the tulip extension **200**. In the illustrated embodiment, both extensions tabs **230**, **232** include one of the retention springs **260**. Greater or fewer retention springs **260** may be provided in alternative embodiments. In an exemplary embodiment, the retention springs **260** are deflectable relative to the extensions tabs **230**, **232** to release the retention springs **260** from the support ring **300** and allow removal of the support ring **300** from the tulip extension **200**. For example, the retention springs **260** may be flexed or deflected inward into the lumen **210** to release the retention springs **260** from the support ring **300** to allow removal of the support ring **300** from the tulip extension **200**.

[0045] In an exemplary embodiment, the retention springs **260** are integral with the extensions tabs **230**, **232**. For example, the retention springs **260** may be stamped or cut from the extensions tabs **230**, **232**. For example, parallel cut lines may be formed on both sides of the retention spring **260** to release the retention spring **260** from the extension tab **230**, **232** and allow movement of the retention spring **260** relative to the extension tab **230**, **232**. Each retention spring **260** extends between a fixed end **262** and a free end **264**. The retention spring **260** is cantilevered from the fixed end **262** the free end **264** is movable relative to the corresponding extension tab **230**, **232**. In an exemplary embodiment, the retention spring **260** is provided at the top of the tulip extension **200**. For example, the free end **264** may be located at the distal end **236** of the extension tab **230**, **232**. In an exemplary embodiment, the extension tab **230**, **232** includes a flanking portions **266**, **268** along both sides of the retention spring **260**. The retention spring **260** is movable relative to the flanking portions **266**, **268**. In alternative embodiments, the extension tab **230**, **232** may have only one of the flanking portions **266** or **268** along only one side of the retention spring **260**. In an exemplary embodiment, the retention spring **260** has a complementary shape as the flanking portions **266**, **268** such that the retention spring **260** forms part of the profile of the extension tab **230**, **232**. In an exemplary embodiment, the retention spring **260** includes a portion of the seat **256**.

[0046] In an exemplary embodiment, the retention spring **260** includes a lip **270** protruding outwardly therefrom to engage the support ring **300**. The lip **270** is a retaining feature of the retention spring **260**. The lip **270** is spaced apart from the seat **256** to form a space therebetween that receives and captures the support ring **300**. When the retention spring **260** is released and flexed inward, the lip **270** is configured to be released from the support ring **300** to allow removal of the support ring **300** from the tulip extension **200**.

[0047] FIG. **11** is a side view of a portion of the pedicle screw assembly **100** showing the top of the tulip extension **200** in accordance with an exemplary embodiment. FIG. **12** is a front view of a portion of the pedicle screw assembly **100** showing the top of the tulip extension **200** in accordance with an exemplary embodiment. FIGS. **11** and **12** illustrate the collar **250** at the top of the tulip extension **200** that is configured to receive the support ring **300** (FIG. **5**). FIGS. **11** and **12** illustrate the retention springs **260** formed in the extensions tabs **230**, **232**. The tulip extension **200** may include other shapes or features to retain and locate the support ring **300** at the top of the tulip extension **200** in alternative embodiments.

[0048] FIG. **13** is an exploded, perspective view of a portion of the pedicle screw assembly **100** showing the support ring **300** poised for loading onto the tulip extension **200** in accordance with an exemplary embodiment. FIG. **14** is a perspective view of a portion of the pedicle screw assembly **100** showing the support ring **300** coupled to the tulip extension **200** in accordance with an exemplary embodiment.

[0049] During assembly, the support ring **300** is aligned with the top of the tulip extension **200**. The tulip extension **200** is received in the opening **312**. The support ring **300** is loaded onto the tulip extension **200** until the bottom **316** of the support ring **300** engages the seat **256**. The retention springs **260** engage the support ring **300** and retain the support ring **300** on the collar **250**. For example, the lips **270** of the retention springs **260** engage the top **314** of the support ring **300** and prevent upward movement of the support ring **300** relative to the tulip extension **200**.

