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(54) **METHODS OF POST-FILLING AN INTERVERTEBRAL IMPLANT**

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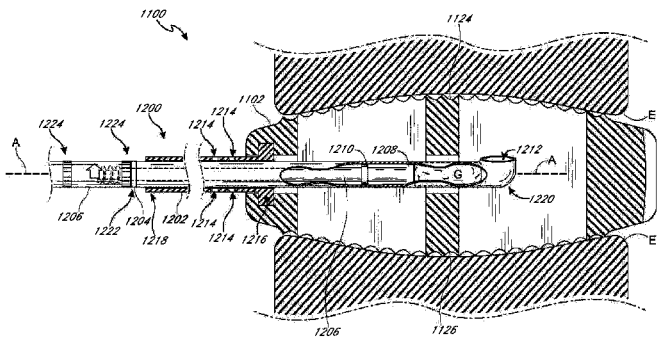
(57) **ABSTRACT**

According to some embodiments, a method for promoting spinal fusion using a spinal implant comprises providing a spinal implant, wherein the spinal implant comprises an anterior wall, a posterior wall and two lateral walls configured to extend between the anterior wall and the posterior wall. In some embodiments, the spinal implant further comprises at least one internal chamber generally positioned between the anterior wall, the posterior wall and the two lateral walls, wherein the internal chamber being is adapted to receive at least one graft and/or other fill material. In some embodiments, at least a portion of the graft and/or other fill material delivered into the internal chamber is configured to exit through the one or more of the openings of the anterior wall.

20 Claims, 27 Drawing Sheets



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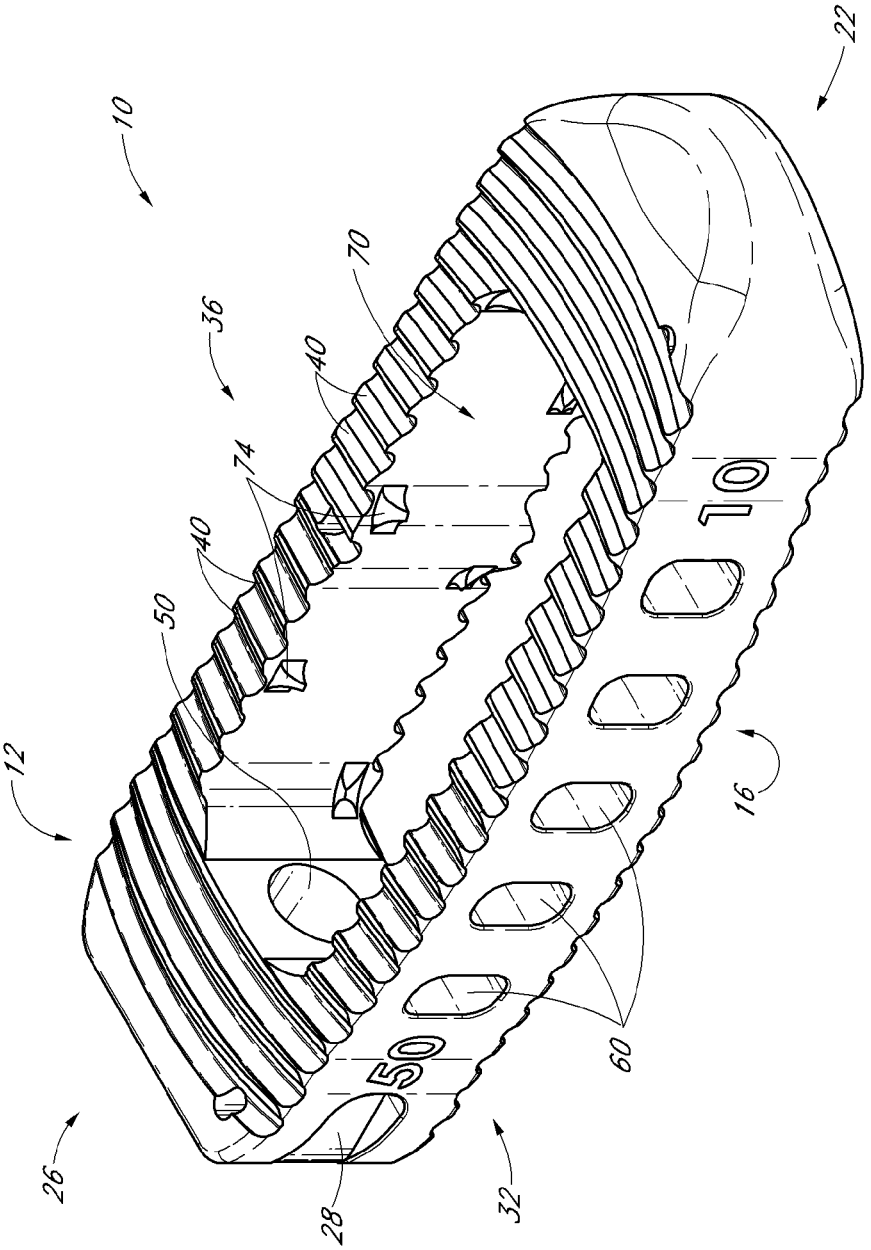

