(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
07 November 2019 (07.11.2019)

WIPO | PCT

(10) International Publication Number
WO 2019/213073 A1

(51) International Patent Classification:
A61F 2/40 (2006.01) *A61F 2/46* (2006.01)
A61F 2/30 (2006.01)

(21) International Application Number:
PCT/US2019/029905

(22) International Filing Date:
30 April 2019 (30.04.2019)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/664,909 30 April 2018 (30.04.2018) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,

(54) Title: INSET/ONLAY GLENOID, POROUS COATED CONVERTIBLE GLENOID, AND HUMERAL HEADS WITH TEXTURED UNDERSIDES

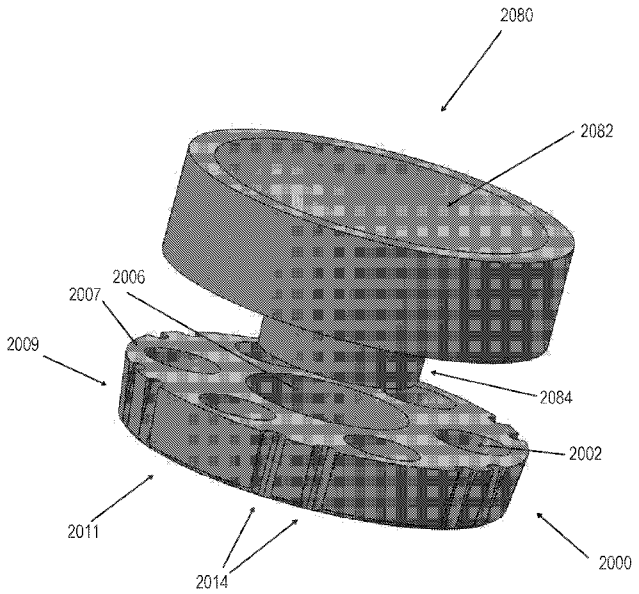

FIG. 23A

(57) Abstract: Disclosed are prosthesis systems and methods that provide porous fixation rings by which the articulating surfaces of the implant can be exchanged such that the anatomic surfaces can be converted to reverse surfaces, while not exchanging the fixation components. Also disclosed herein are methods by which the surgeon can implant an inset anatomic articulating glenoid implant whereby at a later date, can remove the anatomic articulating surface and replace it with a reverse articulating surface such that the primary means of fixation remains well fixed in the glenoid fossa at the moment of articular exchange.

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MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

— *with international search report (Art. 21(3))*

INSET/ONLAY GLENOID, POROUS COATED CONVERTIBLE GLENOID, AND HUMERAL HEADS WITH TEXTURED UNDERSIDES

[0001] This application claims the benefit under 35 U.S.C. § 119(e) as a nonprovisional of U.S. Prov. App. No. 62/664,909 filed on April 30, 2018, which is hereby incorporated by reference in its entirety.

BACKGROUND

[0002] Shoulder Replacement is a commonly performed medical procedure for treatment of osteoarthritis, rheumatoid arthritis, as well as for treatment of certain deformities related to oncological indications as well as trauma. There are two primary types of articulations available to surgeons for treatment: anatomic and reverse. With anatomic, the surgeon replaces the articular surfaces with industrial materials such that the articulating surfaces are substantially the same shape as the natural anatomy. A stem can be commonly fixed inside the canal of the humerus, a metallic articular head can be rigidly fixed to the proximal aspect of the same, the articular head having a convex articular surface adapted to articulate with the glenoid implant. The glenoid implant can include on its back side (medial side) certain pegs or posts or fins adapted to be rigidly fixed within the glenoid fossa of the scapula and on its front side a concave or flat articular surface adapted to articulate with the humeral head of the humeral implant.

[0003] When a reverse prosthesis is used, the articular surface is reversed in that the metallic ball is rigidly fixed to the glenoid fossa of the scapula, and the concave articular surface is rigidly fixed to the humeral bone, thereby reversing the fashion of articulation of the prosthesis.