[0050] In an exemplary embodiment, the first and second extensions tabs **230**, **232** are received in the first and second tab channels **330**, **332**, respectively. When assembled, the support ring **300** circumferentially surrounds the top end of

the tulip extension **200** to prevent spreading apart of the extensions tabs **230**, **232**. The support pads **334**, **336** are located in the slots **242** between the extensions tabs **230**, **232**. The edges **244**, **246** of the extensions tabs **230**, **232** are received in the pockets of the support pads **334**, **336** such that the tab hooks **338** hook partially around the edges **244**, **246**. The tab hooks **338** engage the extensions tabs **230**, **232** to hold the extensions tabs **230**, **232** in the tab channels **330**, **332**. The extensions tabs **230**, **232** are captured in the tab channels **330**, **332** to prevent inward movement of the extensions tabs **230**, **232** relative to each other. The support pads **334**, **336** block inward movement of the extensions tabs **230**, **232** thus maintaining the parallel orientations of the extensions tabs **230**, **232** and preventing closing of the lumen **210**. However, the retention springs **260** are unblocked by the support pads **334**, **336** and are movable relative to the support ring **300** to release from the support ring **300** and allow removal of the support ring **300** from the tulip extension **200**.

[0051] FIG. **15** is a side view of a portion of the pedicle screw assembly **100** showing the support ring **300** on the tulip extension **200**. FIG. **16** is a cross-sectional view of a portion of the pedicle screw assembly **100** showing the support ring **300** on the tulip extension **200**. When assembled, the bottom **316** of the support ring **300** rests on the shoulders **252**, **254** defining the seat **256**. The retention springs **260** engage the top **314** of the support ring **300** to hold the support ring **300** on the seat **256**. The lip **270** of the retention spring **260** may include an angled ramp surface that faces the support ring **300** and drives the support ring **300** downward against the seat **256**.

[0052] FIG. **17** is a perspective, sectional view of a portion of the pedicle screw assembly **100** showing the support ring **300** on the tulip extension **200**. The support ring **300** is shown seated on the shoulders **252**, **254** and captured on the collar **250** by the retention springs **260**. The support ring **300** surrounds the exterior surfaces of the extensions tabs **230**, **232** to prevent outward movement of the extensions tabs **230**, **232** relative to each other. FIG. **17** further shows the extensions tabs **230**, **232** received in the tab channels **330**, **332** of the support ring **300**. The support pad **334** is shown between the extensions tabs **230**, **232**. The tab hooks **338** capture the extensions tabs **230**, **232** in the tab channels **330**, **332** and prevent inward movement of the extensions tabs **230**, **232** relative to each other. As such, the support ring **300** provides both inward support and outward support for the extensions tabs **230**, **232** to maintain relative positions of the extensions tabs **230**, **232** and maintain the shape of the lumen **210**.

[0053] FIG. **18** is a cross-sectional view of the pedicle screw assembly **100** in accordance with an exemplary embodiment. FIG. **18** shows the support ring **300** on the tulip extension **200**. FIG. **18** shows the tulip extension **200** extending from the tulip **120**. FIG. **18** further shows the screw body **110** extending from the bottom of the tulip **120** and the clamping plate **140** holding the screw body **110** in the pocket **128** at the bottom of the tulip **120**.

[0054] FIG. **19** is a cross-sectional view of the pedicle screw assembly **100** through the support ring **300** facing downward. FIG. **20** is a cross-sectional view of the pedicle screw assembly **100** through the support ring **300** facing upward. The support ring **300** surrounds the exterior surfaces of the extensions tabs **230**, **232** to prevent outward movement of the extensions tabs **230**, **232** relative to each other. The extensions tabs **230**, **232** are received in the tab channels **330**, **332** of the support ring **300**. The support pads **334**, **336** are located between the extensions tabs **230**, **232**. The tab hooks **338** capture the extensions tabs **230**, **232** in the tab channels **330**, **332** and prevent inward movement of the extensions tabs **230**, **232** relative to each other. As such, the support ring **300** provides both inward support and outward support for the extensions tabs **230**, **232** to maintain relative positions of the extensions tabs **230**, **232** and maintain the shape of the lumen **210**.