FIG. 1A

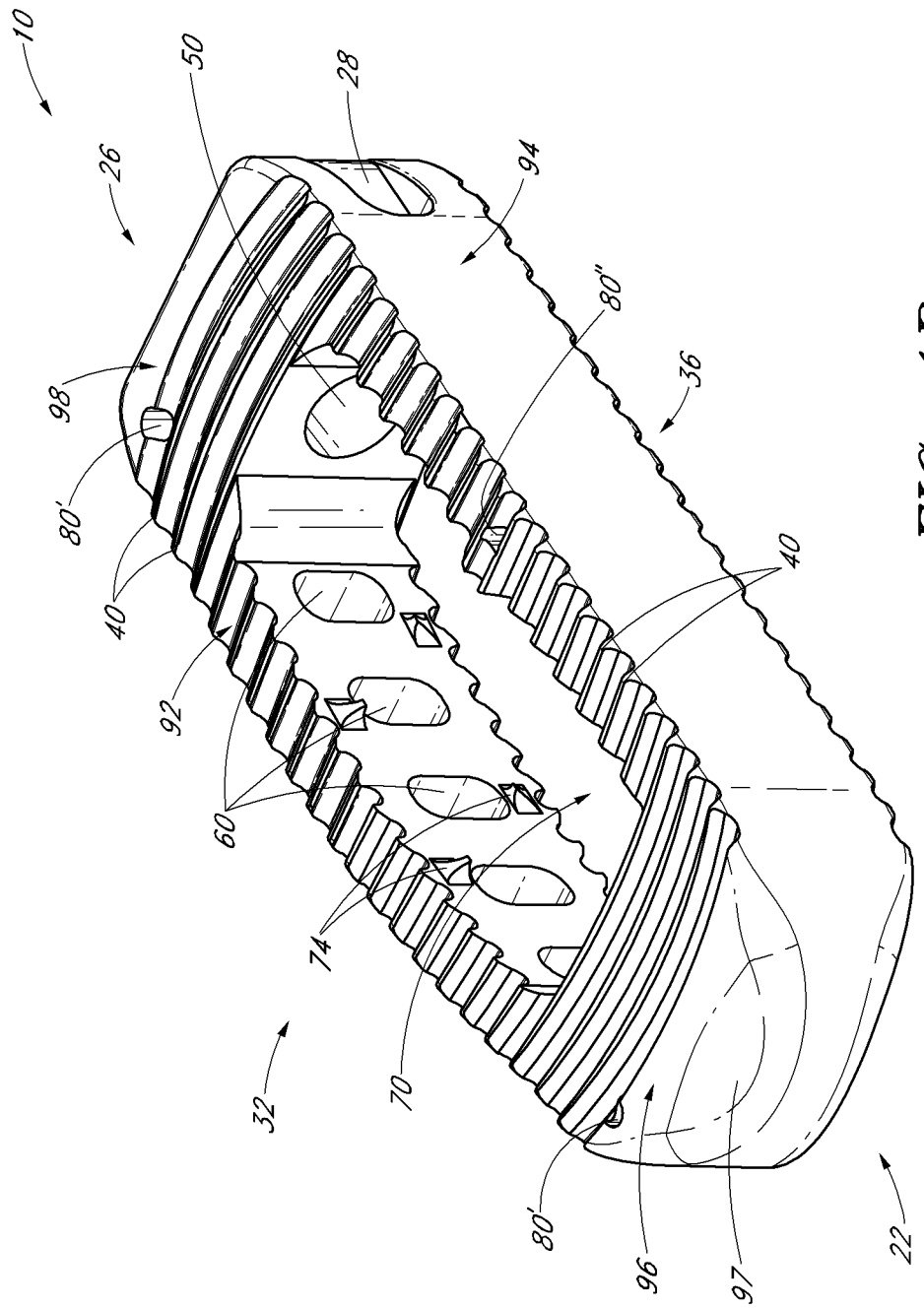

FIG. 1B

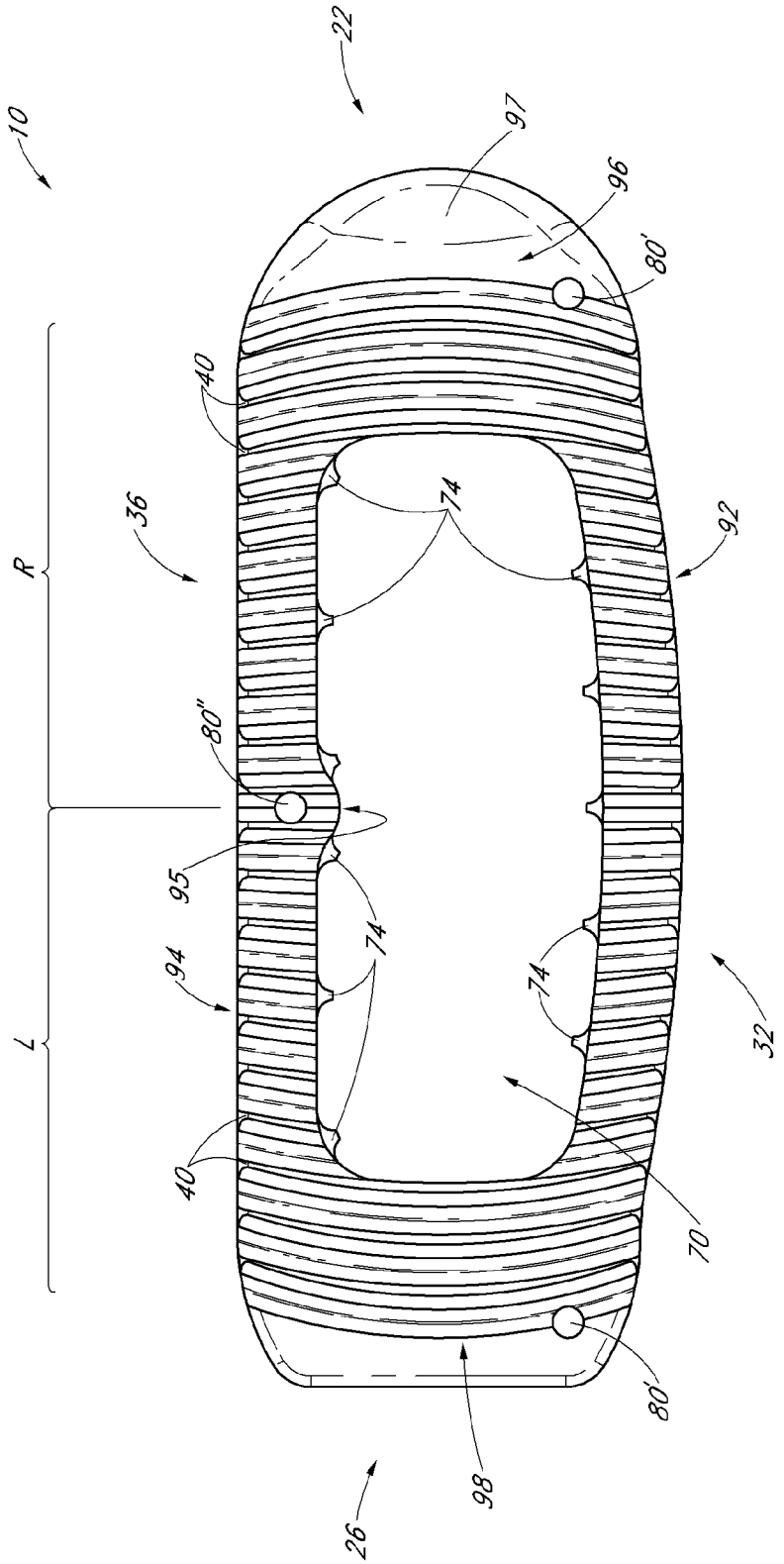

FIG. 2

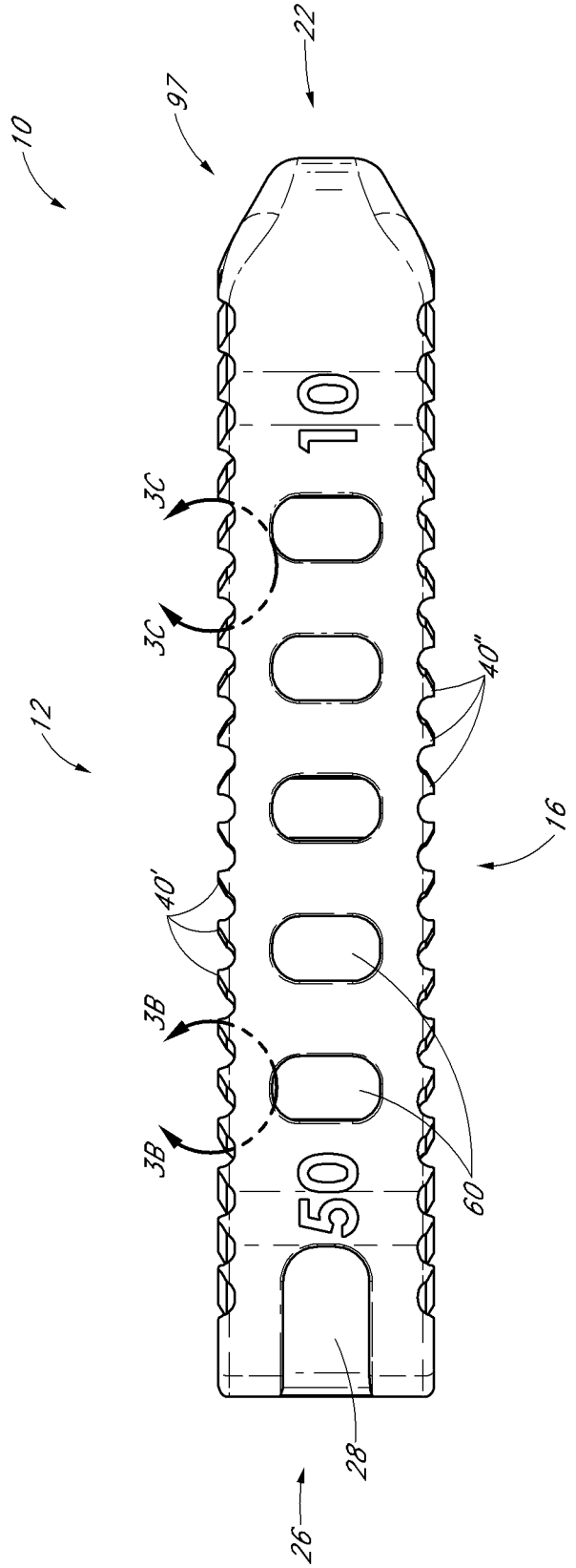

FIG. 3A

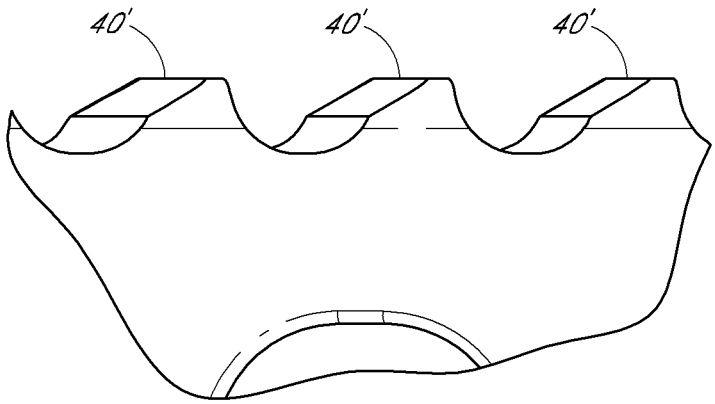

FIG. 3B

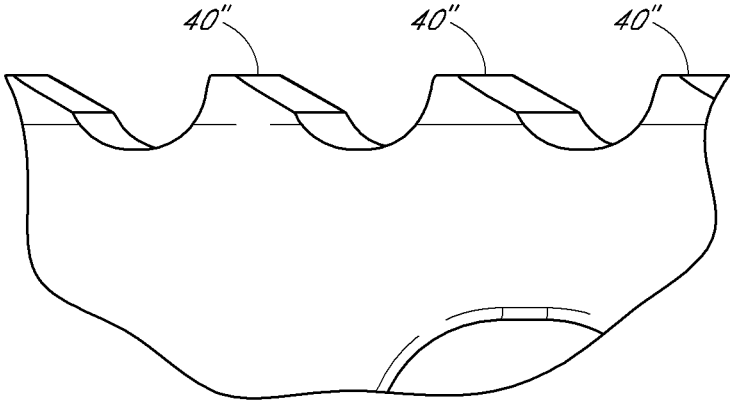

FIG. 3C

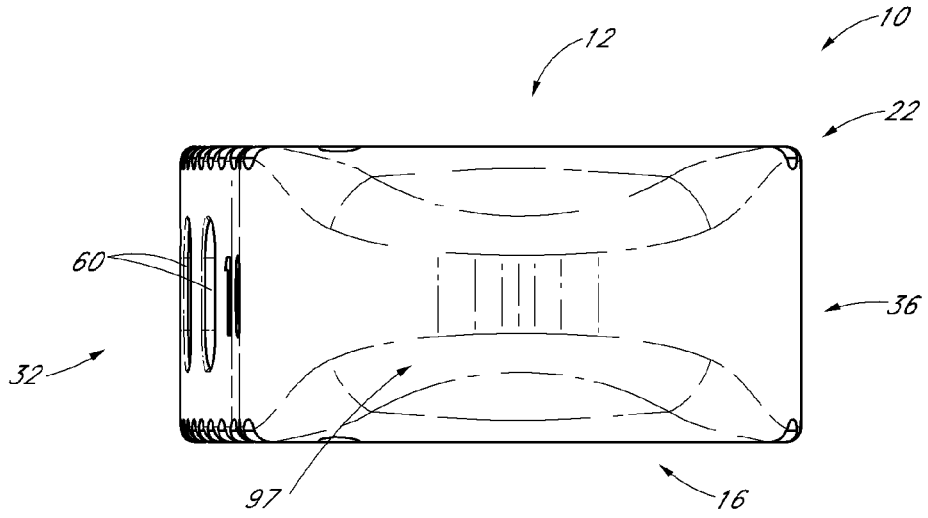

FIG. 4

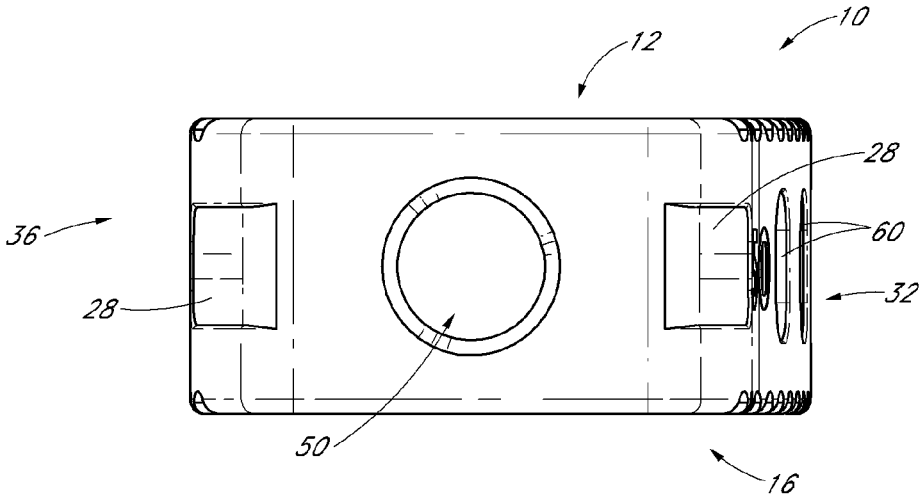

FIG. 5

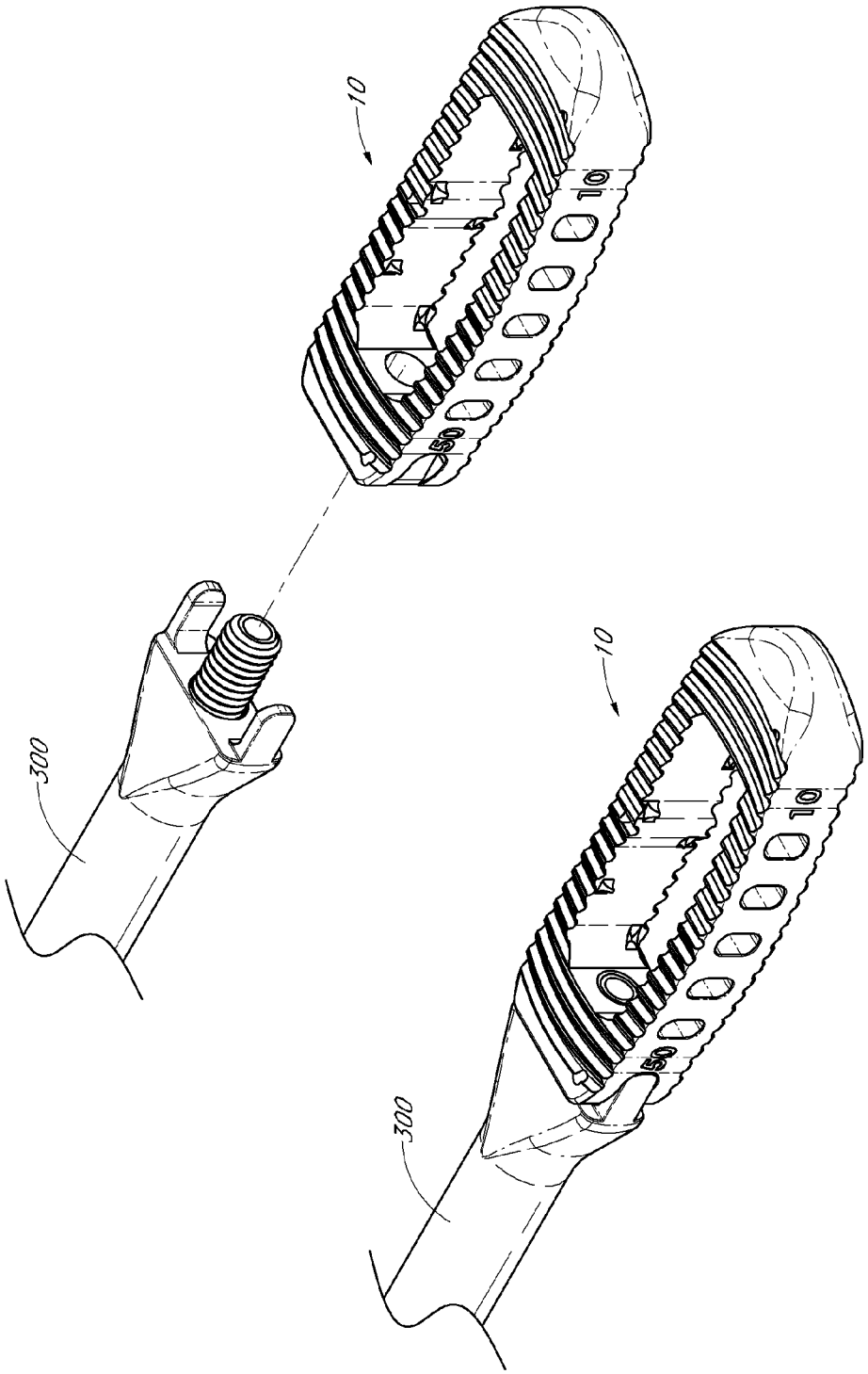

FIG. 6A

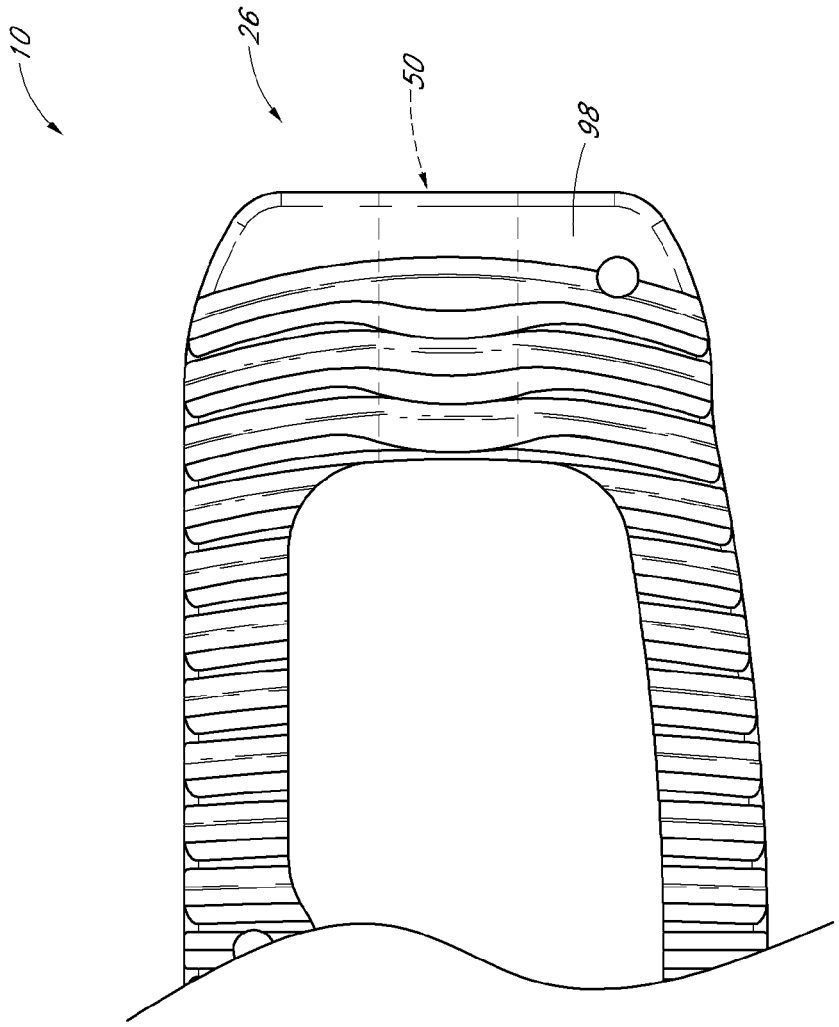

FIG. 6B

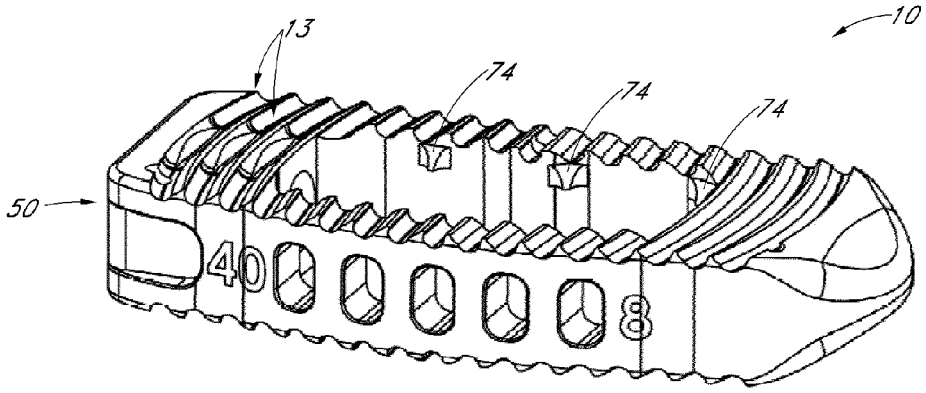

FIG. 6C

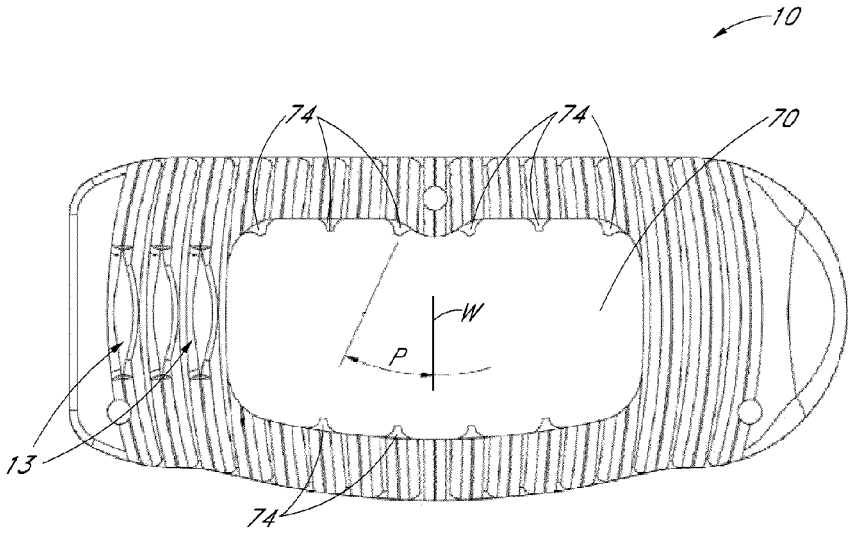

FIG. 6D

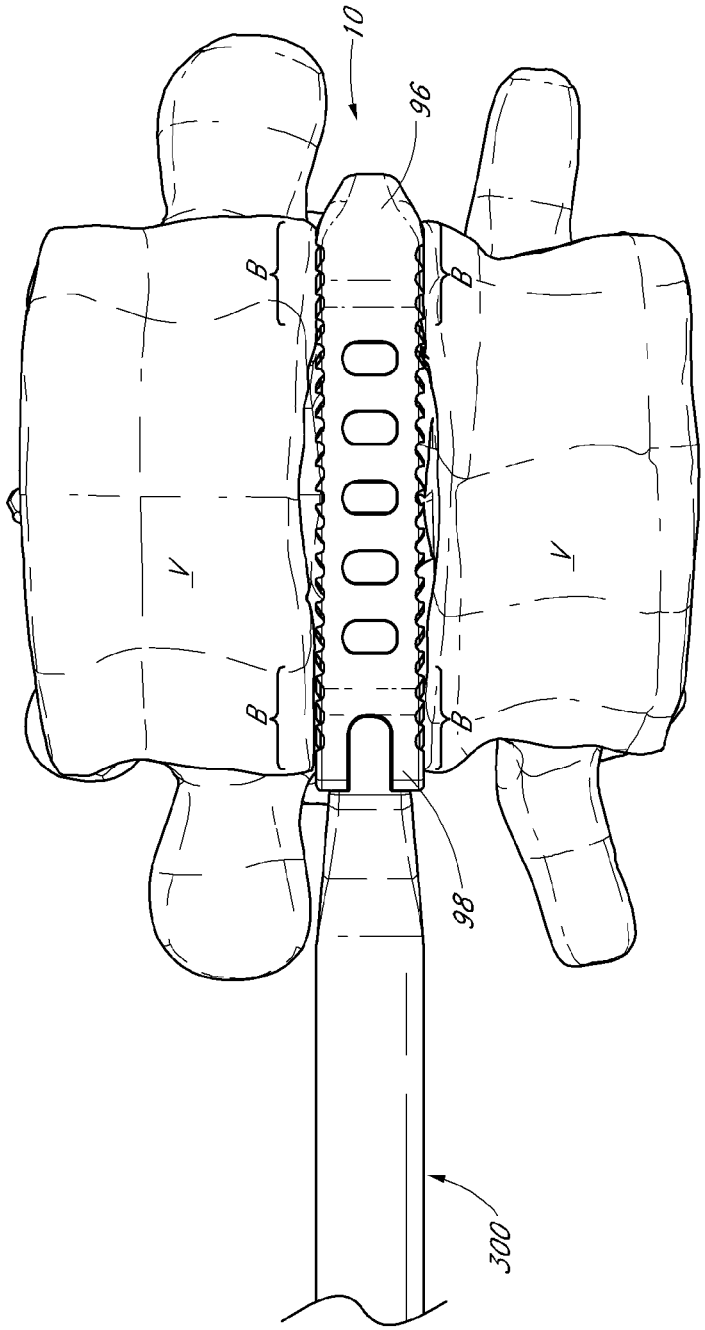

FIG. 7A

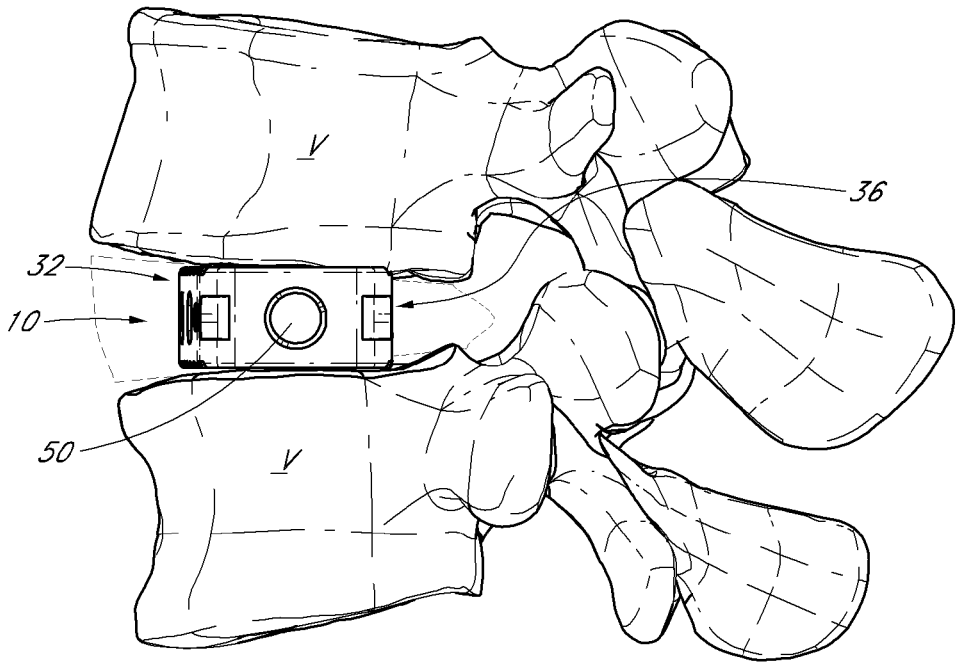

FIG. 7B

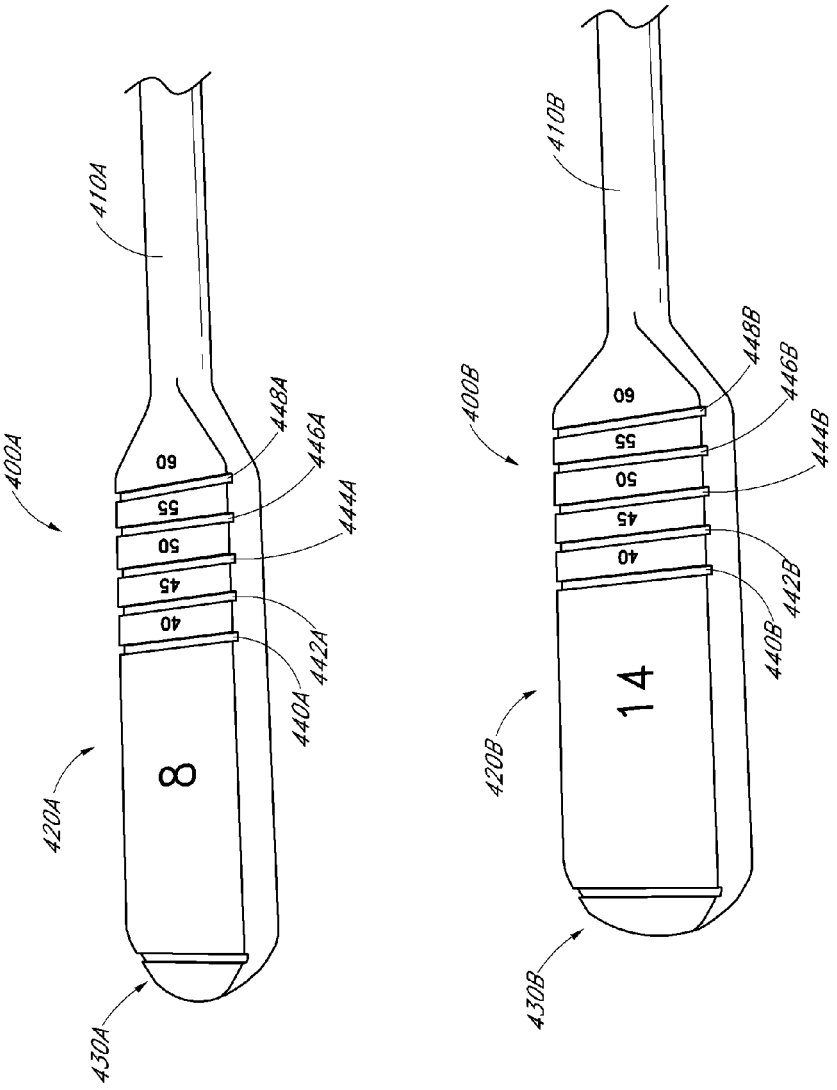
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FIG. 8

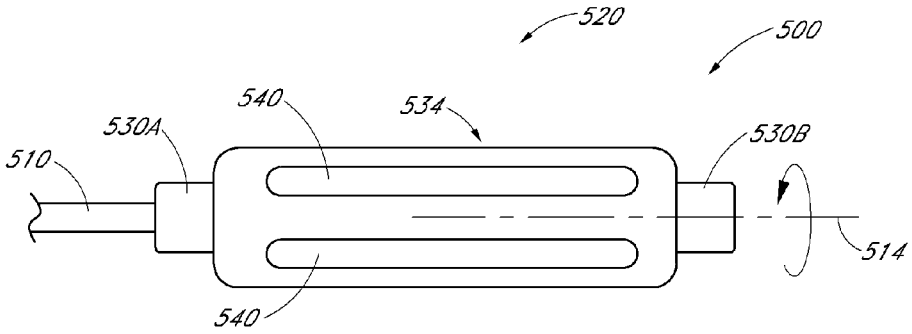


FIG. 9

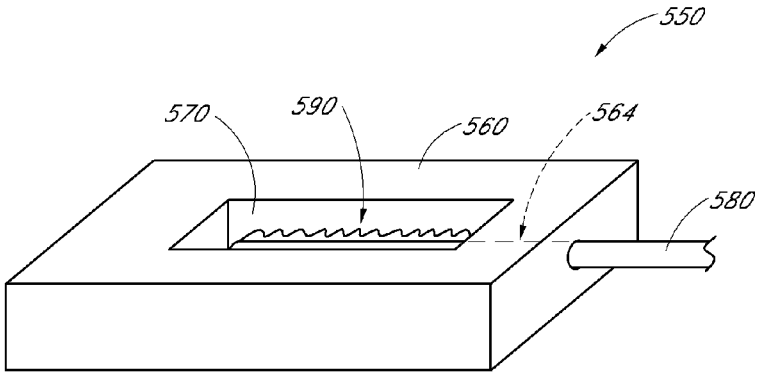


FIG. 10A

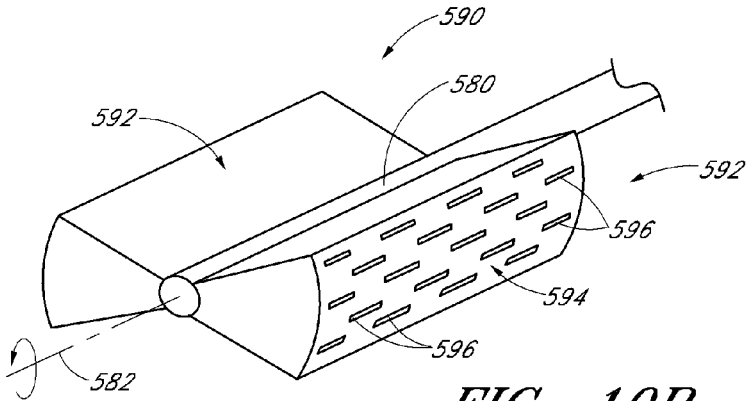
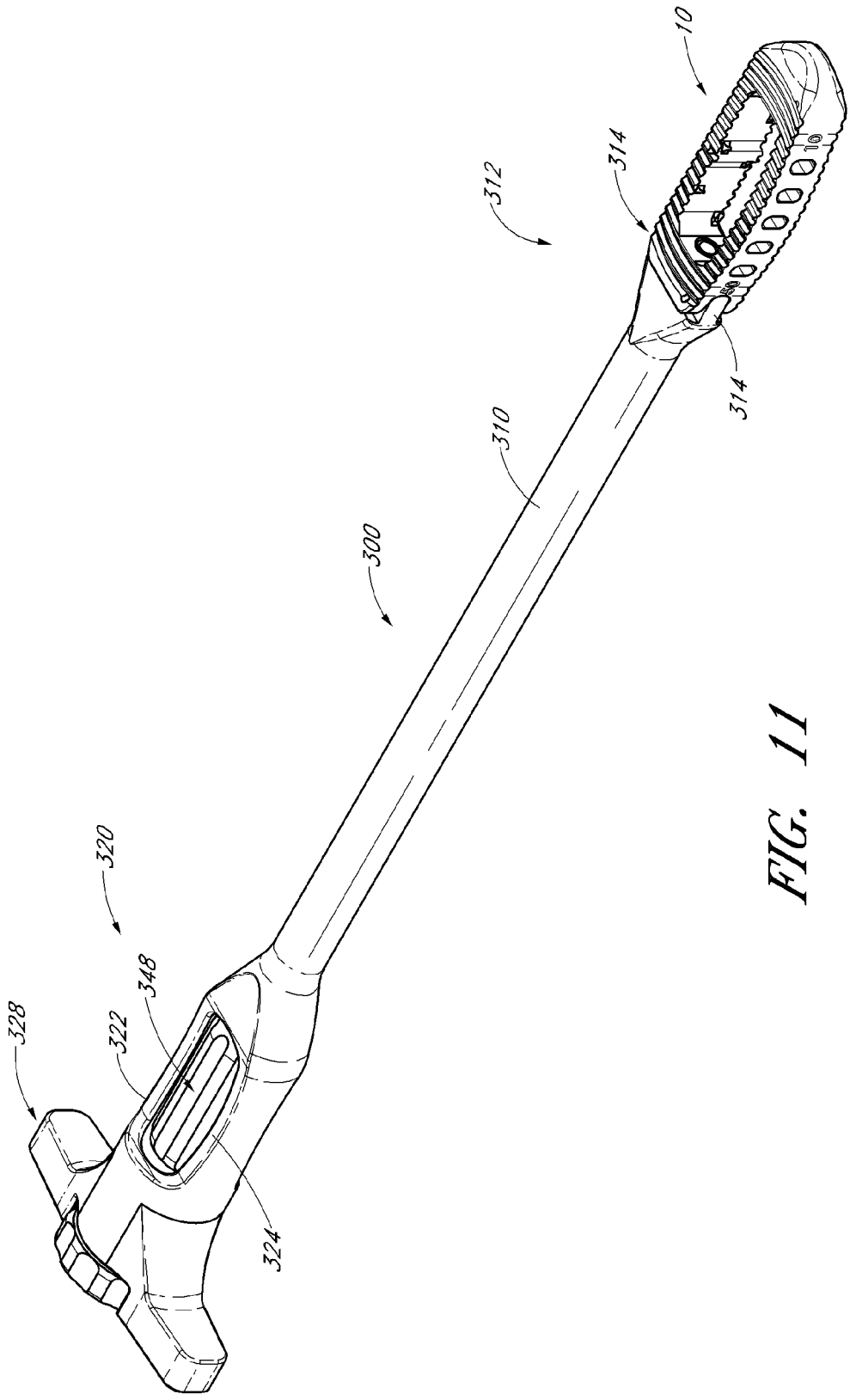