[0004] The surgeon chooses between the two types of prostheses by assessing a number of conditions of the patient including level of pain, patient activity level, deformity or severity of the boney degradation, the strength of surrounding soft tissues, and present or absence of prior surgery, and particularly the health and strength of the rotator cuff muscle and tendon. Disease of the rotator cuff is common among patients with arthritis of the

shoulder. In this circumstance, it is commonly observed that the absence of insufficiency of the rotator cuff leads to a condition where the anatomic shoulder replacement prosthesis is not sufficiently stabilized by surrounding soft tissue. In this case, a reverse shoulder replacement prosthesis can be preferred in some cases due to the higher inherent stability of the articulation. In addition, the reverse prosthesis can advantageously utilize the remaining muscles in a way they can be more effective in the absence of the other soft tissue structures by adjusting the position of the articular surfaces within the joint.

[0005] It is not uncommon that a surgeon selects to use an anatomic prosthesis and is provides effective treatment to the patient though the shoulder replacement operation. However, over time and during use of the prosthesis, the patient's rotator cuff complex can become insufficient, tear, or generally be diseased such that it can no longer perform its function associated with normal joint kinematics. In this case, the surgeon can elect to perform a second operation to remove the anatomic prosthesis, and replace the anatomic prosthesis with a reverse prosthesis.

[0006] Several attempts have been made to attempt to address the need of conversion of the articular surface without interruption of the fixation. Primarily, these are created using a two (or more) system, where there is a metallic fixation component which is rigidly fixed to the glenoid fossa, and a polyethylene (PE) articular component which is secondarily fixed to the metallic component, and provides the concave articular surface adapted to articular with the humeral prosthesis. While referred to herein as a PE component, some embodiments do not require the use of polyethylene and can be made of other biocompatible materials depending on the desired clinical result. The PE component is commonly fixed to the metallic fixation component by conventional industrial techniques such as snap fit mechanisms, snap rings, compression pins, overmolding of the PE and other such means.

[0007] A challenge of this particular articulation in some cases is that the glenoid fossa is relatively small, and commonly there is much reduced presence of bone in patients with arthritis. In this context, the surgeon has limited positioning and bone to work with in order to fit within the patient. In addition, the surgeon must be careful not to overstuff the joint, meaning implant components that move the new articulating surface far from its

original position such that the soft tissues is unnaturally tensioned, which can lead to instability, accelerated where, soft tissue failure, pain, reduced range of motion, or fracture of the prosthesis and surrounding bone. Facing these conditions, the prosthesis typically needs to be designed to remain relatively thin (commonly, 1 piece, where PE glenoid implants typically have a 4mm thick articular surface). In order to design these modular components, there can be little additional packaging space provided into which to fit the attachment mechanisms necessary for use without adversely affecting the performance of the overall joint replacement procedure. Thus, typically, these designs lead to "over-optimization" of the fixation and articular portions in order to provide sufficient attachment mechanisms such that either: the PE is too thin to be sufficiently strong, the metallic components are too small to provide sufficient fixation, or the overall mechanism is insufficiently rigid causing there to be secondary wear surfaces, and generation of wear particles leading to PE disease.

[0008] A problem that can exist is that in the case where the surgeon wants to change the prosthesis type, the anatomic prosthesis is commonly well fixed and adapted to the patient's body such that removal of the prosthesis can be very destructive, and leave natural bone remaining that is perhaps insufficient to support the fixation of the reverse prosthesis. What is needed is a prosthesis system that provides a means by which the articulating surfaces of the implant can be exchanged such that the anatomic surfaces can be converted to reverse surfaces, while not exchanging the fixation components.

[0009] What is also needed is a simple means by which the surgeon can implant an inset anatomic articulating glenoid implant whereby at a later date, can remove the anatomic articulating surface and replace it with a reverse articulating surface such that the primary means of fixation remains well fixed in the glenoid fossa at the moment of articular exchange.

[0010] In some embodiments, disclosed herein is a method of performing a reversible anatomic shoulder replacement procedure. The method can include any number of: reaming a cavity into the glenoid; and inserting an anatomic glenoid articular implant into the glenoid cavity, the glenoid anatomic articular implant comprising a medial surface configured to mate with the glenoid cavity, a central peg extending medially from the medial surface, a lateral surface configured to articulate with a humeral component; and an intermediate

component between the lateral surface and the medial surface, the intermediate component having an outer diameter reversibly attached to a snap ring attached to a fixation ring, the snap ring and the fixation ring at least partially implanted within the glenoid cavity. The anatomic glenoid articular implant can be partially or fully inset into the glenoid cavity. The cavity could be circular, oval, or another shape.