[0055] It is to be understood that the above description is intended to be illustrative, and not restrictive. For example, the above-described embodiments (and/or aspects thereof) may be used in combination with each other. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from its scope. Dimensions, types of materials, orientations of the various components, and the number and positions of the various components described herein are intended to define parameters of certain embodiments, and are by no means limiting and are merely exemplary embodiments. Many other embodiments and modifications within the spirit and scope of the claims will be apparent to those of skill in the art upon reviewing the above description. The scope of the invention should, therefore, be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled. In the appended claims, the terms "including" and "in which" are used as the plain-English equivalents of the respective terms "comprising" and "wherein." Moreover, in the following claims, the terms "first," "second," and "third," etc. are used merely as labels, and are not intended to impose numerical requirements on their objects. Further, the limitations of the following claims are not written in means-plus-function format and are not intended to be interpreted based on 35 U.S.C. § 112 (f), unless and until such claim limitations expressly use the phrase "means for" followed by a statement of function void of further structure.

What is claimed is:

1. A pedicle screw assembly comprising:

a screw body having a head and a threaded shaft extending from the head;

a tulip having a pocket receiving the head of the screw body, the tulip having a first side wall and a second side wall on opposite sides of the pocket, the tulip having rod openings defined between the first and second side walls configured to receive a rod;

a set screw received in the pocket to secure the rod in the slot;

a tulip extension extending from the tulip, the tulip extension including a first extension tab extending from the first side wall and a second extension tab extending from the second side wall, the first and second side walls extending parallel to each other between proximal ends and distal ends of the first and second extension tabs, the tulip extension having a lumen defined between the first and second extensions, the tulip extension having slots defined between the first and second extensions aligned with the rod openings, the tulip extension including a deflectable retention spring along the first extension tab; and

a support ring coupled to the distal ends of the first and second extension tabs to support the first and second extension tabs relative to each other, wherein the sup-

port ring interfaces with the retention spring to retain the support ring on the first and second extension tabs, and wherein the retention spring is releasable from the support ring to allow removal of the support ring from the distal ends of the first and second extension tabs.

2. The pedicle screw assembly of claim **1**, wherein the retention spring includes a lip protruding outwardly to engage the support ring.

3. The pedicle screw assembly of claim **1**, wherein the retention spring is coincident with the first extension tab.

4. The pedicle screw assembly of claim **1**, wherein the retention spring passes through an opening in the support ring along an interior of the support ring.

5. The pedicle screw assembly of claim **1**, wherein the support ring includes an interior surface and an exterior surface, the retention spring engaging the exterior surface of the support ring to retain the support ring on the tulip extension, the interior surface engaging the first and second extension tabs.

6. The pedicle screw assembly of claim **1**, wherein the retention spring is stamped from the first extension tab.

7. The pedicle screw assembly of claim **1**, wherein the retention spring is a first retention spring, the tulip extension further comprises a second retention spring along the second extension tab.

8. The pedicle screw assembly of claim **7**, wherein the second retention spring is on an opposite side of the lumen as the first retention spring.

9. The pedicle screw assembly of claim **1**, wherein the retention spring is deflectable inward into the lumen to release the support ring.

10. The pedicle screw assembly of claim **1**, wherein the tulip extension includes a collar having a first shoulder along the first extension tab and a second shoulder along the second extension tab, the first and second shoulders forming a seat for the support ring to locate the support ring along the first and second extension tabs, the retention spring holding the support ring on the seat.

11. The pedicle screw assembly of claim **1**, wherein the first and second tab extensions are removable from the first and second side walls.