FIG. 10B



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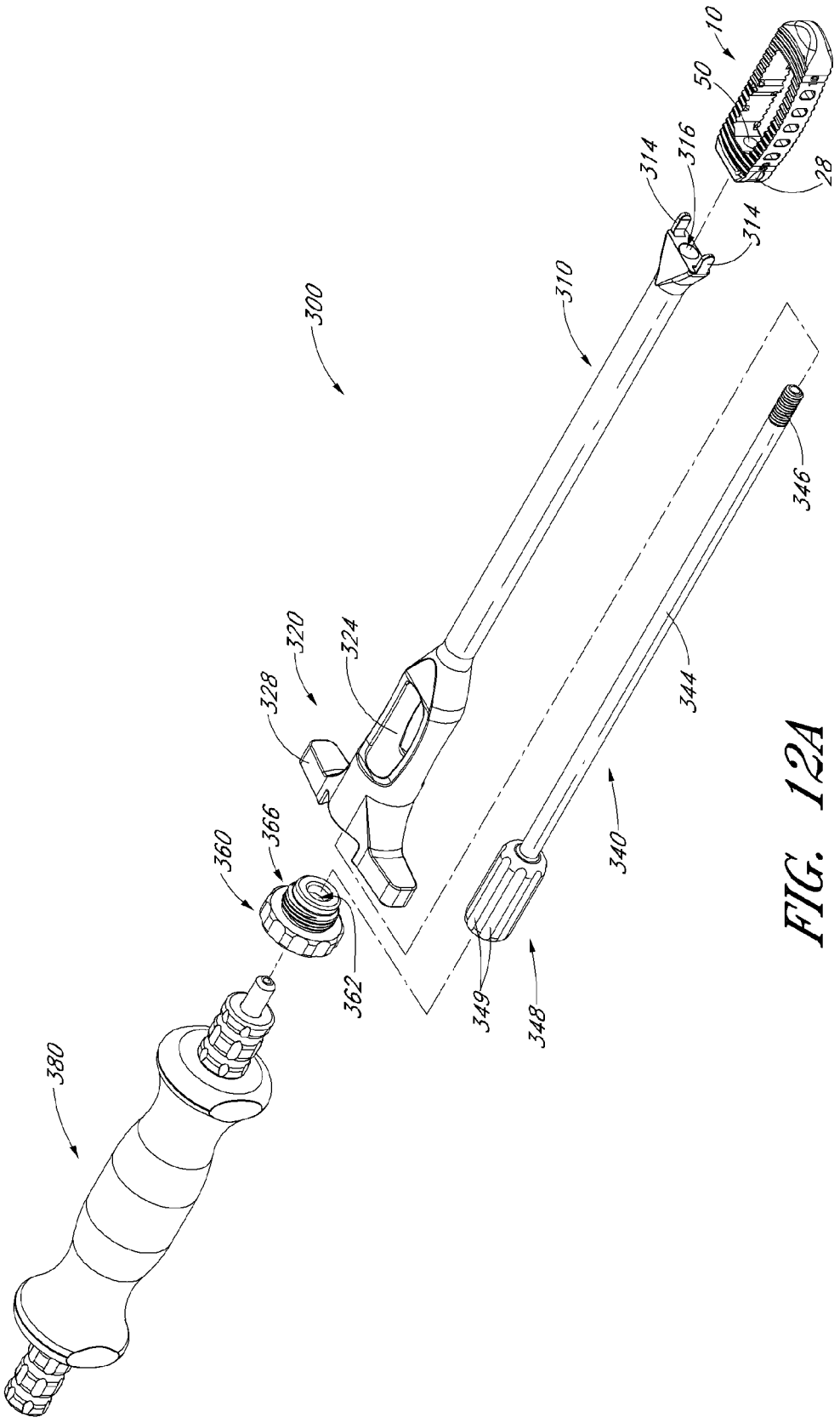
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FIG. 12A

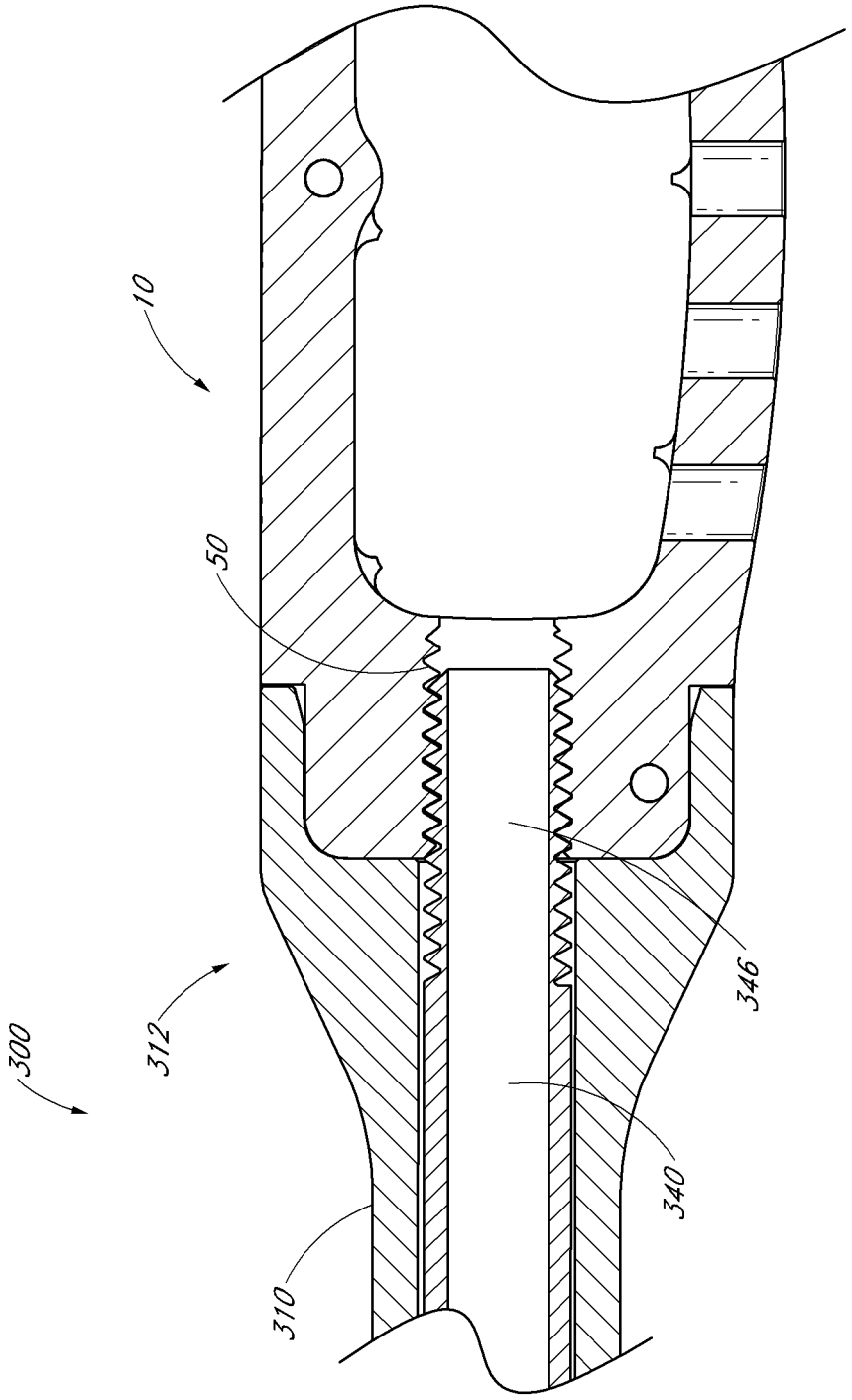
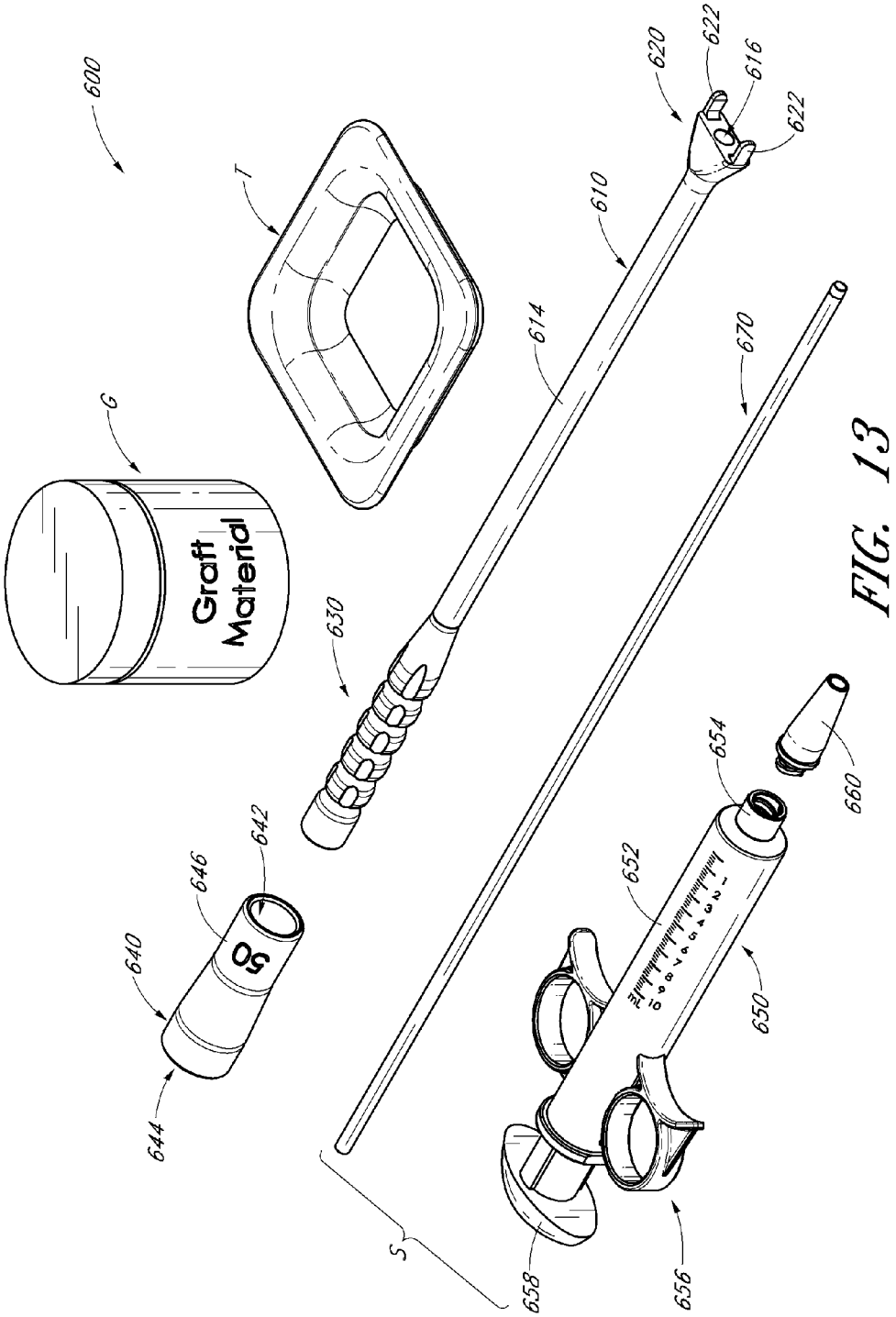


FIG. 12B


600
1
620
622
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622
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G
Graft Material
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FIG. 13