[0011] Also disclosed herein is a method of converting an anatomic to a reverse shoulder prosthesis, including any number of: identifying a patient with an anatomic glenoid articular implant within a glenoid cavity, the anatomic articular implant comprising a medial surface mated with the glenoid cavity, a central peg extending medially from the medial surface, a lateral surface articulating with a humeral component; and a central component between the lateral surface and the medial surface, the central component having an outer diameter reversibly attached to a snap ring and a fixation ring, the snap ring and the fixation ring at least partially implanted within the glenoid cavity; inserting a implant removal tool through the lateral articulating surface of the anatomic glenoid articular implant sufficient to collapse the snap ring; removing the anatomic glenoid articular implant while leaving the fixation ring in place within the glenoid cavity; and inserting a reverse shoulder implant into the glenoid cavity sufficient to actuate the snap ring such that the reverse shoulder implanted is reversibly fixed to the fixation ring. Inserting the removal tool can include driving pins, a drill bit, or another tool of the removal tool through the lateral articulating surface of the anatomic glenoid articular implant.

[0012] In some embodiments, also disclosed herein is a reversible anatomic shoulder replacement system, that can include any number of: a fixation ring configured to be positioned within the glenoid cavity, the fixation ring comprising a peripheral edge comprising an outer diameter and a plurality of spaced-apart radially inward indents in the peripheral edge, the fixation ring comprising a groove configured to house a snap ring therein; a snap ring comprising an expanded configuration and a collapsed configuration; and an anatomic articular implant comprising a medial surface configured to mate with the glenoid cavity, a central peg extending medially from the medial surface, a lateral surface configured to articulate with a humeral component; and an intermediate component between the lateral surface and the medial surface, the intermediate component having an outer

diameter reversibly attached to the snap ring and the fixation ring, the snap ring and the fixation ring configured to be at least partially implanted within the glenoid cavity. The groove can include anti-rotation tabs. The peripheral edge of the fixation ring can be configured to facilitate bone ingrowth, e.g., via an osteoinductive or osteoconductive surface. The groove can be a circumferential groove. The lateral surface can include any appropriate material, such as polyethylene.

[0013] Also disclosed herein is a reverse shoulder replacement kit for an anatomic shoulder replacement system, that can include any number of: an implant removal tool configured to bore through a medial surface of the anatomic glenoid articular implant sufficient to collapse a snap ring; and remove an anatomic glenoid articular implant while leaving a fixation ring in place within the glenoid cavity; and a reverse shoulder implant configured to be implanted into the glenoid cavity, the reverse shoulder implant comprising a generally cylindrical component comprising a medial surface configured to mate with the glenoid cavity, a central receptacle for housing an articular post therethrough, and a plurality of peripheral screw holes; a lateral surface, and a central post extending away from the lateral surface, wherein the reverse shoulder implant is configured to reversibly mate with the snap ring and fixation ring embedded in the glenoid cavity to anchor the reverse shoulder implant.

[0014] In some configurations, disclosed herein is a method of performing a reversible anatomic shoulder replacement procedure, comprising reaming a cavity into the glenoid; and inserting an anatomic glenoid articular implant into the glenoid cavity, the glenoid anatomic articular implant comprising a medial surface configured to mate with the glenoid cavity, a central peg extending medially from the medial surface, a lateral surface configured to articulate with a humeral component; and an intermediate component between the lateral surface and the medial surface, the intermediate component having an outer diameter reversibly attached via press fitting to a fixation ring at least partially comprising a porous surface, the fixation ring at least partially implanted within the glenoid cavity.

[0015] In some configurations, the anatomic glenoid articular implant is partially or fully inset into the glenoid cavity. The cavity can be, for example, circular or oval.

[0016] In some configurations, disclosed herein is a reversible anatomic shoulder replacement system, comprising a fixation ring configured to be positioned within the glenoid

cavity, the fixation ring at least partially comprising a porous coating, the fixation ring also comprising a peripheral edge comprising an outer diameter; and an anatomic articular implant comprising a medial surface configured to mate with the glenoid cavity, a central peg extending medially from the medial surface, a lateral surface configured to articulate with a humeral component; a medial peripheral edge; and a lateral peripheral edge, the medial peripheral edge comprising a substantially constant diameter that is less than a substantially constant diameter of the lateral peripheral edge, the fixation ring comprising an inner diameter sized and configured to circumscribe the medial peripheral edge of the implant. The fixation ring can be configured to be at least partially implanted within the glenoid cavity. The fixation ring can include anti-rotation features on an outer diameter of the fixation ring. The peripheral edge of the fixation ring can be configured to facilitate bone ingrowth, e.g., an osteoinductive or osteoconductive surface. The inner diameter of the fixation ring can include barbs and/or threads, including self-tapping threads.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] FIG. 1 illustrates a lower perspective view of an embodiment of a fixation support which can be an annular fixation ring in some embodiments that can be fixed at least partially within a prepared glenoid cavity.