12. The pedicle screw assembly of claim **1**, wherein the support ring includes a ring body surrounding an opening configured to receive the distal ends of the first and second extension tabs, the ring body surrounding the first and second extension tabs to prevent opening of the first and second extension tabs relative to each other, the ring body coupled to the first and second extension tabs to support the first and second extension tabs and prevent closing of the first and second extension tabs relative to each other.

13. The pedicle screw assembly of claim **12**, wherein the ring body includes a first tab channel along a first side of the opening and a second tab channel along a second side of the opening, the first tab channel receiving the first tab extension, the second tab channel receiving the second tab extension.

14. The pedicle screw assembly of claim **13**, wherein the ring body includes tab hooks defining the first and second tab channels, the tab hooks capturing the first and second tab extensions in the first and second tab channels to prevent inward movement of the first and second tab extensions.

15. The pedicle screw assembly of claim **12**, wherein the ring body includes support pads between the first and second tab channels, the support pads engaging edges of the first and second tab extensions to prevent inward movement of the first and second tab extensions.

16. A pedicle screw assembly comprising:

a screw body having a head and a threaded shaft extending from the head;

a tulip having a pocket receiving the head of the screw body, the tulip having a first side wall and a second side wall on opposite sides of the pocket, the tulip having rod openings defined between the first and second side walls configured to receive a rod;

a set screw received in the pocket to secure the rod in the slot;

a tulip extension extending from the tulip, the tulip extension including a first extension tab extending from the first side wall and a second extension tab extending from the second side wall, the first and second side walls extending parallel to each other between proximal ends and distal ends of the first and second extension tabs, the tulip extension having a lumen defined between the first and second extensions, the tulip extension having slots defined between the first and second extensions aligned with the rod openings; and

a support ring including a ring body surrounding an opening configured to receive the distal ends of the first and second extension tabs, the ring body surrounding the first and second extension tabs to prevent opening of the first and second extension tabs relative to each other, the ring body coupled to the first and second extension tabs to support the first and second extension tabs and prevent closing of the first and second extension tabs relative to each other.

17. The pedicle screw assembly of claim **16**, wherein the ring body includes a first tab channel along a first side of the opening and a second tab channel along a second side of the opening, the first tab channel receiving the first tab extension, the second tab channel receiving the second tab extension.

18. The pedicle screw assembly of claim **17**, wherein the ring body includes tab hooks defining the first and second tab channels, the tab hooks capturing the first and second tab extensions in the first and second tab channels to prevent inward movement of the first and second tab extensions.

19. The pedicle screw assembly of claim **16**, wherein the ring body includes support pads between the first and second tab channels, the support pads engaging edges of the first and second tab extensions to prevent inward movement of the first and second tab extensions.

20. A pedicle screw assembly comprising:

a screw body having a head and a threaded shaft extending from the head;

a tulip having a pocket receiving the head of the screw body, the tulip having a first side wall and a second side wall on opposite sides of the pocket, the tulip having rod openings defined between the first and second side walls configured to receive a rod;

a set screw received in the pocket to secure the rod in the slot;

a tulip extension extending from the tulip, the tulip extension including a first extension tab extending from the first side wall and a second extension tab extending from the second side wall, the first and second side walls extending parallel to each other between proximal ends and distal ends of the first and second extension tabs, the tulip extension having a lumen defined

between the first and second extensions, the tulip extension having slots defined between the first and second extensions aligned with the rod openings, the tulip extension including a deflectable retention spring along the first extension tab; and

a support ring including a ring body surrounding an opening configured to receive the distal ends of the first and second extension tabs, the ring body surrounding the first and second extension tabs to prevent opening of the first and second extension tabs relative to each other, the ring body coupled to the first and second extension tabs to support the first and second extension tabs and prevent closing of the first and second extension tabs relative to each other;

wherein the support ring interfaces with the retention spring to retain the support ring on the first and second extension tabs, and wherein the retention spring is releasable from the support ring to allow removal of the support ring from the distal ends of the first and second extension tabs.

* * * * *