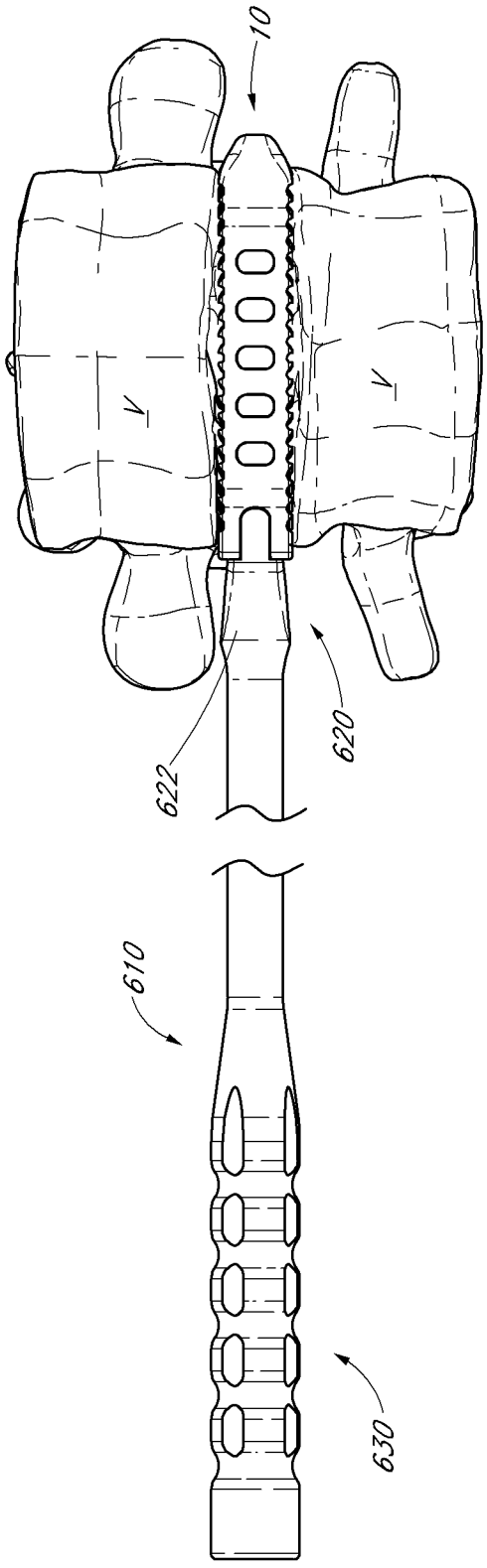

FIG. 14

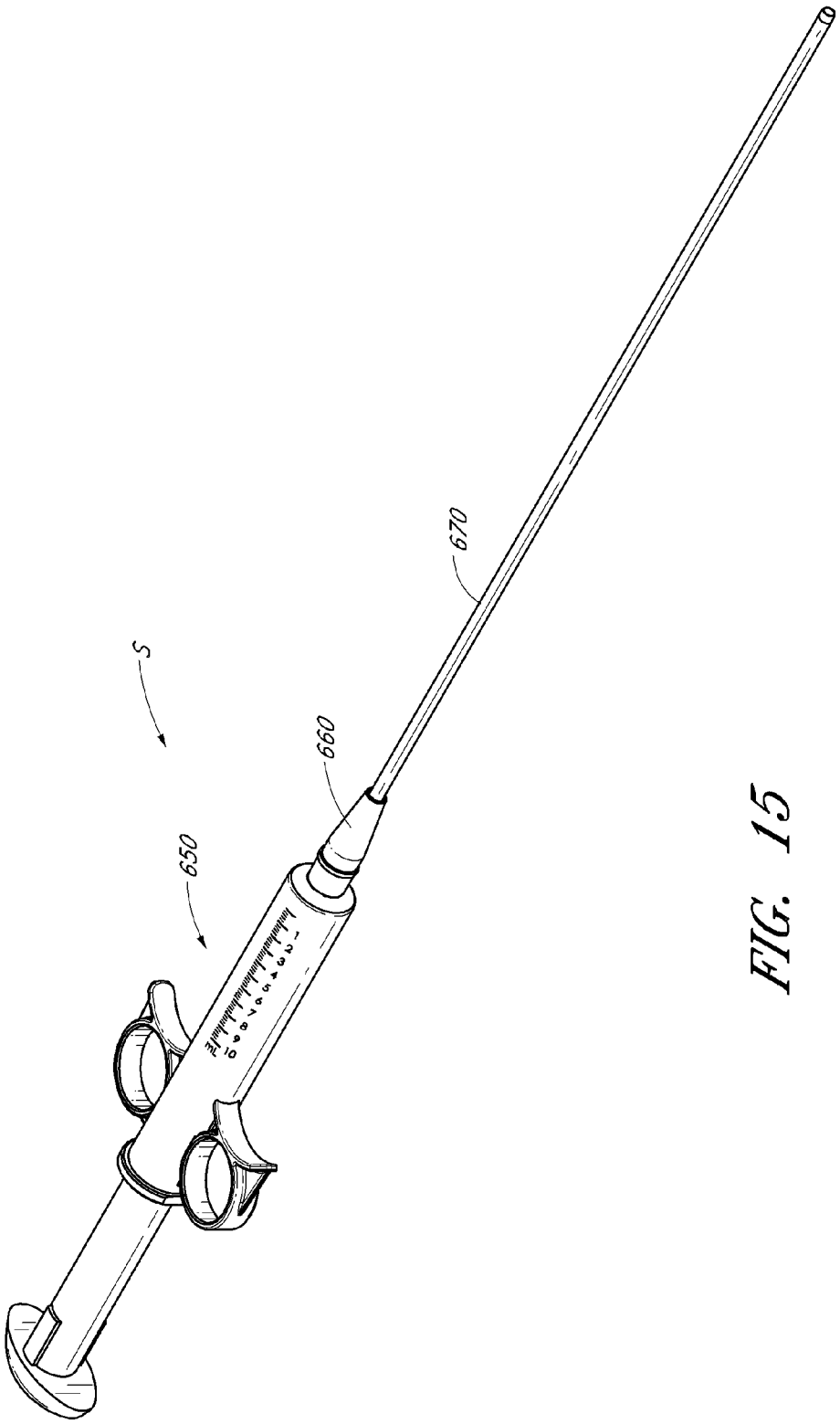

FIG. 15

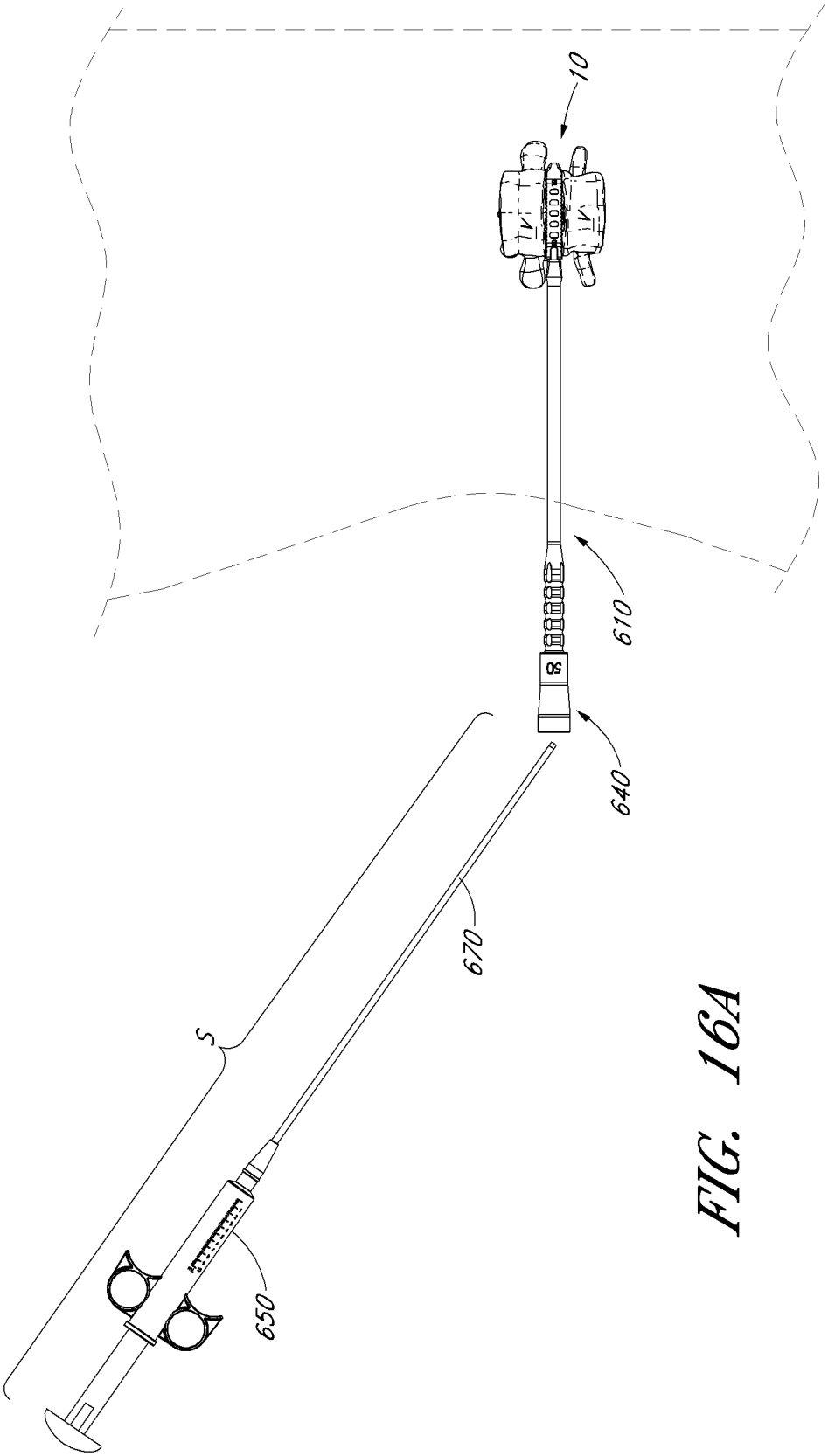

FIG. 16A

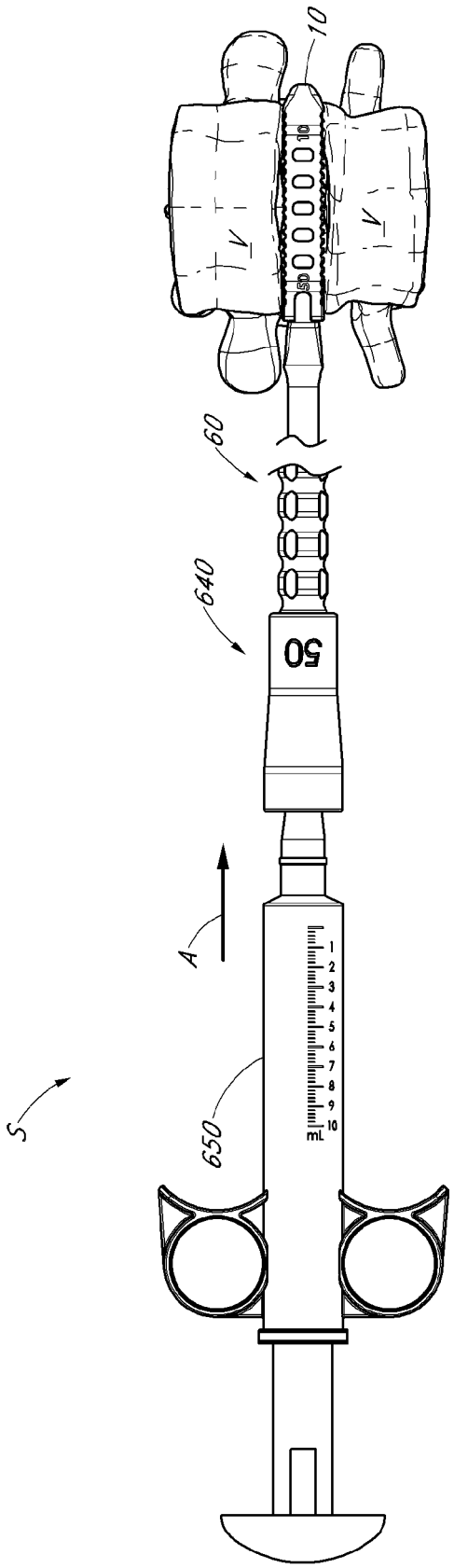

FIG. 16B

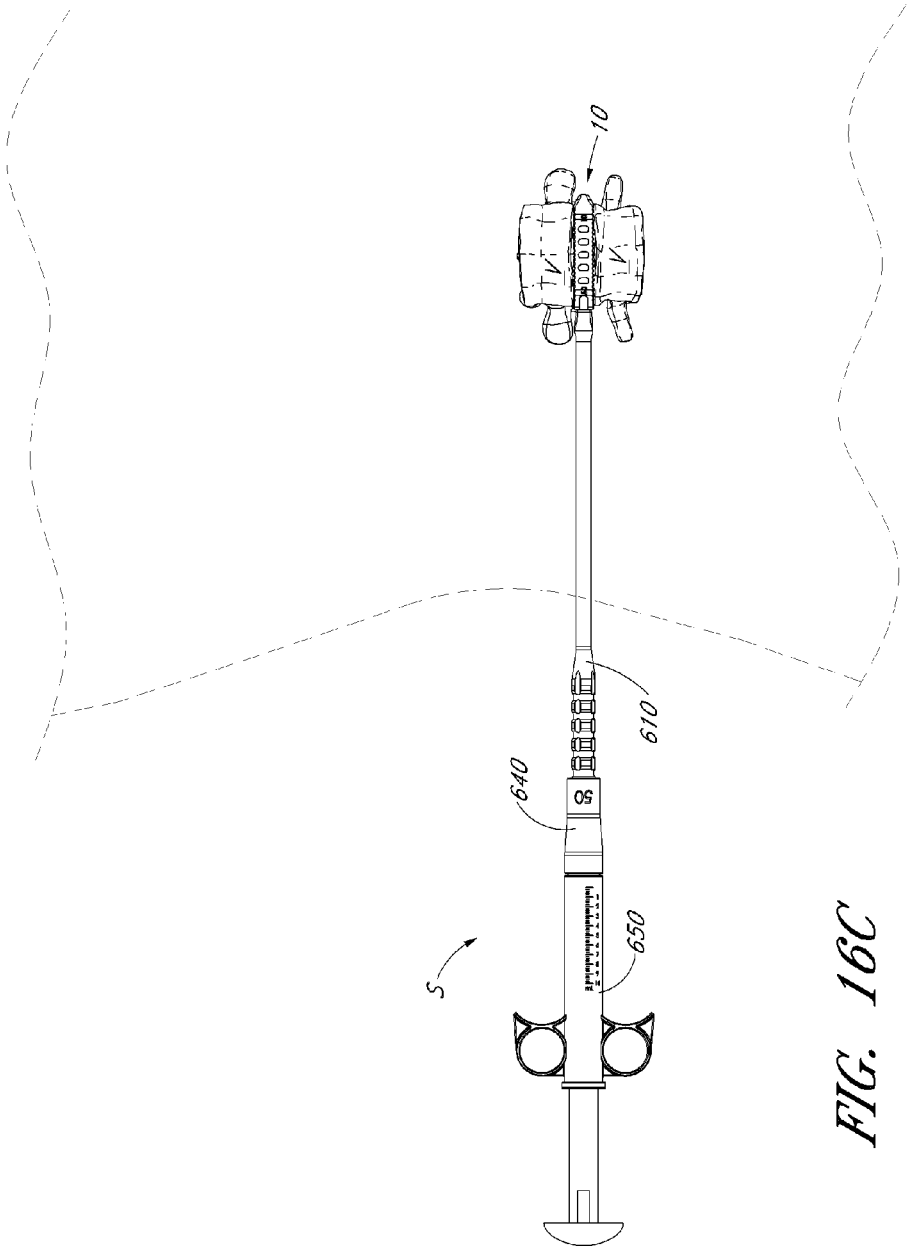

FIG. 16C

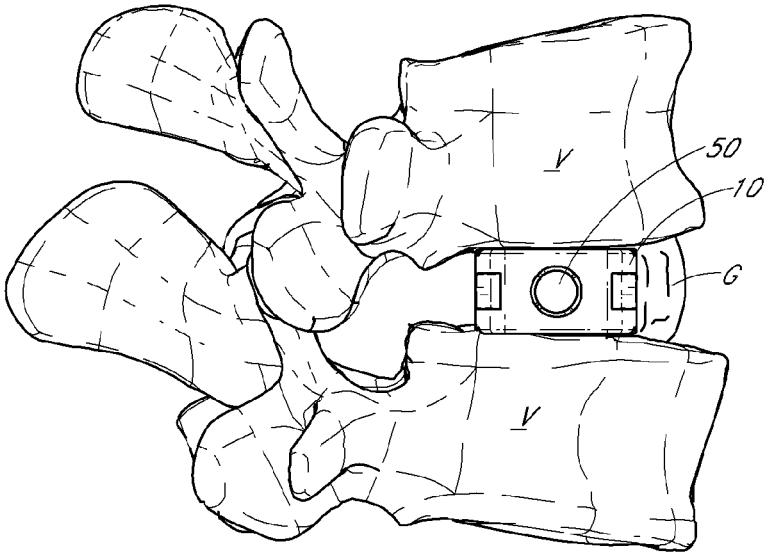

FIG. 17A

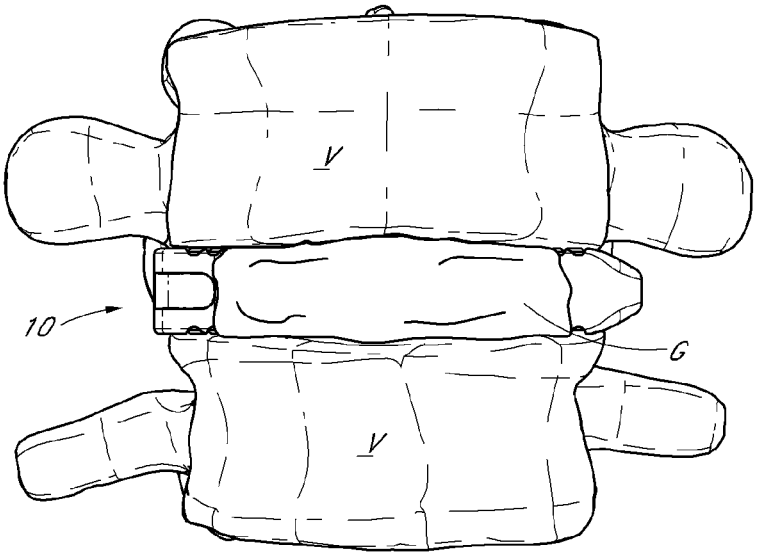

FIG. 17B

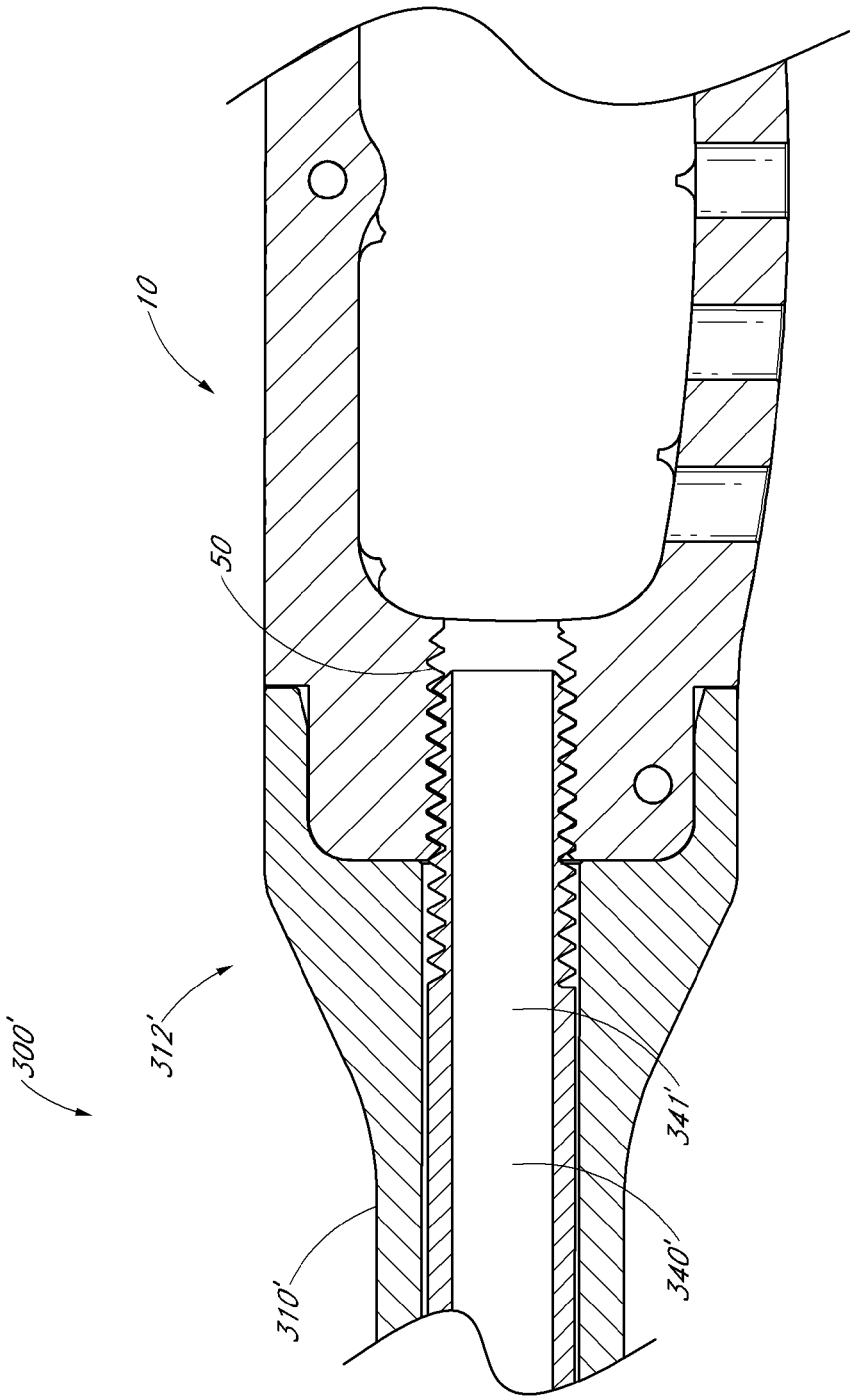

FIG. 18

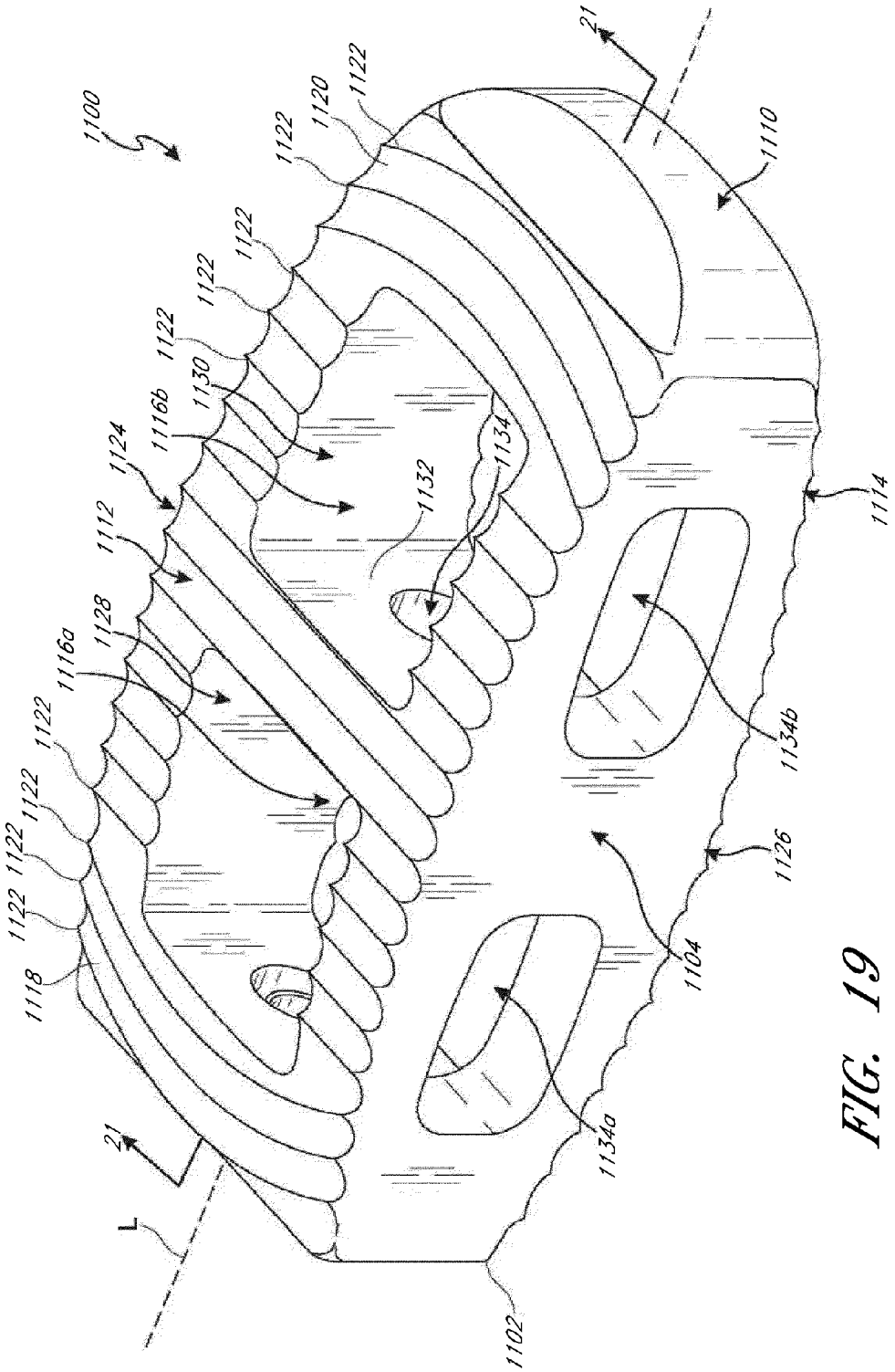
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FIG. 19

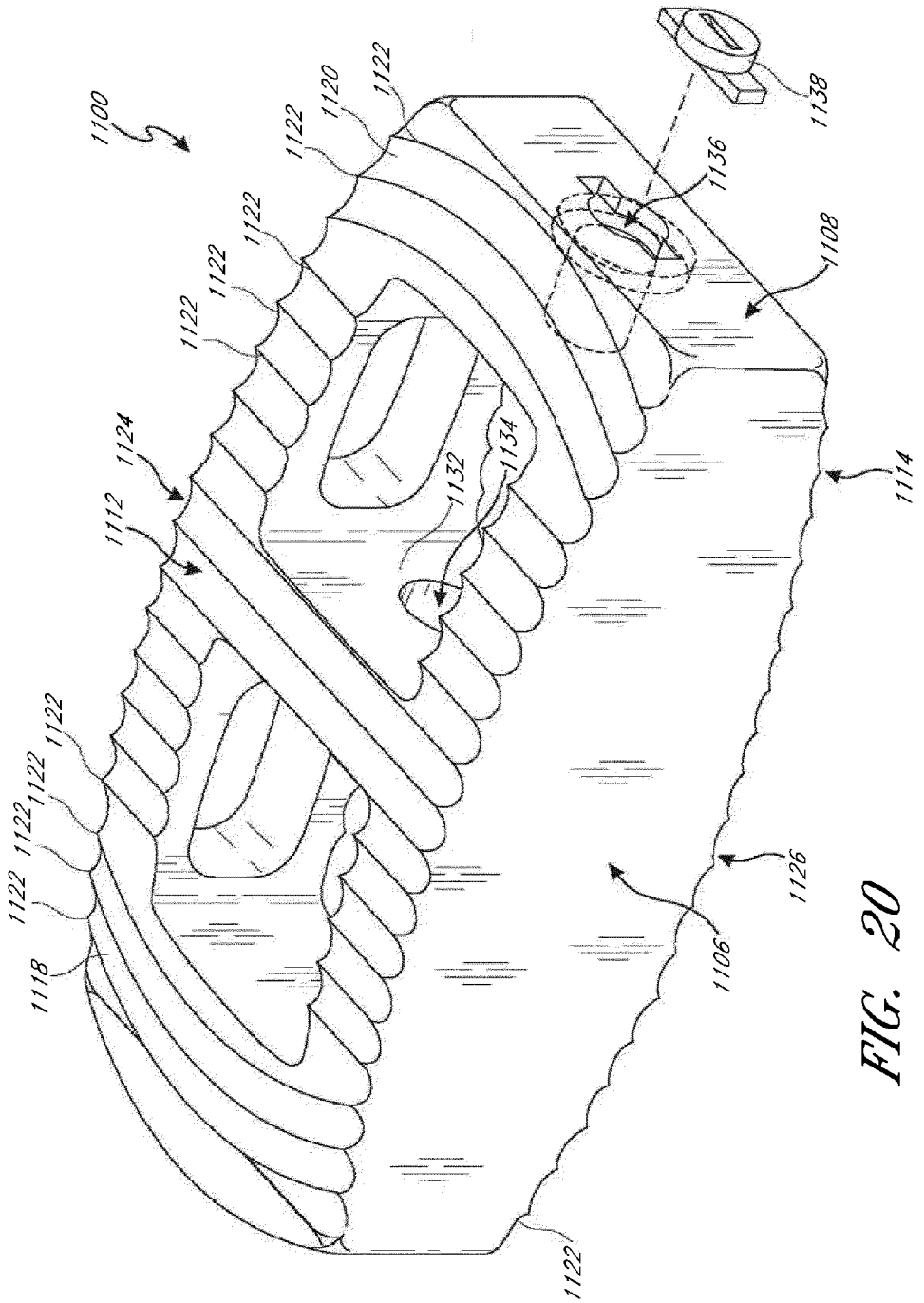
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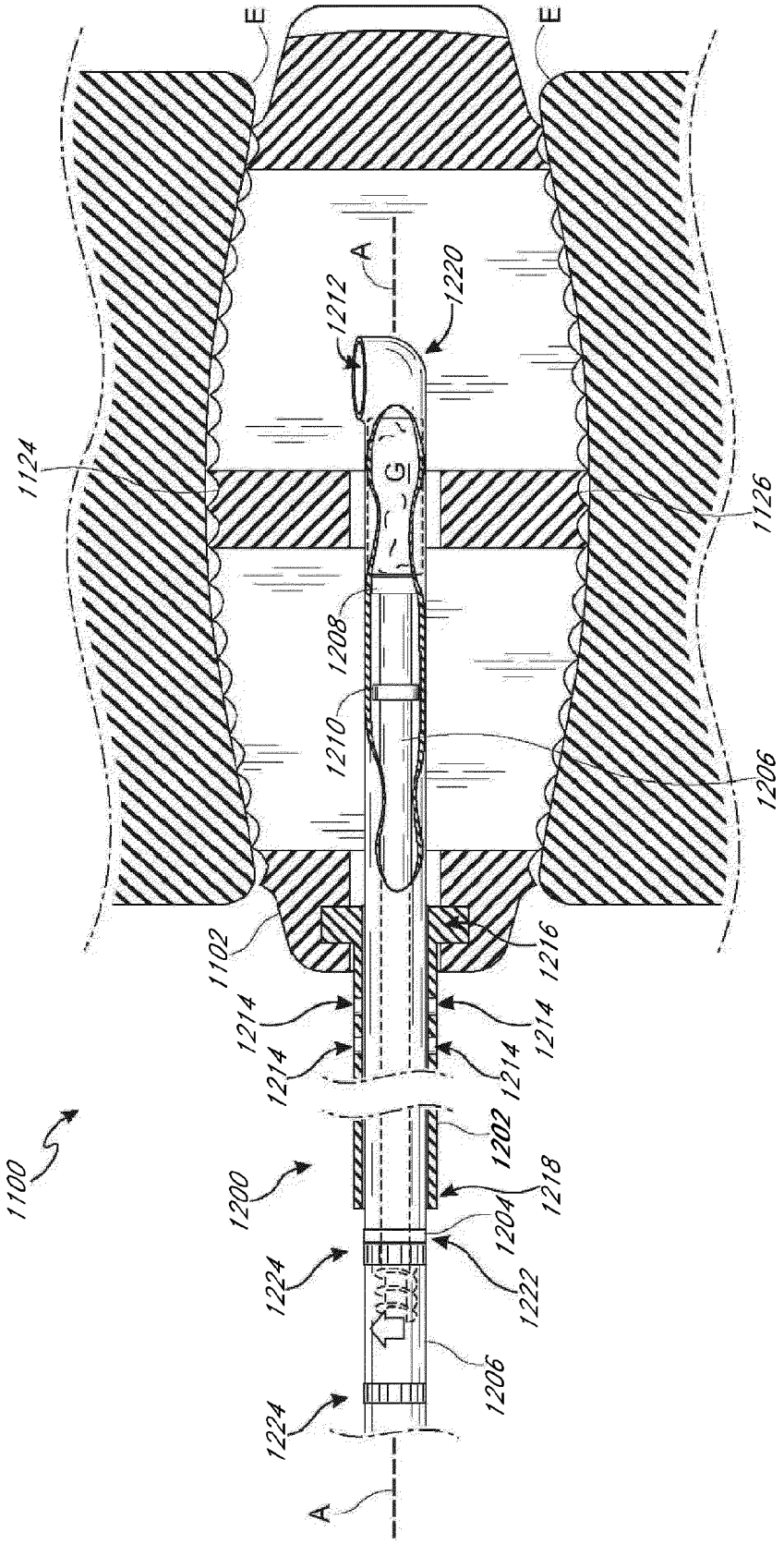
FIG. 20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1210
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1102
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1214
1214
1214
1100
1200
1202
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1204
1224
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1206
1224
A