[0018] FIG. 2 illustrates an upper perspective view of an embodiment of a support, e.g., an annular ring 100.

[0019] FIGS. 3 and 4 illustrate an embodiment of an anatomic articular component 200 for a glenoid cavity which can be made of polyethylene or another appropriate material.

[0020] FIGS. 5 and 6 illustrate different perspective views of an embodiment of a reversible anatomic articular assembly 300 including the anatomic articular component 200, fixation ring 100, and location for placement of a snap ring 400.

[0021] FIG. 7 illustrates a perspective view of an embodiment of a reverse fixation disc 700 including a central fixation post 706 that can include a longitudinal axis aligned along the center of the reverse fixation disc as shown.

[0022] FIGS. 8 and 9 illustrate perspective views of a reverse fixation disc 700 including peripheral screw holes 704, fixation ring 100 and snap ring 400, the snap ring 400 which can have the same mechanism as the anatomic assembly described herein.

[0023] FIGS. 10A-C illustrate part of a method of implanting an anatomic prosthesis into a reamed glenoid cavity, according to some embodiments of the invention.

[0024] FIGS. 11A-D and 12A-B illustrate a method of removing an anatomic prosthesis while leaving a fixation ring in place embedded in the glenoid cavity, as well as embodiments of components for use in the method, according to some embodiments.

[0025] FIGS. 13A-13B, illustrates a method of implanting a replacement reverse prosthesis in the glenoid cavity, and mating the prosthesis with the implanted fixation ring.

[0026] FIGS. 14-16 illustrate views of a glenoid implant with both onlay and inset components, according to some embodiments of the invention.

[0027] FIGS. 17-18D illustrate views of a glenoid implant with a porous ring component, according to some embodiments of the invention.

[0028] FIGS. 19-20 illustrate views of a glenoid implant with a porous ring component and a porous coated stem, according to some embodiments of the invention.

[0029] FIGS. 21-22 illustrate embodiments of bottom views of humeral heads including non-planar underside surfaces such as concentric annular rings or elongated grooves, according to some embodiments of the invention.

[0030] FIGS. 23A-23C illustrate views of a porous fixation support configured to reversibly connect with various glenoid implants, according to some embodiments.

[0031] FIGS. 23D-23F schematically illustrates views of an anatomic glenoid implant configured to mate with a porous fixation ring.

[0032] FIGS. 23G-23H schematically illustrate views of a glenoid implant connectable with a porous fixation ring via barbed elements.

[0033] FIGS. 23I-23K schematically illustrate views of a glenoid implant connectable with a porous fixation ring via threaded elements.

DETAILED DESCRIPTION

[0034] In particular, some embodiments of the invention are focused on advantageously exchanging the articular surface of the glenoid from a concave shape to a convex shape, without removing the components or interface having to do with fixation of the implant into the glenoid fossa.

[0035] In some embodiments, embodiments of the invention can be used or modified with use with particular advantages of using inset glenoid fixation technology in anatomic shoulder arthroplasty, such as described, for example, in U.S. Pat. Nos. 8,007,538 and/or 8,778,028 to Gunther, which are hereby incorporated by reference in their entireties.

[0036] What is further described are methods by which the surgeon can achieve the use of the inset glenoid technology with an anatomic articulation, while after having the ability to convert the technology to a reverse articulation, without requiring removal the rigid fixation between the inset fixation and the scapula bone (in other words, allowing the rigid fixation support between the inset fixation and the scapula bone to remain in place during conversion from an anatomic to a reverse prosthesis).