FIG. 21

METHODS OF POST-FILLING AN INTERVERTEBRAL IMPLANT

PRIORITY DATA

This application is a continuation application of U.S. application Ser. No. 13/725,933, filed Dec. 21, 2012, which is a continuation of Ser. No. 13/049,693, filed Mar. 16, 2011, now U.S. Pat. No. 8,343,224, which claims the priority benefit under 35 U.S.C. §119(e) of U.S. Provisional Application No. 61/314,509, filed Mar. 16, 2010, and U.S. Provisional Application No. 61/389,671, filed Oct. 4, 2010. The entire contents of all of the foregoing applications are hereby incorporated by reference herein.

BACKGROUND

Field

This application generally relates to spinal fusion, and more specifically, to spinal implants and related systems, tools and methods.

Description of the Related Art

Intervertebral discs can degenerate or otherwise become damaged over time. In some instances, an intervertebral implant can be positioned within a space previously occupied by a disc. Such implants can help maintain a desired spacing between adjacent vertebrae and/or promote fusion between adjacent vertebrae. The use of bone graft and/or other materials within spinal implants can facilitate the fusion of adjacent vertebral bodies. Accordingly, a need exists for an improved intervertebral implant, as well as related instrumentation, tools, systems and methods.

SUMMARY

According to some embodiments, a spinal implant configured for placement within an intervertebral space of a patient comprises an anterior wall, a posterior wall, a first lateral wall and a second lateral wall, such that the first and second lateral walls generally extend between the anterior wall and the posterior wall. The spinal implant additionally comprises at least one internal chamber defined, at least in part, by the anterior wall, the posterior wall and the first and second lateral walls. In some embodiments, the implant comprises a top surface having a plurality of teeth configured to at least partially engage a lower surface of a first vertebral body and/or a bottom surface comprising a plurality of teeth configured to at least partially engage an upper surface of a second vertebral body, the second vertebral body being adjacent to said first vertebral body. In some embodiments, the at least one internal chamber extends at least partially from the top surface to the bottom surface of the implant. The implant further comprises at least one opening extending through the anterior wall, wherein such an opening is in fluid communication with the internal chamber. In some embodiments, the spinal implant additionally comprises at least one access port located in the anterior wall, the first lateral wall and/or the second lateral wall. In some embodiments, the implant is configured to releasably secure to an insertion tool using the access port. In some embodiments, the implant is configured to span across an entire width or substantially an entire width of the adjacent vertebral bodies. In one embodiment, the access port is configured to receive at least one graft material delivered into the at least one internal chamber. In some embodiments, the posterior wall does not comprise any openings.

According to some embodiments, excess graft material delivered into the at least one internal chamber through the access port is configured to exit the implant through one or more openings of the anterior wall. In one embodiment, the access port is threaded, so that a delivery tool comprising a corresponding thread pattern can be selectively attached and detached to the spinal implant. In some embodiments, the implant comprises one or more recesses and/or other features configured to mate with corresponding flanges or other protruding members of an implant delivery tool. In one embodiment, each of the first and second lateral walls is configured to generally align with peripheral bearing areas of the adjacent vertebral members. In other embodiments, the teeth along the top and/or bottom surfaces of the implant are configured to slant toward a lateral center of the implant. In some embodiments, the slanted teeth help retain the implant within the target intervertebral space after implantation and/or help reduce the likelihood the migration of grafting materials out of the at least one internal chamber of the implant along the top and bottom surfaces of the implant.

According to some embodiments, the first lateral wall and/or the second lateral wall comprises a tapered portion to facilitate insertion of the implant into the intervertebral space. In one embodiment, the spinal implant further comprises a plurality of prongs that extend into the internal chamber for retaining a graft or other member positioned therein. In some embodiments, such prongs are configured to retain at least one of a sponge, a porous foam and cured grafting materials within the at least one internal chamber of the implant. In some embodiments, the implant is configured for placement within a lumbar or thoracic portion of a patient's spine. In some embodiments, the implant is configured for lateral or anterior insertion into the intervertebral space. In several embodiments, the implant comprises polyether etherketone (PEEK) and/or any other material.

According to some embodiments, the length of each of the first and second lateral walls is approximately 10% to 20% of an overall length of the implant. In other embodiments, the length of each of the first and second lateral walls is less than about 10% or greater than about 20% of an overall length of the implant. In one embodiment, the teeth along at least one of the top and/or bottom surfaces of the implant are oriented, at least in part, in a concentric manner. In one embodiment, a radius of curvature of the teeth along at least one of the top and bottom surfaces of the implant increases with increasing distance from a center of the implant. In some arrangements, the top and/or bottom surfaces of the implant are generally planar. In other embodiments, the top and/or bottom surfaces of the implant are generally curved, fluted, rounded and/or non-planar.

According to some embodiments, the implant comprises a lordotic implant, such that a height of the first lateral wall is greater than a height of the second lateral wall. In some embodiments, the internal chamber does not comprise any interior walls or baffles. In alternative embodiments, the internal chamber comprises at least two internal sub-chambers divided by at least one interior wall or baffle. In one embodiment, the implant comprises at least one radiopaque marker. In several embodiments, the access port is generally circular. In other embodiments, the access port is non-circular (e.g., square, other rectangular or polygonal, oval, elliptical, irregular, etc.).

According to some embodiments, the access port comprises a minimum diameter of approximately 6 mm. In other embodiments, the diameter or other cross-sectional dimension of the access port is greater or less than about 6 mm (e.g., 4 mm, 5 mm, 7 mm, 8 mm, etc.). In some embodi-

ments, the access port is adapted to receive a fill tube, catheter or other conduit therethrough, wherein such fill tube, catheter or other conduit is configured to selectively deliver a grafting or fill material into the internal chamber of the implant. In some embodiments, a ratio of a diameter of the at least one access port to a height of the first or second lateral wall through which the at least one access port is located is between approximately 0.4 and 0.8 (e.g., about 0.4, 0.45, 0.5, 0.55, 0.6, 0.65, 0.7, 0.75, 0.8, 0.85, 0.9, etc.). In one embodiment, a minimum ratio of a diameter of the at least one access port to a height of the first or second lateral wall through which the at least one access port is located is approximately 0.5, 0.6, 0.7 or 0.8.

According to some embodiments, the access port comprises a valve or other flow blocking device or feature to help retain grafting materials within the at least one internal chamber of the implant. In some embodiments, an exterior profile of the anterior wall is generally curved. In some arrangements, an exterior profile of the posterior wall is generally planar.

According to some embodiments, a method for promoting spinal fusion comprises providing a spinal implant (e.g., such as one of the implants disclosed herein or equivalents thereof) and positioning the spinal implant between two adjacent vertebral bodies or vertebrae of a patient. The method further comprises directing at least one graft material into the internal chamber of the spinal implant through a port of the implant. In some embodiments, at least a portion of the graft and/or other filler material (e.g., materials in excess of the capacity of the implant) delivered into the at least one internal chamber is configured to exit through one or more openings of the anterior wall when a sufficient amount of the at least one graft material has been delivered into the at least one internal chamber.

According to some embodiments, positioning the spinal implant between two adjacent vertebrae comprises removably securing the spinal implant to the distal end of an insertion tool assembly, wherein the insertion tool assembly is secured to, at least in part, to the access port of the spinal implant. In some embodiments, the access port is used to both secure the implant to an implant delivery tool and to deliver grafting and/or other materials to the inside of the implant. In some embodiments, directing graft and/or other materials into the internal chamber comprises passing such materials through a cannulated portion of the insertion tool assembly. In other embodiments, directing the material into the internal chamber comprises passing the materials through a separate conduit adapted to be removably positioned within the access port of the spinal implant. In one embodiment, directing the graft and/or other materials into the internal chamber comprises injecting such materials through tubing using a syringe.

According to some embodiments, the tubing is routed through an internal passage of a fill tube assembly, wherein fill tube assembly is configured to engage at least a portion of the spinal implant while the graft and/or other materials are directed into the internal chamber of the implant. In some embodiments, at least a portion of the graft material delivered into the internal chamber is configured to exit through an interface between the upper and/or lower surface of the implant and the adjacent endplate surfaces of the vertebral bodies. In some embodiments, at least a portion of the internal chamber comprises a graft material prior to positioning the spinal implant between the two adjacent vertebrae. In some embodiments, an additional volume of a graft material is delivered into the internal chamber of the implant after the spinal implant has been secured between the two adjacent vertebrae.

According to some embodiments, the method further includes preparing at least one adjacent vertebral body surface for the delivery of the spinal implant, wherein preparing an adjacent vertebral body surface comprises abrading said surface using a rasping and/or other abrading or roughening tool. In some embodiments, such tools comprise one or more roughened surfaces or features configured to abrade bone and/or other tissue. In some embodiments, the method additionally comprises placing a sizing tool within a target intervertebral space prior to positioning the spinal implant between two adjacent vertebrae of a patient in order to determine the appropriate size of said spinal implant. In some embodiments, the sizing tool is configured to distract the adjacent vertebrae by a desired distance.

According to some embodiments, a kit includes a spinal implant (e.g., such as any of those disclosed herein or equivalents thereof), an implant delivery tool configured to removably secure to the spinal implant and a graft material delivery system configured to selectively deliver at least one graft and/or other filler material into an interior (e.g., internal chamber) of the spinal implant. In some arrangements, the graft material delivery system comprises a syringe, a sizing tool and a conduit configured to pass through the at least one access port of the spinal implant.

According to some embodiments, a method for promoting spinal fusion using a spinal implant comprises providing a spinal implant, wherein the spinal implant comprises an anterior wall, a posterior wall and two lateral walls configured to extend between the anterior wall and the posterior wall. In some embodiments, the spinal implant further comprises at least one internal chamber generally positioned between the anterior wall, the posterior wall and the two lateral walls, wherein the internal chamber being is adapted to receive at least one graft and/or other fill material. In some arrangements, the anterior wall of the spinal implant comprises at least one opening or hole that places the internal chamber in fluid communication with an exterior area or portion of the spinal implant. In one embodiment, at least one of the two lateral walls comprises an access port. The method additionally includes positioning the spinal implant between two adjacent vertebrae of a patient and directing at least one graft and/or other fill material into the internal chamber of the spinal implant through the access port. In some embodiments, at least a portion of the graft and/or other fill material delivered into the internal chamber is configured to exit through the one or more of the openings of the anterior wall.

In some embodiments, positioning the spinal implant between two adjacent vertebrae comprises removably securing the spinal implant to the distal end of an insertion tool assembly, wherein the insertion tool assembly is secured to, at least in part, to the access port of the spinal implant. In one embodiment, directing the graft material into the internal chamber comprises passing the graft material through a cannulated portion of the insertion tool assembly. In some embodiments, directing the graft material into the internal chamber comprises injecting one or more graft materials through flexible tubing using a syringe. In some embodiments, the flexible tubing is routed through an internal passage of a fill tube assembly, wherein the fill tube assembly is configured to engage at least a portion of the spinal implant while the graft material is being directed into the internal chamber. In some arrangements, at least a portion of the graft and/or other fill material delivered into the internal

chamber is configured to exit through an interface between the upper surface and/or lower surface of the spinal implant and an adjacent endplate surface of a vertebral body. In one embodiment, at least a portion of the internal chamber comprises a graft material prior to positioning the spinal implant between the two adjacent vertebrae. In some embodiments, such a pre-loaded graft material or item comprises a graft, an absorbent sponge or other member and or the like.

According to some embodiments, an implant configured for placement within an intervertebral space of a patient comprises an anterior wall, a posterior wall, a first lateral wall and a second lateral wall, wherein the first and second lateral walls are configured to extend between the anterior wall and the posterior wall. The implant further includes a top surface having a plurality of teeth adapted to at least partially engage a lower surface of a first vertebral body and a bottom surface having a plurality of teeth adapted to at least partially engage an upper surface of a second vertebral body, wherein the second vertebral body is adjacent to the first vertebral body. The implant further comprises one or more internal chambers positioned between the anterior wall, the posterior wall, the first lateral wall and the second lateral wall, wherein the internal chamber at least partially extends from the top surface to the bottom surface of the implant.

In some embodiments, the implant additionally includes at least one opening extending through the anterior wall, wherein the opening is in fluid communication with the internal chamber. In one embodiment, the implant further comprises at least one access port located in the anterior wall, the first lateral wall and/or the second lateral wall, wherein the implant is configured to releasably secure to an insertion tool using the access port. In some embodiments, the access port is configured to receive a graft material that is delivered into the internal chamber after the implant has been secured within the intervertebral space. In one embodiment, the posterior wall does not comprise any openings. In some arrangements, the graft material delivered into the internal chamber is configured to exit the implant through at least one opening of the anterior wall.

According to some embodiments, the implant comprises polyether etherketone (PEEK). In several arrangements, the length of each of the first and second lateral walls is approximately 10-20% of the overall length of the implant. In some embodiments, each of the first and second lateral walls is configured to generally align with the peripheral bearing areas of the adjacent vertebral members. In some embodiments, the plurality of teeth situated along the top and/or bottom surfaces of the implant are configured to slant to toward a lateral center of the implant. In one embodiment, the first lateral wall and/or the second lateral wall comprises a tapered portion to facilitate insertion of the implant into the intervertebral space. In some arrangements, the implant is configured for lateral, anterior or posterior insertion into the targeted intervertebral space. In some embodiments, the implant is configured for placement within a lumbar or thoracic portion of a patient's spine. In one embodiment, the implant additional comprises a plurality of prongs extending into the interior chamber for retaining a graft or other member positioned therein.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects and advantages of the present application are described with reference to drawings of certain embodiments, which are intended to illustrate, but not to limit, the present disclosure. It is to be understood that these drawings are for the purpose of illustrating concepts of the present disclosure and may not be to scale.

FIG. **1**A illustrates a front perspective view of a spinal implant according to one embodiment;

FIG. **1**B illustrates a rear perspective view of the implant of FIG. **1**A;

FIG. **2** illustrates a top view of the implant of FIG. **1**A;

FIG. **3**A illustrates a side view of the implant of FIG. **1**A;

FIGS. **3**B and **3**C illustrate detailed side views of the implant of FIG. **1**A;

FIGS. **4** and **5** illustrate different side views of the implant of FIG. **1**A;

FIG. **6**A illustrates perspective views of an implant and an insertion tool configured to engage the implant according to one embodiment;

FIG. **6**B illustrates a partial top view of a spinal implant according to one embodiment;

FIG. **6**C illustrates a perspective view of a spinal implant according to one embodiment;

FIG. **6**D illustrates a top view of a spinal implant according to one embodiment;

FIG. **7**A illustrates an anterior side view of an implant within a targeted intervertebral space and secured to an insertion tool assembly, according to one embodiment;

FIG. **7**B illustrates lateral side view of the implant of FIG. **7**A;

FIG. **8** illustrates two embodiments of sizing and distraction tools;

FIG. **9** illustrates one embodiment of a rasping or abrading tool for use as a preparatory tool in advance of implantation of a spinal implant;

FIGS. **10**A and **10**B illustrate perspective views of another embodiment of a rasping or abrading tool for preparing an intervertebral space;

FIG. **11** illustrates a perspective view of an insertion tool assembly attached to a spinal implant, according to one embodiment;

FIG. **12**A illustrates an exploded perspective view of the insertion tool assembly and implant of FIG. **11**;

FIG. **12**B illustrates a partial cross-sectional view of an insertion tool assembly secured to an implant, according to one embodiment;

FIG. **13** illustrates a perspective view of various components of a graft fill kit, according to one embodiment;

FIG. **14** illustrates an anterior side view of a fill tool assembly engaged with a spinal implant positioned within a targeted intervertebral space, according to one embodiment;

FIG. **15** illustrates a syringe assembly configured for post-filling a spinal implant with graft and/or other fill materials, according to one embodiment;

FIGS. **16**A-**16**C illustrate various view of time-sequential steps related to positioning a syringe assembly within a fill tool assembly, according to one embodiment;

FIGS. **17**A and **17**B illustrates different side views of excess graft and/or other fill material that has exited the interior chamber of a spinal implant, according to one embodiment;

FIG. **18** illustrates a partial cross-sectional view of an insertion tool assembly having a cannulated threaded rod and secured to an implant, according to one embodiment;

FIGS. **19** and **20** illustrate different top perspective view of a spinal implant according to one embodiment; and

FIG. **21** illustrates a cross-sectional view of the implant of FIGS. **19** and **20**.

DETAILED DESCRIPTION

A variety of embodiments and examples described herein illustrate various configurations that may be employed to

achieve desired improvements. The particular embodiments and examples are only illustrative and not intended in any way to restrict the general nature of the inventions presented and the various aspects and features of and relating to these inventions.

Spinal Implant

FIG. **1** illustrates one embodiment of a spinal implant **10** configured for placement between adjacent vertebrae of a patient. According to certain arrangements, the implant **10** is sized, shaped and otherwise adapted for placement with an intervertebral space along the lumbar region of spine. Alternatively, however, the implants and/or the methods disclosed herein can be modified for placement in any other portion of the spine, such as, for example, the thoracic or cervical region. In any of the embodiments disclosed herein, the implant can be inserted into a target intervertebral space using a lateral delivery approach (e.g., XLIF or TLIF), an anterior approach (e.g., ALIF), a posterior approach (e.g., PLIF) and/or any other approach or technique.

With continued reference to FIG. **1**, the implant **10** can include a generally rectangular shape. However, in alternative configurations, the implant **10** includes another shape, as desired or required by a particular application or use. For example, one or more of the implant's surfaces or sides can be more or less tapered and/or rounded (e.g., curved, convex, etc.). Further, the implant can comprise a completely different overall shape (e.g., as viewed from the top, bottom, one or more sides, etc.), such as, for example, round, oval, elliptical, other polygonal, irregular and/or the like.

According to some embodiments, the top surface **12** and/or the bottom surface **16** of the implant **10** comprise one or more teeth **40**, protruding members and/or other features that are sized, shaped and otherwise configured to contact and engage adjacent surfaces of the vertebral endplates once the implant has been positioned within the intervertebral space. In one embodiment, only the top surface **12** comprises teeth or similar engagement features. In another embodiment, only the bottom surface **16** comprises teeth or similar engagement features. However, in some embodiments, both the top and the bottom surfaces **12**, **16** comprise teeth or similar engagement features.

The teeth **40** or other engagement members or features can be distributed either completely or partially along the top surface **12** and/or bottom surface **16** of the implant **10**. For example, the teeth or other engagement features **40** can cover the entire or substantially the entire top and/or bottom surfaces of the implant. In other arrangements, the teeth **40** are located along only selected portions of the top and/or bottom surfaces, as desired or required. As illustrated in FIGS. **1** and **2**, the teeth **40** can extend, at least partially, from the anterior end **32** to the posterior end **36** of the implant. In some embodiments, at least some of the teeth **40** are generally parallel to each other. However, in other arrangements, at least some of the teeth or similar engagement features **40** of an implant intersect with one another or are otherwise non-parallel relative to each other.

With continued reference to FIGS. **1** and **2**, the teeth or other engagement features **40** can be symmetrically disposed along the top surface **12** and/or bottom surface **16** of the implant **10**. Alternatively, however, the tooth pattern along the top and/or bottom surfaces of the implant can be asymmetrical in one or more directions. In the illustrated embodiment, the teeth **40** are generally straight along the middle portion of the implant **10** and generally curved (e.g., circular, oval, etc.) along each of the lateral ends **22**, **26** of the implant **10**. Thus, the radius of curvature of the teeth **40** along the lateral ends **22**, **26** of the implant is greater than the curvature of the teeth along the middle, center or interior portion of the implant. In some arrangements, the radius of curvature of the rows of teeth **40** or other engagement features can increase with increasing distance from the center of the implant **10**.

The teeth or other engagement features **40** along the top surface **12** and/or the bottom surface **16** of the implant **10** can be bi-directional or unidirectional, as desired or required. Such teeth or other engagement features **40** can help ensure that the implant **10** does not migrate or otherwise undesirably move after implantation within a target intervertebral space. In addition, as discussed in greater detail herein, the teeth **40** can assist in maintaining graft and/or other fill materials within or near the implant **10** (e.g., within an internal chamber of the implant, between the endplates of adjacent vertebral members, etc.), thereby improving and/or facilitating spinal fusion. The type, quantity, shape (e.g., curvature along the top and/or bottom surfaces of the implant, the cross-sectional shape of the teeth, etc.), size (height, length, etc.), orientation, spacing and/or other details of the teeth or other engagement features **40** can vary, as desired or required.

With reference to the top view of FIG. **2**, the implant **10** can include a left lateral side L and a right lateral side S. According to some embodiments, the teeth **40** along the top and/or bottom surfaces **12**, **16** of the implant **10** are unidirectional. For example, the teeth **40** along the left side L of the implant are generally curved, sloped, slanted or otherwise pointed in a first direction, whereas the teeth **40** along the right side R of the implant are generally curved, sloped, slanted or otherwise pointed in a second direction, which in some arrangements, is generally opposite of the first direction.

Further, as illustrated in the side view of FIG. **3**A, in some embodiments, the teeth **40'**, **40"** along the upper and/or lower surfaces **12**, **16** of the implant **10** are sloped or slanted toward the horizontal center of the implant. As noted above, such a configuration can help ensure that the implant **10** engages adjacent portions of a patient's spine (e.g., vertebral endplate surfaces) and does not inadvertently migrate or otherwise move after implantation. Further, such embodiments can help ensure that the likelihood that grafting agents and/or other fill materials delivered into the interior chambers of the implant **10** undesirably escape from within or near the implant (e.g., between the upper and/or lower surfaces **12**, **16** and the adjacent endplate surfaces of the patient's vertebrae) is advantageously reduced or minimized. For example, with such a tooth orientation, the implant **10** needs to migrate or otherwise shift against the tooth grain (e.g., in one or more directions) in order to move laterally away from the target intervertebral space following implantation. In addition, according to some embodiments, the inwardly oriented shape of the teeth **40** makes it more difficult for grafting and/or other filler materials to flow or otherwise move at or near the implant-endplate interface.

As illustrated in FIG. **3**A, the implant **10** can include generally planar top and/or bottom surfaces **12**, **16**, at least partially along its length and/or width. In other embodiments, however, the top surface **12** and/or the bottom surface **16** of the implant **10** comprises one or more portions that are non-planar. Such non-planar areas or portions can extend only partially along the length and/or width of the implant. In other embodiments, the entire top and/or bottom surface of the implant can be generally non-planar.

For example, the top and/or bottom surfaces can be generally concave, rounded or otherwise curved (e.g., in the vertical direction so that the thickness of the implant varies

along one or more regions of the implant). Such configurations can provide for a tighter fit between the implant **10** and the adjacent endplates or other surfaces or portions of the vertebral members. In some arrangements, such configurations can help improve or enhance the spinal fusion process. In yet other arrangements, the implants can be generally planar but non-horizontal (e.g., from anterior to posterior ends). For instance, as discussed in greater detail herein, "lordotic" implant designs can include a generally higher anterior wall relative to the posterior wall.

In some embodiments, one or both lateral ends of an implant can be tapered. A tapered lateral end **22**, as illustrated in FIG. **3**A, can facilitate insertion of the device **10** within the target intervertebral space during an implantation procedure. In the depicted arrangement, the leading end **97** along the right lateral end **22** of the implant **10** includes both a vertical taper and a rounded profile when viewed from the top. In some embodiments, as discussed in greater detail below, at least a portion of such a "bullet" or tapered leading lateral end of the device can be configured to extend outside the intervertebral space into which the implant is implanted. According to some embodiments, one or both lateral ends of the implant comprise a rounded or curved contour. Such a rounded or curved contour or profile can be included in the vertical direction, in the horizontal direction or in both the vertical and horizontal directions, as desired or required.

In addition, as best illustrated in FIG. **2**, the exterior surface of the implant's posterior side **36** can be generally flat or planar when viewed from the top. Such a design can help ensure that a proper clearance is provided between the posterior end of the implant **10** and sensitive portions of the patient's spine (e.g., nerve roots, spinal cord, etc.). Further, the exterior surface of the implant's anterior side **32** can include a rounded or other non-planar shape. In some embodiments, such a rounded or other non-planar shape is relatively gradual or slight. Likewise, as shown, the exterior of the implant's lateral sides **22**, **26** can be either generally planar (e.g., flat) or rounded, as desired or required. In other embodiments, the exterior shape of the implant's sides can be different than illustrated and discussed herein.

In order to help perform an implantation procedure and to facilitate the delivery of an implant to a targeted location within a patient's spine, the implant **10** can include one or more insertion tool receiving ports **50**, slots and/or other features. For example, in the embodiment illustrated in, inter alia, FIGS. **1**A, **1**B, **2** and **3**B, a single port **50** is positioned along one of the lateral ends **26** of the implant **10**. However, in other configurations, the port **50** can be positioned along any other portion of the device. The location of the port **50** can depend, at least in part, on the desired method by which the implant **10** will be inserted into the patient's spine (e.g., laterally, anteriorally, posterially, etc.). For example, in the illustrated arrangement, the port **50** is positioned along a lateral end **26**, primarily because the implant **10** is designed to be inserted into the target intervertebral space laterally. Therefore, in other configurations, an insertion tool receiving port **50** can be included along the anterior side **32**, posterior side **36** and/or any other portion of the implant.

According to some embodiments, the insertion tool receiving port **50** is configured to releasably engage a corresponding insertion tool using a threaded connection. For instance, the port **50** can include internal threads that are sized, shaped and otherwise adapted to match external threads of an insertion tool **300** (FIG. **6**A). In other arrangements, however, other types of connection features or devices are used to releasably secure an insertion tool to the implant, such as for example, a press-fit or friction fit connection, a snap-fit connection, a tabbed connection, any other standard or non-standard coupling and/or the like. In some embodiments, as discussed in greater detail herein, the port **50** also serves as an inlet into the implant's interior chambers through which grafting and/or other fill materials can be selectively delivered within the implant. Thus, is such embodiments, a single port **50** is used both an implant delivery mechanism and a graft material passage. In some embodiments, the port **50** comprises one or more valves (e.g., check valve, other one-way valve, etc.), other flow-regulating devices or features and/or one or more other sealing members to help prevent or reduce the likelihood of the inadvertent loss of grafting and/or other fill materials from within the interior of an implant through such a port **50**.

The port **50** can be threaded or non-threaded, as desired or required. In some embodiments, the port comprises one or more other engagement or other features, such as for example, alignment slots, tabs, teeth, other protruding members and/or the like. Such features can extend inwardly (e.g., in the direction of the port's opening) from the wall or other surface defining the port **50**. According to some embodiments, the shape (e.g., cross-sectional shape) of the port is generally circular. However, the port can include one or more other shapes, such as, for example, oval, elliptical, square, rectangular, other polygonal, irregular and/or the like.

According to some embodiments, the threaded port **50** along a lateral end **26** of the implant is configured to pass at least partially through the implant's lateral wall **98**. For example, in one embodiment, the port **50** passes through the entire lateral wall **98** and extends into one or more internal chambers **70**, cavities or other openings of the implantable device **10**. According to some embodiments, the port **50** is sized to permit a catheter, syringe, tubing, other tube, conduit and/or other delivery device to be passed therethrough. Such a catheter or other delivery tube or device can be sized and configured to allow grafting and/or other materials to be selectively injected or otherwise administered into one or more chambers of the implant. In one embodiment, the port is sized to permit a catheter or other tube of size French 12 or French 15 (e.g., per the standard French gauge scale) to be passed therethrough. Thus, in such arrangements, the port **50** can include a minimum inside diameter of about 4 mm or about 5 mm. In other embodiments, however, the port **50** can be sized, shaped and otherwise configured to permit the passage of larger catheters, tubes or other conduits therethrough. For instance, in some embodiments, an implant is configured to permit a catheter, tube or other conduit having an outer diameter as large as about 5 mm through 8 mm (e.g., approximately 5 mm, 5.5 mm, 6 mm, 6.5 mm, 7 mm, 7.5 mm, 8 mm, sizes between the foregoing, etc.) to pass through its port **50**. In other embodiments, the port is sized and shaped to allow conduits having an outer diameter larger than 8 mm (e.g., approximately 8 mm, 8.5 mm, 9 mm, larger than about 9 mm, etc.) to pass therethrough.

In some embodiments, the threaded port **50** or access hole comprises an M6×1.0 configuration. However, as noted above, the port can comprise a nominal diameter that is greater than or less than about 6 mm, such as, for example, approximately 4 mm, 5 mm, 7 mm, 8 mm, 9 mm, 10 mm, greater than 10 mm, sizes between the foregoing values, etc.). Further, in embodiments that comprise a threaded port, the thread along the inside of the port can differ from that in an M6×1.0 configuration, as desired or required. For example, the thread type, pattern, height and/or other characteristics of the thread can vary.

According to some embodiments, the spinal implants disclosed herein or equivalents thereof comprise a generally closed structure along their sides. For example, in some arrangements, the only openings along the outer sidewalls (e.g., lateral, posterior, anterior) of an implant are one or more ports **50** (e.g., used to engage the implant with a delivery tool and/or used to pass a graft delivery tube to the interior of the implant) and/or one or more openings that permit excess grafting materials to exit an interior chamber or other cavity of the implant (e.g., openings **60** along the anterior side wall of the implant, as illustrated in FIG. **3**A).

According to some embodiments, the port **50** or other openings through a wall of the implant is configured to be as large as possible for a given implant. This can permit a larger device (e.g., catheter, syringe, tubing, other conduit or device, etc.) to be positioned therein. For example, as discussed in greater detail herein, the port **50** can be advantageously adapted to receive a tube that is configured to transfer grafting and/or other fill materials from a syringe (or other supply source) to the interior of the implant. Therefore, in such embodiments, the inside diameter (or other cross-sectional clearance dimension) of the port **50** is slightly larger than the outer diameter (or other outer dimension) of the fill catheter or other conduit.

In some embodiments, the port comprises a diameter of approximately 6 mm to 8 mm (e.g., about 6 mm, 6.5 mm, 7 mm, 7.5 mm, 8 mm, diameters between the foregoing values, etc.). Alternatively, however, the diameter or other cross-sectional dimension of the port **50** can be smaller than about 6 mm (e.g., approximately 4 mm, 4.5 mm, 5 mm, 5.5 mm, 5.9 mm, diameters between the foregoing values, etc.) or larger than about 8 mm (e.g., approximately 8.1 mm, 8.5 mm, 9 mm, 9.5 mm, diameters between the foregoing values, larger than about 9.5 mm, etc.), as desired or required. In some embodiments, a target diameter or other cross-sectional dimension of the port **50** is generally maintained, irrespective of the size of the implant (e.g., 6 mm, 8 mm, 10 mm, 12 mm tall implants). This can help ensure that a surgeon or other clinician can insert a desired fill tube or other conduit within an interior of an implant (e.g., to delivery grafting and/or other fill materials during a post-fill procedure). Accordingly, as noted herein with reference to the embodiments illustrated in FIGS. **6**B-**6**D, one or more implant walls through which the port **50** passes (e.g., lateral side walls) may need to be reinforced or otherwise strengthened to accommodate a desired port diameter (e.g., 6 mm, 8 mm, etc.) in light of the implant's thickness.

By maintaining a relatively large port diameter or other dimension, a larger fill tube or conduit can be advantageously positioned through such a port. Accordingly, the friction associated with passing grafting and/or other fill materials through the fill tube can be reduced. This allows for less strenuous delivery of grafting and/or other fill materials into the interior of an implant (e.g., during a post-fill procedure). Accordingly, the surgeon or other clinician performing a fill procedure can more easily deliver the necessary materials through the fill tube. Therefore, although it is somewhat counterintuitive to include a relatively large port or other openings along one or more walls of the implant (e.g., because of the likelihood of grafting and/or other filler materials leaking out of the implant), such an oversized port can provide one or more benefits and advantages during a fill procedure.

According to some embodiments, the ratio of the port diameter (or other port opening size) to the height of the implant wall through which the port is located (e.g., lateral wall) is between about 0.4 and about 0.9 (e.g., approximately 0.4, 0.45, 0.5, 0.55, 0.6, 0.65, 0.7, 0.75, 0.8, 0.85, 0.9, ratios between the foregoing values, etc.), depending on the size of the implant. For example, in some embodiments, the port diameter is approximately 6 mm and the height of the corresponding implant wall is 8 mm, 10 mm, 12 mm or the like. Thus, the ratio can be approximately 0.75, 0.6, 0.5 and/or the like. In some embodiments, the ratio of the port diameter (or other port opening size) to the height of the implant wall through which the port is located (e.g., lateral wall) is at least about 0.5, 0.55, 0.6, 0.65, 0.7, 0.75, 0.8, 0.85, 0.9, greater than about 0.9 and/or the like.

In some embodiments, the area of the port **50** is at least about 10%, 15%, 20%, 25% or 30% of the overall area of the wall (e.g., lateral implant wall) through which the port is positioned. However, the port area can be smaller than about 10% or greater than about 25% of the overall area of the wall through which the port is positioned, as desired or required.

As discussed in greater below, the implants disclosed herein can be provided in a variety of shapes, sizes and configurations in order to better accommodate the intervertebral spaces into which they will be inserted and secured. Thus, in some embodiments, the various types of implants that are supplied to a surgeon or other clinician comprise an identical port **50** (e.g., having an identical diameter, shape, thread pattern, etc.), regardless of the actual size, shape and other details of the devices. Accordingly, a surgeon or other clinician can use a single insertion tool and/or a single set of other instruments to engage and manipulate the various types of implants provided. Further, as noted above, in addition to serving as a securement site and/or other engagement means for a tool used during the delivery of the implant through a patient's anatomy, the port **50** can also be used as a passageway for a catheter, syringe, tube or other conduit. Such conduits can be passed through the port **50** to selectively deliver grafting agents, other filler materials and/or any other device or substance within an interior chamber, cavity or other portion of the implant. In some embodiments, the passage of catheters and/or other conduits through the port is performed after the implant has been securely positioned within a target intervertebral site and after one or more delivery tools have been detached from the implant. In other embodiments, as disclosed herein, the graft delivery catheter or other conduit can be passed through the port **50** to reach an interior portion of the implant while an implant delivery tool is secured to the port. For example, such a catheter or conduit can be passed through an interior lumen or other passage of a cannulated implant delivery tool.

In order to maintain an identical threaded or other type of port **50**, one or more portions of smaller implants (e.g., implants that have a smaller height, such as, for example, 6 mm, 8 mm or 10 mm devices) may be reinforced with additional material and/or other support along or near an area surrounding the port **50**. For example, as depicted in the embodiment illustrated in FIGS. **6**B-**6**D, additional implant material **13** (e.g., PEEK, other polymeric or other material, etc.) is included along the top and/or bottom surfaces of the implant **10** along or near the port **50**. This can advantageously permit the manufacture of implants of various sizes that include a single type of port **50**, while maintaining the requisite structural and functional integrity of the implant. For instance, the use of additional material or other reinforcement **13** along the top and/or bottom surface of the implant **10** can provide the requisite resistance to the forces and moments to which the implant may be subjected during delivery and/or use. As shown in FIGS. **6**B-**6**D, in arrangements where additional reinforcing material **13** is provided along the top and/or bottom surfaces, such additional mate-

rial can be positioned within at least of the grooves that help define the teeth **40** or other engagement features of the implant **10**. Thus, the depth and general configuration of the teeth **40** along such reinforced areas may vary from adjacent areas of the implant.

Further, the implant **10** can include one or more additional features that facilitate engagement with a corresponding insertion tool. According to some embodiments, as depicted, for example, in FIG. **3**, the implant comprises two recesses or slots **28** along one of the lateral ends **26** (e.g., along the lateral end that includes the insertion tool receiving port **50**). Such recesses or other features **28** can be sized, shaped, positioned, spaced, oriented and/or otherwise adapted to align and mate with corresponding wings, tabs or other portions of an insertion tool. The recesses, slots and/or other engagement features **28** can help a surgeon or other clinician to manipulate (e.g., rotate) the implant during surgery or other procedure involving moving or repositioning the implant. Further, such engagement features **28** can help ensure that the corresponding implant insertion tool (and/or graft fill tool, as discussed in greater detail herein) is properly positioned relative to the implant.

With continued reference to the embodiments depicted in, inter alia, FIGS. **1**A, **1**B and **2**, the spinal implant **10** can include one or more internal chambers **70**. In one embodiment, the implant comprises only a single chamber. However, in alternative embodiments, the implant comprises two or more chambers. As shown, such internal chambers **70** can extend across the entire implant depth (e.g., from the top surface **12** to the bottom surface **16**) and across a majority of the implant's length and width. For example, in some arrangements, the chamber **70** spans approximately 60-70% of the implant length and width. However, in other embodiments, the chamber **70** can extend less than about 60% of the implant length and/or width (e.g., approximately 30%, 35%, 40%, 45%, 50%, 55%, 60%, less than 30%, percentages between the aforementioned values, etc.), or more than about 70% of the implant length and/or width (e.g., approximately 70%, 75%, 80%, 85%, more than about 90%, percentages between the aforementioned values, etc.), as desired or required by a particular application or use.

In some embodiments, an implant comprises two or more chambers. For example, the implants illustrated in FIGS. **1**A-**5** can include one or more dividing walls (not shown) that extend across the chamber **70** generally between the anterior and posterior walls **92**, **94**. Such dividing walls or other separators, which may be integrally formed with adjacent portions of the implant, can effectively create two or more sub-chambers or cavities in the implant. In implant arrangements having two or more chambers, sub-chambers, cavities and/or other openings, such chambers or sub-chambers can be of equal or different shape and/or size. Further, one or more openings can be included in the dividing wall or other separators to permit the chambers to be in fluid communication with one another. This may be particularly important when the filling the implant with grafting and/or other materials (e.g., to help ensure that such fill materials are delivered into all of the chambers).

As depicted in FIGS. **1**A and **1**B, a spinal implant **10** can include one or more openings **60** that extend through its anterior wall **92**, but no openings along its posterior wall **94**. The openings **60** can be in fluid communication with the implant's chamber(s) **70**. Thus, as is discussed in greater detail below, excess grafting and/or other fill materials delivered into the chamber(s) **70** (e.g., through a fill port **50** and/or other opening in the implant) can exit through the openings **60** toward the anterior portion of the spine. By eliminating openings along the posterior wall, the passage of fill materials along the posterior side of the implant can be generally reduced or prevented. Thus, a majority (or almost all) of excess grafting agent and/or filler material delivered within such an implant can be configured to exit the interior of the implant through the anterior openings **60**. For example, in some arrangements, more than approximately 70% (e.g., more than about 70%, 75%, 80%, 85%, 90%, 95%, etc.) of excess fill materials delivered into an implant exit through the openings **60**. In some embodiments, this can advantageously help prevent or reduce the likelihood of migration of grafting and/or other fill materials toward nerve roots, spinal cord and other sensitive regions of the spine.

With continued reference to the side view of the embodiment illustrated in FIG. **3**A, an implant **10** can include a total of five openings **60** that are generally equally sized and equally spaced apart from each other along the anterior wall. In the depicted configuration, the openings **60** comprise an oval shape or a generally rectangular shape with rounded corners. Alternatively, the openings **60** can include any other shape (e.g., circular, square, rectangular, other polygonal, irregular, etc.). Further, the quantity, spacing, relative size, orientation and/or other characteristics of the openings **60** can be different than illustrated and discussed herein. For example, depending on the implant's size, design bearing capacity and/or other properties, additional (e.g., six, seven, eight, nine, ten, more than ten, etc.) or fewer openings (e.g., four, three, two, one) can be provided.

In addition, as illustrated in, among other places, the top view of FIG. **2**, the implant **10** can comprise one or more internal prongs or other protruding members **74** that extend into the chamber **70**. As with other features of the implant, such prongs **74** can be formed as a unitary structure with adjacent portions of the implant. Alternatively, the internal prongs **74** can be separate members that are subsequently secured to the implant using one or more connection devices or methods, such as for example, screws, rivets, other fasteners, adhesives and/or the like. The prongs **74** can be positioned along various locations of the implant's interior surface. For example, in some embodiments, as illustrated in FIGS. **6**A and **6**C, the prongs are positioned along various lateral portions near the top and/or bottom of the implant. However, the internal prongs or other engagement member can be situated along any other portion or area of the chamber **70**, either in addition to or in lieu of the top and/or bottom portions of the implant.