[0037] Some embodiments of the invention can utilize an inset glenoid articulation implant described by Gunther et al. including in U.S. Pat. No. 8,007,538 or 8,778,028. However, some embodiments of the invention can also utilize onlay glenoid articulation implants. The peripheral rim of the implant can in some cases have an important role in the fixation stability of the implant and its resistance to motion relative to the glenoid bone during articulation. In addition, it is recognized that a known "rule of thumb" in the industry is that the bearing component of the glenoid implant, such as the polyethylene (PE) component, should be at least about 3mm thick at its thinnest position in order to achieve a sufficient material strength to minimize risk of accelerated implant failure. Of course, this rule is only a guide, but has proven helpful in assessing longevity of implant designs. With these points in mind, it is recognized that in some embodiments the design of the implant (which can be inset in some embodiments) might be improved upon by providing a step in the outer diameter of the inset glenoid implant at its most medial aspect while being able to maintain a minimum PE thickness of about or at least about 2mm, 2.5mm, 3mm, 3.5mm, 4mm, or ranges incorporating any of the aforementioned values. In the space that this step

provides is placement of an annular ring which can be rigidly fixed on the outer diameter of the articular implant such that the outer diameter of the inset glenoid implant remains a contiguous surface, albeit in some embodiments made a plurality of materials: the lateral aspect being part of the PE articulation, the medial aspect being the outer diameter of the annular ring, which can be metallic in some cases. The annular ring and the PE articular component can be attached to one another through the use of a snap ring mechanism or other ways, some of which are described elsewhere herein.

[0038] The annular ring can be configured such that its outer diameter presents a surface to the surrounding bone which can be adapted to be biologically attractive for the growth of surrounding bone tissue. This technology can be achieved by several means such as, for example, various coatings or secondary manufacturing operations, mechanical modification through machining operations, creation of an adapted surface using 3D printing manufacturing, or other means. One advantage of the surface on the outer diameter is such that over the course of the healing process following surgery, bone grows and adapts itself to this annular ring so as to provide rigid attachment of surrounding bone to the annular ring. Thus, at the moment of articular component exchange, the ring is well fixed to bone, and following removal of the PE articulation component, the ring remains well fixed within the glenoid bone, and can be useful as a support surface in attachment of a new reverse articulating surface to the bone.

[0039] FIG. 1 illustrates a lower perspective view of an embodiment of a fixation support which can be an annular fixation ring in some embodiments that can be fixed at least partially within a prepared glenoid cavity. The annular ring 100 can include a central cavity 106 and a plurality of radially inward indents 102 in the outer circumference of the peripheral edge 104 of the annular ring 100 as shown and be sized and configured for fixation screw clearance. The ring 100 could have any number of indents 102 such as 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, or more, or ranges including at least two of the aforementioned values. The indents 102 could be regularly or irregularly spaced apart along the circumference in some embodiments, and have a curved shape as shown or other shapes. As shown, the peripheral edge 104 can include a coating or other surface, e.g., osteoinductive or osteoconductive surface to facilitate bone ingrowth and fixation into the cavity. The surface could include, for example, cortical

bone, cancellous bone, particulate matter, a powder form, granules, chips, a synthetic bone substitute, growth factors and/or bone growth promoting proteins, or combinations thereof. The annular ring 100 can also include a groove or slot 108 that can be oriented along the outer circumference of the central cavity 106 (e.g., inner diameter of the ring) and configured to house a snap ring therein (not shown).

[0040] FIG. 2 illustrates an upper perspective view of an embodiment of a support, e.g., an annular ring 100, showing the indents 102 as previously described. Also shown is the groove or slot 108 configured to house a snap ring as well as radially-inward extending anti-rotation tabs 112. The outer diameter of the peripheral edge 104 of the annular ring 100 can match that of a bearing, e.g., polyethylene component in some embodiments.

[0041] FIGS. 3 and 4 illustrate an embodiment of an anatomic articular component 200 for a glenoid cavity which can be made of polyethylene or another appropriate material. The anatomic articular component 200 can include a concave articulating surface 202 as shown, as well as a central fixation post or peg 204, which can be only a single post or peg in some cases, and be aligned coaxially with the center of the implant. The peripheral edge of the implant could have a generally cylindrical shape in some embodiments, and/or have a circular, oval, or other cross-section. The articular component 200 can also include a feature configured to mate with the fixation support, such as a cylindrical component 206 lateral to the articular surface 202 that can have an outer diameter that corresponds to the inner diameter of the fixation support (not shown) as well as a slot or groove (not shown) configured to house a snap ring (not shown). The outer diameter of the component 206 can be in some cases less than, such as about or at least about 5%, 10%, 20%, 30%, 40%, 50%, or more less than that of the outer diameter of the articulating surface 202 of the anatomic articular component 200, or ranges including any two of the aforementioned values.