According to some embodiments, as depicted in FIG. **6**D, the prongs **74** are directed toward the interior chamber or cavity **70** of the implant **10**. The prongs **74** can be aligned generally perpendicularly relative to the interior vertical wall that defines the chamber **70** and from which the prongs extend inwardly. Thus, one or more of the prongs can be positioned along a line that is offset from the lengthwise or widthwise centerline of the implant **10**. For example, as shown in FIG. **6**D, one or more prongs **74** are offset by angle P relative to the widthwise centerline W of the implant **10**. In some embodiments, such an angle P is approximately 20-25% (e.g., about 20%, 25%, 30%, etc.). Further, as illustrated in FIG. **6**D, the prongs **74** can comprise a generally conical, wedge-like, truncated cone-like, triangular, pyramid-like and/or any other shape (e.g., when viewed from the top). However, the shape, size, spacing, orientation and/or other characteristics of the prongs **74** can be different than illustrated and discussed herein.

Regardless of their exact quantity, size, shape, spacing, orientation and/or other characteristics, such prongs or other features **74** can help ensure that grafting agents and/or other

fill materials are properly retained within the internal chamber(s) **70** of the implant **10**. For example, in some embodiments, a solid graft, a porous foam structure, a sponge and/or other solid or non-flowable member is positioned within the chamber **70** of the implant, either before or after implantation into a patient. Thus, the prongs **74** can help engage such items and maintain them within the implant. In some embodiments, the prongs **74** help secure grafting and/or other filler materials within a chamber **70** of the implant only after such materials have become adequately hardened or solidified.

As illustrated in FIGS. **1**A-**5**, the thickness (e.g., vertical height) and width (e.g., anterior-posterior distance) of the implant **10** can be generally consistent throughout its entire length. Alternatively, one lateral end of the implant can comprise a larger thickness than the opposite lateral end. Such arrangements can be advantageously used when inserting an implant along to a lordotic portion of the spine. For example, the height difference between opposing ends in such lordotic implants can differ by about 2 mm. In other embodiments, the height difference is less or greater than about 2 mm (e.g., approximately 0.5 mm, 1 mm, 1.5 mm, 2.5 mm, 3 mm, 3.5 mm, 4 mm, greater than 4 mm, distances between the aforementioned values, etc.), as desired or required for a particular patient or fusion procedure.

According to some embodiments, the horizontal width of the implant's lateral walls **96**, **98** can be configured to enhance the implant's ability to withstand the bearing forces, moments and other loads to which it will be subjected once properly implanted into a patient's spine. For example, as illustrated in the anterior-posterior view of FIG. **7**A, the lateral walls **96**, **98** of the implant **10** can be configured to align with portions B of the adjacent vertebrae V through which the highest concentration of bearing forces are transferred to the implant **10**. In general, such high bearing load areas or portions B are situated near the lateral or circumferential ends of the vertebrae V. Typically, as depicted in FIG. **7**A, the endplates of the vertebrae V move further away from the adjacent intervertebral space near the center of the vertebral body. Thus, most of the bearing load created by the adjacent vertebrae V is expected to be concentrated toward the peripheral ends of the implant **10**.

Accordingly, in order to improve its load bearing capacity, the implant **10** can include lateral walls **96**, **98** that are generally reinforced and otherwise adapted to safely handle the bearing loads imposed upon the implant following implantation. For example, the lateral walls **96**, **98** can be wider (e.g., horizontally) than the anterior and/or posterior walls **92**, **94** of the implant. In some embodiments, the horizontal length (e.g., along the longer axis of the implant) of each of the lateral walls **96**, **98** is at least about two times greater than the horizontal width of the anterior or posterior wall. For instance, in some embodiments, the horizontal length of one or both of the lateral walls **96**, **98** is approximately at least two, three, four or more than four times the horizontal width of the anterior wall or the posterior wall of the implant. In some embodiments, the horizontal length of one or both of the lateral walls **96**, **98** is approximately 10 to 20% (e.g., about 10%, 12%, 14%, 16%, 18%, 20%, percentages between the foregoing values, etc.) of the overall horizontal length of the implant (e.g., along the longer axis of the implant). Alternatively, however, the horizontal length of the one or both of the lateral walls **96**, **98** can be greater than about 20% or less than about 10% of the overall horizontal length of the implant **10**, as desired or required. Consequently, one or both of the implant's lateral ends **22**, **26** can be configured to better withstand the bearing forces and moments to which the implant it will be subjected once inserted and secured within a targeted intervertebral space of the patient's spine.

According to some embodiments, a spinal implant is sized to generally span across the entire width of the adjacent vertebral members V. Thus, as discussed above, the lateral walls of the implant can be generally aligned with the load bearing portions of the inferior and superior vertebral members. In some embodiments, as discussed above with reference to FIG. **7**A, the implant contacts the adjacent vertebral members primarily or only along the lateral ends of the implant. Thus, portions of the implant that are interior to the lateral ends of the implant are configured to encounter less or no forces from the adjacent vertebral members.

According to some embodiments, the implant **10** comprises one or more radio-opaque markers **80**. Such markers **80** can facilitate a surgeon or other clinician to properly position the implant within the target intervertebral space, especially when minimally invasive surgery is utilized. By way of example, as illustrated in FIGS. **1**A, **1**B and **2**, the implant **10** can include a total of three tantalum or other types of radiopaque markers **80'**, **80"**. In the depicted arrangement, two markers **80'** are located at or near the lateral ends **22**, **26**, while a third marker **80"** is located at or near the horizontal center of the implant **10**. In one embodiment, the lateral or horizontal location of the middle marker **80"** is exactly between the two lateral markers **80"**. The quantity, type, location, orientation, spacing and/or other details of the markers can be varied, in accordance with the specific requirements of an application or use.

As illustrated in the top view of FIG. **2**, the posterior wall **94** of the implant **10** can include a bump or other reinforced region **95** in order to accommodate the center radio-opaque marker **80"**. In addition to providing additional material that can surround a marker, such bumps **95** or similar features can advantageously improve the implant's strength and/or other structural characteristics.

The various configurations of the implants disclosed herein can include one or more materials. For example, in some embodiments, the implants comprise polyether etherketone (PEEK), other radiolucent materials, other thermoplastics, metals, alloys and/or any other materials having the desired structural (e.g., rigidity), mechanical, chemical and thermal resistance and/or other properties.

As discussed in greater detail herein, the size of the implant can be selected based, at least in part, on the patient's weight, height, age, the amount of intervertebral distraction that the implant should provide and/or any other factor or consideration. For example, in some embodiments, the implant is precisely selected based on the size of the patient's intervertebral space into which the implant will be placed. For instance, the vertical height of the implant can vary between approximately 8 and 14 mm (e.g., 8 mm, 10 mm, 12 mm, 14 mm, values between such ranges, etc.). As noted herein, the vertical height of the implant can be consistent from the anterior end to the anterior end. Alternatively, the vertical height of the implant can vary in one or more horizontal directions (e.g., anterior-posterior direction, lateral direction, etc.).

In some embodiments, the implant includes a concave or other non-planar (e.g., domed, curvate, etc.) upper surface and/or lower surface. Such a configuration can help provide improved contact between the implant and the endplate surfaces of the adjacent vertebrae. Further, the height of the implant can vary along the anterior-posterior direction. For example, in some embodiments, the vertical height of the anterior wall of the implant is approximately 2 mm higher

than the vertical height of the posterior wall. Such a configuration can be advantageously used when performing fusion to a lordotic portion of the spine. Therefore, as noted above, any of the fusion implants disclosed herein can have vertical dimensions that vary along their longitudinal direction. As a result, a variety of different lordotic implants can be provided, such as, for example, 8 mm by 10 mm (e.g., posterior height by anterior height), 10 mm by 12 mm, 12 mm by 14 mm implants and/or the like.

Moreover, the implant can be provided in a variety of horizontal dimensions in order to better accommodate the targeted intervertebral space into which the implant will be inserted and secured. For instance, the length of the implant (e.g., from one lateral end to the other) can vary between 40 mm and 60 mm. In some embodiments, the implant is provided in a variety of different lengths, such as, for example, 40 mm, 45 mm, 50 mm, 55 mm, 60 mm, lengths between the foregoing values, etc. Alternatively, the length of an implant can be greater than 60 mm or smaller than 40 mm, as desired or required. Likewise, the width (e.g., the distance between the anterior and posterior ends) of the implant can vary, both from implant to implant and within a specific implant design. For example, in some embodiments, the width of the implant is between about 19 mm and 21 mm. As discussed above with reference to FIG. **2**, the width can vary along an implant's length. In some embodiments, such a variation in width results from rounded or curved anterior and/or posterior surfaces. Thus, in some embodiments, the implant comprises a width of approximately 21 mm at its longitudinal center (e.g., at or near the location of the middle marker **80"** is located in the arrangement depicted in FIG. **2**) and a width of approximately 19 mm at or near the lateral ends **22**, **26**. The implants can include any other shape, size or orientation, irrespectively of the specific examples provided herein.

Implantation into Targeted Intervertebral Space

The initial surgical steps in preparing a patient for a spinal fusion procedure can include, among other things, making an incision along the patient's skin and accessing a targeted region of the spine (e.g., lumbar region) using one or more dilators, retractors and/or other instruments or tools. Depending on the state of the diseased intervertebral disc or space, one or more preparatory steps may be necessary or recommended prior to delivery of the implant within the patient's anatomy. For example, at least some of the native disc material can be removed in order to provide the necessary space for the subsequent insertion of the implant. In some arrangements, a distraction tool is used to separate the vertebrae between which the implant will be positioned.

Further, the surgeon or other clinician performing the procedure may choose to size the target intervertebral space prior to implantation. For example, such a step can be performed in order to more accurately select a properly sized implant. In addition, a surgeon may choose to prepare one or more native surfaces of the vertebrae that will be adjacent to the implant. For instance, one or more coarsening or abrading tools can be used to selectively roughen one or more portions of the vertebral endplates adjacent to the implant. Under certain circumstances, such a roughening step can promote healing and can accelerate the fusion process following delivery of the implant within the spine.

FIG. **8** illustrates two different arrangements of a distraction and sizing tool **400**A, **400**B that can be used in advance of the delivery of an implant during a spinal fusion procedure. As shown, the distraction and sizing tool **400**A, **400**B can include a proximal handle **410**A, **410**B (which is only partially depicted in FIG. **8**) and a distal head **420**A, **420**B. In the depicted embodiments, the two tools **400**A, **400**B are substantially similar to each other in overall design; however, their distal heads **420**A, **420**B vary in size (e.g., vertical thickness, length, etc.). A plurality of such distraction and sizing tools may be provided to a surgeon in order to allow him or her to determine what type of implant should be inserted into targeted intervertebral space. Such tools **400**A, **400**B can also be used to precisely distract or separate adjacent vertebrae in preparation for implantation.

In some embodiments, the sizing and distraction tool **400**A, **400**B comprises stainless steel, other metals or alloys and/or one or more other rigid material that are adequate for insertion into a patient's anatomy and configured to withstand the anticipated forces, moments and/or other conditions (e.g., pH, temperature, etc.) to which they will be subjected. With continued reference to FIG. **8**, the sizing and distraction tool **400**A, **400**B can include a baseline marker **430**A, **430**B at or near the distal end of the head **420**A, **420**B. In some arrangements, the surgeon can insert the tool's head **420**A, **420**B within the target intervertebral space and advance the tool (e.g., under the guidance of x-ray, ultrasound, fluoroscopy and/or other imaging technology) until the baseline marker **430**A, **430**B exactly or approximately aligns with the peripheral distal edge of the adjacent vertebral bodies. Once the distal end of the head has been aligned, the surgeon can use the proximal markings **440**A, **442**A, **444**A, **446**A, **448**A to determine the appropriate length of the intervertebral space. For example, the length can be determined based on the proximal marking that is closest to the peripheral proximal edge of the adjacent vertebral bodies. Thus, the markings **440**A, **442**A, **444**A, **446**A, **448**A can be visualized using one or more imaging technologies to determine the proper implant size for the targeted intervertebral space.

Likewise, the surgeon can attempt to position tools **400**A, **400**B of varying head thickness into a targeted intervertebral space in order to determine a desired implant height. Accordingly, the sizing and distraction tool **400**A, **400**B can be used to select a well-suited implant for insertion into the patient's spine. In some embodiments, such a tool **400**A, **400**B can be used to create a desired level of vertical distraction within the targeted intervertebral space, especially if the adjacent vertebral bodies are undesirably close to one another (e.g., due to severe disc degeneration and/or disease).

FIG. **9** schematically illustrates one embodiment of a shaver **500** configured to selectively rasp, abrade and/or otherwise compromise or remove tissue. In some arrangements, the shaver **500** is inserted into an intervertebral space to remove disc tissue and/or prepare the vertebral endplate surfaces for the subsequent delivery of a spinal implant. As shown, the shaver **500** can comprise an abrading assembly **520** positioned along a distal end of a longitudinal shaft **510**. The abrading assembly **520** can include a center or main portion **534** located between a pair of tapered outer portions **530**A, **530**B. In some embodiments, the center portion **534** comprises one or more abrading members **540** that are adapted to contact and at least partially remove, abrade or otherwise affect tissue. Thus, as the shaft **510** is rotated about a longitudinal axis **514**, the abrading member **540** can help remove native disc tissue and/or attack the endplate wall in preparation for the subsequent implantation of the fusion device. In some embodiments, as illustrated in FIG. **9**, the shaver **500** comprises tapered or lower profile outer portions **530**A, **530**B so as to reduce or prevent damage to the peripheral bearing areas B of the vertebral members V (see FIG. **7**A). By avoiding or reducing the likelihood of

damage to these native load bearing portions B of adjacent vertebrae, the structural integrity of the patient's spine, and thus the fusion procedure, can be maintained.

A different embodiment of a shaver instrument **550** is schematically illustrated in FIGS. **10**A and **10**B. As shown, the shaver **550** comprises a main portion **560** that is shaped, sized and otherwise configured for delivery into a targeted intervertebral space. The upper and lower surfaces of the main portion may or may not include teeth or other engaging features or members. In some arrangements, the main portion **560** includes a central chamber or other opening **570** that generally extends from the top to the bottom surface of the main portion **560**. As depicted in FIG. **10**A, an access port or opening **564** can provide access from a lateral side of the main portion **560** to the interior of the central chamber **570**. An abrading assembly **590** can be positioned along the distal end of an elongated member **580**. The elongated member **580** can be sized, shaped and otherwise adapted for passage through the access port **564** of the main body. Likewise, the abrading assembly **590** can be configured for placement within the chamber **570** of the main portion **560**. According to some embodiments, the abrading assembly **590** is configured for selective movement within the central chamber **570** as the elongated member **580** is rotated about a longitudinal axis **582**.

With continued reference to FIG. **10**B, the abrading assembly **590** can comprise a generally horizontal configuration. As shown, the abrading assembly **590** can include one or more lateral wing portions **592** positioned on either side of the elongated member **580**. In some embodiments, the outer surface **594** of each wing portion **592** can include one or more abrasive members or features **596** that are adapted to contact and at least partially remove or damage tissue. In some arrangements, the abrading assembly **590** is fully retained within the central chamber **570** when in the illustrated low profile or stowed orientation. Thus, the shaver **550** can be delivered to the patient's spine without interference by the abrading assembly **590**. Once properly positioned within the target intervertebral space, the surgeon or other clinician can selectively rotate the elongated member **580** to move the distal wing portions **592** toward the adjacent tissue (e.g., native disc tissue, endplate surfaces, etc.). Thus, continued and repetitive rotation of the abrading assembly **590** can cause a desired amount of abrasion to the adjacent vertebral members in preparation for delivering the implant device to the intervertebral space. In some embodiments, the central chamber **570** of the shaver **550** generally aligns with a central portion of the adjacent vertebrae between the peripheral bearing areas B (FIG. **7**A). Thus, damage to the load bearing areas B of the vertebrae can be reduced or avoided, as the abrading assembly **590** will be generally confined to a limited central portion of the adjacent vertebral members. Consequently, as noted above, the structural integrity of the adjacent bearing areas of the vertebral members can be advantageously maintained.

FIG. **11** illustrates a perspective view of a spinal implant **10**, identical or similar to those disclosed herein, secured to a distal end of an insertion tool assembly **300** according to one embodiment. An exploded view of the insertion tool assembly **300** of FIG. **11** is provided in FIG. **12**A. As shown in FIGS. **11** and **12**A, the insertion tool **300** can include an outer elongated member **310** having a distal end **312** that is adapted to releasably engage a spinal implant **10**. In some embodiments, the distal end **312** of the outer elongated member **310** comprises a pair of wings or tabs **314** that are sized, shaped and otherwise configured to engage corresponding recesses or slots **28** (FIG. **1**A) of an implant **10**.

With continued reference to FIGS. **11** and **12**A, the outer elongated member **310** can include an inner passage **316** that extends from the proximal end **320** to the distal end **312** of the insertion tool assembly **300**. Thus, in some embodiments, the outer elongated member **310** is cannulated. The proximal portion **320** of the assembly **300** can include a handle **322** and a flared end **328**. According to some embodiments, the outer elongated member **310** includes one or more windows **324** at or near the handle. As discussed in greater detail below, such a window can permit access to a thumbwheel or other movable control member that daylights or is exposed through the window **324**.

As depicted in FIGS. **11** and **12**A, the outer elongated member **310** can be configured to slidably receive a threaded rod **340** within its inner passage or opening **316**. In some embodiments, the threaded rod **340** comprises a main elongated portion **344** having a threaded distal end **346**. The threaded distal end **346** can be shaped, sized and otherwise adapted to engage a corresponding port **50** of a spinal implant (FIG. **1**A). A partial cross-sectional view of such threaded engagement between the distal end **346** of the rod **340** and the port **50** of the implant **10** is illustrated in FIG. **12**B. When the main elongated portion **344** is properly inserted within the cannulated opening of the outer member **310**, the threaded distal end **346** can extend through the distal end of the opening **316**, generally between the wings or tabs **314** of the outer member **310**.

As depicted herein, the proximal end of the threaded rod **340** can comprise a generally cylindrical thumbwheel **348** that includes a larger diameter than the adjacent main elongated portion **344**. According to some embodiments, at least a portion of the thumbwheel **348** is accessible through the window(s) **324** of the outer elongated member **310** when the insertion tool assembly **300** is properly assembled for use. Thus, a surgeon or other clinician can selectively rotate the thumbwheel **348** while grasping the insertion tool assembly **300** to either engage or release the implant from the assembly's distal end. The thumbwheel **348** can include a plurality of longitudinal grooves **349** and/or other features that can facilitate rotation of the threaded rod relative to the outer elongated member **310**.

With continued reference to FIGS. **11** and **12**A, a hammer or strike pad **360** can be secured to the proximal end of the outer elongated member **310** once the threaded rod **340** has been properly positioned therein. According to some embodiments, the hammer pad **360** includes distal threads **366** or other engagement features that are configured to engage corresponding threads or features of the outer elongated member **310**. Thus, the hammer pad **360** can be releasably attached to the outer elongated member **310**.

Once the targeted intervertebral space has been prepared (e.g., in accordance with a desired or required protocol), a spinal implant **10** can be secured to the distal end **312** of the insertion tool assembly **300**. For example, as discussed above, the threaded distal end **346** of the rod **344** can threadably secure to the access port or opening **50** along a lateral end of the implant **10**. Further, the tabs or wings **314** of the outer elongated member can engage corresponding recesses **28** of the implant **10**. The insertion tool assembly **300** and the implant **10** can include one or more other types of corresponding mating or engaging features or members, either in lieu of or in addition to those disclosed herein.

Once the implant has been properly secured to the distal end of the insertion tool assembly **300**, the surgeon or other clinician can drive the implant **10** into the targeted intervertebral space. In some embodiments, the insertion tool assembly **300** can be advanced into the anatomy (e.g., against any

resistive forces) by impacting the proximal end of assembly **300** with a slap hammer assembly **380**, a mallet or any other tool or instrument. The implantation procedure can be performed under real-time visualization in order to ensure that the implant is properly advanced and positioned.

The various components of the insertion tool assembly **300** disclosed herein, including the outer elongated member **310**, the threaded rod **340** and the hammer pad **360**, can comprise one or more rigid materials, such as, for example, hardened stainless steel, other types or grades of steel, titanium, other metals or alloys, composites, other natural or synthetic materials and/or the like. Such components can be reusable (e.g., sterilizable) or disposable, as desired or required.

Filling of the Implant

Once the implant has been properly positioned within the targeted intervertebral space, the internal chamber(s) of the implant can be at least partially filled with one or more grafting materials, other fill materials and/or the like. For example, the various materials that can be delivered to the internal chamber(s) of an implant include, but are not limited to: bone forming cells, demineralized bone matrix (DBM), bone morphogenetic protein (BMP), collagen matrix, bone cement, other flowable grafting agents or materials, flaky or other non-flowable grafting agents or materials, other biological or non-biological materials or substances and/or any other grafting or filler material.

As noted herein, in some embodiments, the implant is at least partially prefilled with one or more grafting agents, other fillers and/or any other material or item prior to implantation. For example, in some arrangements, a sponge, foam, other porous structure or member or other absorbent member is positioned within the implant's chamber prior to advancing the implant within the anatomy. Such an absorbent member can initially include one or more graft materials and/or can be configured to absorb or otherwise retain graft materials that are delivered into the chamber after the implant has been positioned with the targeted intervertebral space. In other arrangements, one or more graft materials and/or other fill materials can be provided in solid or partially-solid form within the implant's internal chamber(s) prior to implantation. Regardless of what items or materials are positioned within the implant prior to its delivery within a patient's spine, one or more internal prongs **74** (FIG. **2**), other protruding members and/or other retaining features can be used to securely maintain such items or materials within the implant. As discussed herein, such prongs or other protruding members are configured to engage and retain materials contained within an internal chamber or cavity of the implant after such materials have at least partially solidified or cured.

According to some embodiments, once the spinal implant has been properly implanted, the insertion tool assembly **300** (FIGS. **11** and **12**A) is decoupled from the implant and the assembly **300** is removed. In some embodiments, a fill tool assembly is subsequently inserted into anatomy in order to engage the implant and selectively deliver graft and/or other types of materials into the implant's internal chamber. Such a fill tool assembly can include a catheter, tube, syringe and/or other conduit that is sized, shaped and otherwise adapted to be positioned through one or more ports of the implant. As discussed in greater detail herein, such a port **50** can be identical to the port that is also used to secure the implant to the distal end of a delivery tool during delivery of the implant within the patient's anatomy. One embodiment of a kit **600** that comprises, among other things, a fill tool assembly **610** is illustrated in FIG. **13**.

As illustrated in FIG. **13**, a fill kit **600** can include one or more of the following items: a fill tool assembly **610**, a coupler **640**, a syringe assembly S, a mixing tray T, a container of graft or other fill material G and/or the like. As noted above, the graft and/or other types of fill materials can be selected by the surgeon or other clinician according to a desired or required protocol or procedure. The mixing tray T can be used to combine, mix, dilute or otherwise process the various graft and/or other fill materials that will be selectively transferred within or near the implant. The various components included in the kit **600** can be disposable or reusable, as desired or required. Thus, such components can include one or more rigid, semi-rigid and/or flexible materials, including metals or alloys (e.g., stainless steel), polymeric or thermoplastic materials, rubber or other elastomeric materials, composites, other natural or synthetic materials and/or the like.

According to some embodiments, as depicted in FIG. **13**, the fill tool assembly **610** includes an elongated cannulated shaft **614** that terminates in a distal end **620**. The distal end **620** can include a discharge opening **616** that is in fluid communication with the internal passage of the shaft **614**. Further, the distal end **620** of the fill tool assembly **610** can comprise one or more tabs or wings **622** that are sized, shaped and otherwise configured to engage corresponding recesses **28** or other features of the implant **10** (FIG. **1**B). Although such tabs **622**, wings or other alignment features are not necessary, they can provide assurance that the fill tool assembly has been properly positioned relative to the implant in anticipation of the subsequent filling steps. The proximal end **630** of the fill tool assembly **610** can include a handle. In the depicted embodiment, the proximal end **630** comprises a number of ring shaped portions. One embodiment of a fill tool assembly **610** aligned and engaged with an implant **10** that has been properly secured within a targeted intervertebral space is illustrated in FIG. **14**.

With continued reference to FIG. **13**, graft or other fill materials can be loaded into a syringe **650** of a syringe assembly S. As shown, the syringe **650** can include a barrel portion **652** into which the graft and/or other fill materials are placed. Further, the syringe **640** can include a plunger **658** that can be selectively advanced within the barrel **652** in order to help urge the graft and/or other fill materials out of the distal exit opening **654** of the syringe **650**. In addition, the syringe can include a pair of grasping members **656** to facilitate handling and manipulation during use. Further, one or more mechanical tools can be used to assist the surgeon or other clinician in slidably displacing the plunger or similar movable member within the barrel. The use of such syringe/plunger configurations can be particularly helpful when transferring graft and/or other fill materials that are relatively thick, dense, concentrated, viscous or otherwise difficult to move.

As shown in the exploded view of FIG. **13**, a discharge coupling **660** can be used to attach the distal end of the syringe **650** to a length of flexible catheter, tubing or other conduit **670**. In some embodiments, the tubing **670** is cable-lined and/or otherwise reinforced to reduce the likelihood of kinking during use. Such cable-lined tubing can also be used to confirm its location within the anatomy during use, as the cable lining can be visualized using one or more visualization technologies. The coupling **600** can be permanently or removably secured to the syringe **650** and/or the tubing **670** using one or more types of connection methods or devices, such as, for example, luer connections, threaded connections, friction fit or press fit connections, other types of fasteners, adhesives and/or the like. A per-

spective view of one embodiment of a fully-assembled syringe assembly S is illustrated in FIG. **15**.

According to some embodiments, the flexible tubing or other conduit **670** and/or other components of the syringe assembly S retain the same characteristics, irrespective of the type of spinal implant that will be filled. For example, the length of the tubing **670** and coupling can be maintained consistent or substantially consistent in all kits **600**. Thus, in some embodiments, a coupler **640** can be used to ensure that a volume of graft and/or fill material is adequately, accurately and consistently delivered to the implant.

As illustrated in FIG. **13**, the coupler **640** can be configured to receive and engage the proximal end of the fill tool assembly **610** through its distal opening **642**. Likewise, the coupler **640** can receive and engage a distal end of the syringe assembly S through its proximal opening **644**. In some arrangements, the coupler **640** is selected based on the size and/or type of spinal implant that will be filled. Such a configuration can help ensure that the distal end of the syringe assembly's tubing, catheter or other conduit **670** is properly positioned within the implant's internal chamber at the initiation of the graft filling stage. For example, according to some embodiments, the coupler **640** is generally longer for the filling of smaller (e.g., shorter) implants, and generally shorter for the filling of larger (e.g., longer) implants. A kit **600** can be provided with a number of differently sized couplers **640** from which a clinician can choose (e.g., depending on the type of implant that will be at least partially filled). Further, the couplers **640** can include a size identifier **646**, such as, for example, the length of the implant to be filled.

FIGS. **16**A-**16**C illustrate three time-sequential steps performed in preparation for a post filling procedure, in which grafting and/or other fill materials are delivered within an interior portion of a spinal implant following implantation. In FIG. **16**A, the fill tool assembly **610** has been properly secured to the implant **10**. For example, as noted above, the tabs or wings along the distal end of the fill tool assembly **610** can be aligned with and mated with corresponding recesses of the implant. As shown, a properly selected coupler **640** can be positioned along the proximal end of the fill tube assembly **610**. In some arrangements, one or more engagement members or features are positioned within the distal end of the coupler **640** to ensure that the proximal end of the fill tube assembly **610** has been properly positioned therein.

Next, as illustrated in the side view of FIG. **16**B, the syringe assembly S is inserted within and advanced (e.g., in a direction generally represented by arrow A) relative to the coupler **640** and the fill tool assembly **610**. FIG. **16**C shows the syringe assembly S advanced to its full distal position relative to the coupler **640**. Accordingly, in some embodiments, if the appropriately sized coupler **640** was used, the distal end of the tubing should be properly positioned within the chamber of the implant **10**. Accordingly, the coupler assists the surgeon to accurately position the distal end of the conduit or other tubing within an internal chamber, along a specific longitudinal location of the implant. Thus, the surgeon can reliably and confidently begin injecting the graft and/or other filler materials loaded into the syringe **650** into a chamber or other interior portion of the implant **10**.

According to some post fill arrangements, the surgeon can select a desired volume of graft and/or other filler materials that will be transferred to the chamber of the implant **10** according to his or her own requirements and protocols. In some embodiments, the maximum internal volume of each type of implant is provided to the clinician in corresponding printed literature, on the implant itself, using graduation marks on the syringe and/or the like.

According to some embodiments, the surgeon or clinician continues to inject the graft and/or other filler material into the interior chamber of the implant by manipulating the syringe plunger and/or by actuating some other mechanical device (e.g., hand-operated ratchet, other motorized device, etc.) that facilitates much manipulation of the plunger. The surgeon can choose to slowly, either incrementally or continuously, retract the syringe assembly S, and thus the distal end of the tubing, catheter or other conduit, while the graft and/or other fill material is delivered to the implant **10**. This can facilitate and promote more even distribution of the graft and/or fill material within the internal chamber. In some embodiments, the syringe barrel, the coupler and/or any other component or features of the syringe assembly S comprise graduation marks or other indicia to assist the clinician in determining how much and/or at what rate to retract the tubing during use.

In some arrangements, the amount of graft and/or other fill materials delivered to the implant generally exceeds the internal capacity of the chamber. Thus, at some point, excess graft and/or other fill material G can be expected to begin discharging out of one or more implant openings **60** (e.g., openings located along anterior wall of the implant). This is illustrated in the embodiment depicted in FIGS. **17**A and **17**B. As noted above, in some embodiments, the posterior wall of the implant does not comprise any openings. Further, excess graft and/or other fill material can also be directed at the upper and/or lower interfaces of the implant and the adjacent vertebral endplate surfaces. According to some arrangements, as discussed herein, the orientation of the teeth or other engagement members along the upper and/or lower surfaces of the implant can help prevent, reduce the likelihood of and/or slow down the flow of excess graft and/or other fill material across the implant-endplate interfaces.

According to some embodiments, excess graft and/or other fill material G can generally fill any gap that exists between the vertebral endplates and the adjacent surfaces of the implant. This can result in improved spinal fusion. Further, spinal fusion can benefit from the excess graft and/or other fill material that exits through the openings **60** along the anterior wall of the implant **10**. As illustrated in the embodiment of FIGS. **17**A and **17**B, such material G can fill any gaps that exist between the implant and the remaining disc material and/or other tissue along the anterior end of the spine. For example, excess graft and/or other fill material G can at least partially cover the anterior face of the implant, can span the vertical gap between adjacent vertebral V endplates along the anterior side of the implant and/or can migrate to other portions along the anterior end and/or the lateral ends of the implant to help improve fusion. As noted above, similar openings along the posterior wall of the implant can be eliminated in order to prevent or reduce the likelihood of excess graft and/or other fill materials from migrating to nerve roots, the spinal cord and/or other sensitive portions of the patient's spine.

According to some embodiments, as illustrated in the partial cross sectional view of FIG. **18**, the threaded rod **340'** of the insertion tool assembly **300'** can be cannulated. Thus, the insertion tool **300'** can be used to both deliver the implant to its proper intervertebral position and to subsequently fill the interior chamber(s) of the implant **10** with one or more graft and/or other fill materials. For example, in the depicted arrangement, the internal passage **341'** of the cannulated threaded rod **340'** can be sized, shaped and otherwise con-

figured to receive a flexible tube, catheter or other conduit of a syringe assembly. Accordingly, the need to disengage the implant **10** from the distal end of the insertion tool assembly **300'** and engage a separate fill tool assembly (as discussed herein with reference to several embodiments) can be eliminated. Instead, the insertion tool assembly **300'** can remain engaged to the implant **10** while a fill tube or other conduit is inserted within the internal passage **341'** of the cannulated rod **340'**. Once the desired or required amount of grafting agents and/or other fill materials has been transferred to the implant, the fill conduit and the insertion tool assembly can be removed from the patient anatomy. In some embodiments, the hammer or strike plate **360** (FIG. **12**A) can include a corresponding opening through which the tubing can be routed to reach the passage **341'** of the cannulated rod **340'**. Accordingly, the cannulated rod **340'**, as with any other components of the insertion tool and/or fill assemblies, can be disposable.

As discussed in relations to several embodiments disclosed herein, a spinal fusion procedure can comprise an initial implant delivery step followed by a subsequent filling step. Thus, in some embodiments, the implant is delivered within the patient's anatomy with its internal chambers or cavities either empty or only partially filled with grafting agents, other filler materials and/or other components. For example, as discussed above, an implant can comprise a porous foam, a sponge and/or one or more other absorbent devices or materials prior to its delivery within a target intervertebral space. In such an embodiment, no other materials (e.g., grafting agents, other filler materials, etc.) are present within the implant prior to or during delivery of the implant. In other arrangements, an interior chamber or other cavity of the implant is only partially filled with graft and/or other filler materials prior to or during delivery to the target interbody space.

In accordance with the various embodiments and examples disclosed herein, one or more biological and/or non-biological grafting and/or other fill materials can be injected or otherwise delivered within or near the implant following implantation. Such a procedure can help ensure that grafting and/or other filler materials are not lost during the delivery of the implant within the patient (e.g., due to hammering or other impact forces imparted on the implant during such delivery protocols). Further, by delivering excess fill materials within or near the implant, as discussed herein, more enhanced fusion of the implant to adjacent spinal surfaces (e.g., endplate surfaces) can be advantageously provided.

Yet another embodiment of a spinal implant **1100** is illustrated in FIGS. **19-21**. As shown, the implant **1100** can include top and bottom surfaces **1112**, **1114** having one or more teeth **1122** and/or other features configured to engage corresponding portions of the patient's vertebral members (e.g., adjacent endplate surfaces). In addition, as discussed herein with respect to other embodiments, the depicted implant **1100** comprises one or more anterior holes or openings **1134***a*, **1134***b* through which excess grafting and/or other filler materials can exit the interior chambers or cavities **1116***a*, **1116***b* of the implant **1100**. Further, in some embodiments, the posterior wall of the implant does not comprise any openings, thereby preventing or reducing the likelihood that excess grafting and/or other fill materials will move in that direction.

With continued reference to FIGS. **19** and **20**, as with any embodiments disclosed herein, the implant **1100** can comprise one or more interior walls **1132** or baffles that divide an interior chamber or cavity into two or more areas. In some embodiments, such separate interior chambers, cavities or areas **1116***a*, **1116***b* can be in fluid communication with one another via one or more openings **1134** or other orifices within the interior wall or baffle **1132**. However, in some embodiments, an implant does not comprise any interior walls or baffles. Thus, an implant can include only a single relatively large interior chamber or cavity, while maintaining a desired load bearing capacity and other structural design criteria.

As with other embodiments disclosed herein, the implant **1100** can be advantageously sized, shaped and otherwise configured to span or extend across the entire or substantially the entire width of the inferior and superior vertebral members between which it is to be placed and secured. Further, the lateral ends **1118**, **1120** of the implant **1100** can comprise relatively large walls that generally coincide with load bearing portions of the adjacent vertebral members (see, for example, FIGS. **7**A and **21**).

As noted herein with regards to other implant arrangements, the depicted implant **1100** can comprise one or more ports **1136** along one or more of its surfaces. For example, as illustrated in FIGS. **19-21**, a single port **1136** can be provided along one of the lateral side walls of the implant **1100**. As discussed in greater detail herein, such a port **1136** can be configured to receive an implant delivery tool (e.g., to assist a surgeon in moving the implant through the patient's anatomy to a target intervertebral space) and/or to pass one or more fill tubes or conduits for post-filling, at least partially, an interior chamber or cavity of the implant with grafting agents and/or other fill materials. In any of the implant embodiments disclosed herein, or equivalents thereof, such a port that can serve a dual purpose related to implant positioning and graft delivery can be located along any side wall (e.g., lateral, anterior, posterior) of the implant.

In addition, as illustrated in FIG. **20**, a cap or other sealing member **1138** can be secured to the port **1136**. Such a cap **1138** can help ensure that grafting and/or filler materials delivered or otherwise positioned within the interior of the implant do not escape through the port **1136**. In other embodiments, the port can comprise one or more valves or other flow blocking members to help reduce the inadvertent escape of materials from the interior of the implant.

With reference to the side cross-sectional view of FIG. **21**, the implant port can be sized, shaped and otherwise configured to receive a fill tube or other conduit **1200**. Such a fill tube **1200** can be passed through the port and into one or more interior chambers or other cavities of the implant **1100**. As shown, a distal end **1220** of the fill tube **1200** can be angled so that the outlet **1212** is oriented generally perpendicular to the axis A of the port and the fill tube **1200**. In other embodiments, the face of the outlet **1212** can be oriented along a different angle (e.g., between 0 and 90 degrees relative the longitudinal axis A), as desired or required. In some embodiments, a plunger assembly **1206** can be positioned within the fill tube or can be operatively coupled to it. Accordingly, such a plunger assembly **1206** can be selectively actuated in order to provide the necessary driving force to move grafting material G through the tube **1200** and into an interior area of the implant.

According to some embodiments, as illustrated in FIG. **21**, the top and/or bottom surfaces of a spinal implant can be generally curved or rounded. In such arrangements, the curvature of the top and/or bottom surface can be configured to match or generally align with the shape of the adjacent endplates E or other native tissue of the patient. However, as discussed above with reference to the implant embodiment

illustrated in FIGS. **1**A and **1**B, the top and/or bottom surfaces can be generally planar.

To assist in the description of the disclosed embodiments, words such as upward, upper, bottom, downward, lower, rear, front, vertical, horizontal, upstream, downstream have been used above to describe different embodiments and/or the accompanying figures. It will be appreciated, however, that the different embodiments, whether illustrated or not, can be located and oriented in a variety of desired positions.

Although the subject matter provided in this application has been disclosed in the context of certain specific embodiments and examples, it will be understood by those skilled in the art that the inventions disclosed in this application extend beyond the specifically disclosed embodiments to other alternative embodiments and/or uses of the subject matter disclosed herein and obvious modifications and equivalents thereof. In addition, while a number of variations of the inventions have been shown and described in detail, other modifications, which are within the scope of these inventions, will be readily apparent to those of skill in the art based upon this disclosure. It is also contemplated that various combinations or subcombinations of the specific features and aspects of the embodiments may be made and still fall within the scope of the inventions disclosed herein. Accordingly, it should be understood that various features and aspects of the disclosed embodiments can be combine with or substituted for one another in order to form varying modes of the disclosed inventions. Thus, it is intended that the scope of the subject matter provided in the present application should not be limited by the particular disclosed embodiments described above, but should be determined only by a fair reading of the claims that follow.

What is claimed is:

1. A method of promoting spinal fusion within a spine of a patient, comprising:

advancing an implant through an anatomy of a patient, the implant comprising at least one internal chamber defined by peripheral walls of the implant, wherein the implant comprises at least one access port extending through at least one of the peripheral walls of the implant;

wherein the implant is advanced through an anatomy of a patient using an insertion tool;

positioning the implant between a first vertebra and a second vertebra of a patient, the first and second vertebrae being immediately adjacent to one another;

directing graft material into the at least one internal chamber of the implant through the at least one access port to fill the at least one internal chamber of the implant, after positioning the implant between the first and second vertebrae, such that the graft material is in flush contact with endplate surfaces of each of the first and second vertebrae, and wherein the graft material is contained within the at least one internal chamber;

wherein the at least one internal chamber of the implant, after implantation, extends from or near an endplate of the first vertebra to or near an endplate of the second vertebra such that the graft material directed into the at least one internal chamber can be substantially retained between the first and second vertebrae; and

withdrawing the insertion tool from the anatomy of the patient, leaving the implant situated between the first and second vertebrae.

2. The method of claim **1**, wherein the implant is advanced through the anatomy of a patient and positioned between the first and second vertebrae using a lateral approach.

3. The method of claim **1**, wherein the implant is advanced through the anatomy of a patient and positioned between the first and second vertebrae using a transforaminal approach.

4. The method of claim **1**, wherein the implant is advanced through the anatomy of a patient and positioned between the first and second vertebrae using an anterior approach.

5. The method of claim **1**, wherein the implant is advanced through the anatomy of a patient and positioned between the first and second vertebrae using a posterior approach.

6. The method of claim **1**, wherein directing the graft material into the at least one internal chamber comprises using a graft material delivery system, the graft material delivery system comprising a conduit, wherein a volume of graft material is configured to be delivered to the at least one internal chamber of the implant via the conduit.

7. The method of claim **6**, wherein directing the graft material into the at least one internal chamber comprises passing the conduit through the at least one access port of the implant to position the conduit within the at least one internal chamber of the implant.

8. The method of claim **6**, wherein the graft delivery system further comprises a plunger assembly configured to be positioned and moved within the conduit, the method further comprising actuating the plunger assembly to provide the necessary driving force to move a volume of graft material through the conduit and into the at least one internal chamber of the implant.

9. The method of claim **1**, wherein graft material is directed into the at least one internal chamber of the implant so that at least a volume of excess graft material exits the at least one internal chamber of the implant through at least one opening along a peripheral wall of the implant.

10. The method of claim **1**, wherein graft material is directed into the at least one internal chamber of the implant so that at least a volume of the graft material delivered into the at least one internal chamber exists through an interface between an endplate surface of the first or second vertebra and an upper or lower surface of the implant.

11. A method of promoting spinal fusion within a spine of a patient, comprising:

advancing an implant through an anatomy of a patient, the implant comprising at least one internal chamber;

positioning the implant between a first vertebra and a second vertebra of a patient, the first and second vertebrae being immediately adjacent to one another; and

directing graft material into the at least one internal chamber of the implant through an access port of the implant to fill the at least one internal chamber of the implant, after positioning the implant between the first and second vertebrae, such that the graft material is in flush contact with endplate surfaces of each of the first and second vertebrae, and wherein the graft material is contained within the at least one internal chamber;

wherein the at least one internal chamber of the implant, after implantation, extends from or near an endplate of the first vertebra to or near an endplate of the second vertebra such that the graft material directed into the at least one internal chamber can be substantially retained between the first and second vertebrae.

12. The method of claim **11**, wherein the implant is advanced through the anatomy of a patient and positioned between the first and second vertebrae using a lateral approach.

13. The method of claim 11, wherein the implant is advanced through the anatomy of a patient and positioned between the first and second vertebrae using a transforaminal approach.

14. The method of claim 11, wherein the implant is advanced through the anatomy of a patient and positioned between the first and second vertebrae using an anterior approach.

15. The method of claim 11, wherein the implant is advanced through the anatomy of a patient and positioned between the first and second vertebrae using a posterior approach.

16. The method of claim 11, wherein directing the graft material into the at least one internal chamber comprises using a graft material delivery system, the graft material delivery system comprising a conduit, wherein a volume of graft material is configured to be delivered to the at least one internal chamber of the implant via a conduit.

17. The method of claim 16, wherein directing the graft material into the at least one internal chamber comprises passing the conduit through the access port of the implant to position the conduit within the at least one internal chamber of the implant.

18. The method of claim 16, wherein the graft delivery system further comprises a plunger assembly configured to be positioned and moved within the conduit, the method further comprising actuating the plunger assembly to move a volume of graft material through the conduit and into the at least one internal chamber of the implant.

19. The method of claim 11, wherein graft material is directed into the at least one internal chamber of the implant so that at least a volume of excess graft material exits the at least one internal chamber of the implant through at least one opening along a peripheral wall of the implant.

20. The method of claim 11, wherein graft material is directed into the at least one internal chamber of the implant so that at least a volume of the graft material delivered into the at least one internal chamber exists through an interface between an endplate surface of the first or second vertebra and an upper or lower surface of the implant.

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