[0042] FIGS. 5 and 6 illustrate different perspective views of an embodiment of a reversible anatomic articular assembly 300 including the anatomic articular component 200, fixation ring 100, and location for placement of a snap ring 400 as previously described and illustrated.

[0043] FIG. 7 illustrates a perspective view of an embodiment of a reverse fixation implant, e.g., disc 700 including a central fixation post 706 that can include a longitudinal axis aligned along the center of the reverse fixation disc as shown. The medial surface 702 of the disc can include a central receptacle 708 for an articular post, as well as a plurality, e.g., 2, 3, 4, or more screw holes 704 oriented more peripherally with respect to the peripheral edge 706 of the disc, which can be generally cylindrical as shown, or another suitable geometry.

[0044] FIGS. 8 and 9 illustrate perspective views of a reverse fixation disc 700 including peripheral screw holes 704, fixation ring 100 and snap ring 400, the snap ring 400 which can have the same mechanism as the anatomic assembly described herein. Also shown is the other end of the receptacle 708 for the articular post that can extend through the implant. The apertures 704 (e.g., screw holes) can be axially aligned and configured to correspond with each of the indents 102 of the fixation ring 100 with the indents 102 as previously described, to house fixation screws therethrough.

[0045] FIGS. 10A-10C illustrates part of a method of implanting an anatomic prosthesis into a reamed glenoid cavity, according to some embodiments of the invention. A pocket P can be prepared, such as by reaming, in the glenoid G (shown in FIG. 10A), which can be an appropriate shape, such as circular as shown, ovoid, or other geometries, with a central distal extending hole H for a central peg in some embodiments, as shown in FIG. 10C. The anatomic implant, one embodiment of which is shown in FIG. 10B along with the fixation ring and snap ring, can be implanted into the cavity, shown schematically in FIG. 10C such as in a partially or completely inset manner, with about or at least about 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, or 100% of the thickness of the peripheral edge of the implant inset below the prepared glenoid surface, or ranges including any two of the aforementioned values. The attachment of the ring to the PE implant can be preferably achieved in a reversible fashion using techniques and tools available to a surgeon such that the operation can be performed in situ, or in place within the patient. In order to accomplish this, a snap ring mechanism can be utilized such that another component, such as an angular metallic ring is positioned between the bearing component, e.g., PE component and the snap ring and/or metallic ring.

[0046] FIG. 11A schematically illustrates an anatomic articular implant 300 inserted into bone, such as the glenoid cavity. FIG. 11B schematically illustrates a side view, and FIG. 11C a top view, of an implant that can be as previously described. As shown in FIGS. 11A-D and 12 in some embodiments, at the moment the surgeon seeks to remove the PE component from the annular ring, the snap ring 400 (shown in phantom in FIG. 11C) can be collapsed in order to eliminate its interference fit between the annular ring and the PE component. This can be performed through the use of a guide 600 shown in FIG. 11D which can be placed over the surface of the PE component which can be in situ. In some embodiments, the guide 600 can have an elongate shaft 601 and a distal end 604 including an annular sidewall 606 defining a cavity 608 and an open distal end configured to have an inner diameter that can match, substantially match, or be the same size or larger than the outer diameter of the peripheral edge of the bearing component of the implant, such that the annular sidewall 606 and cavity 608 is placed over the glenoid implant. Release pins 602, a drill, or other tool can be axially advanced into apertures 607 of the guide 600 to facilitate release of the snap ring from the glenoid implant.

[0047] The guide 600 provides positioning of a plurality of holes, e.g., about or at least about two, three, four, five, or more holes positioning around the periphery of the PE implanted such that which a drill or pin 602 is mechanically driven into the guide holes 607, they are aligned to force the snap ring 400 in an radially inward fashion to allow for release of the snap ring. FIG. 12A schematically illustrates the guide 600 being advanced toward the glenoid implant 300 in situ in the glenoid G, along with pins 602 that can be placed in apertures 607 of the guide 600. Once a number of pins 602, e.g., three pins are driven through the guide and PE component, the snap ring is collapsed, and the PE component and snap ring can be removed from the annular fixation ring as an assembly, as shown in FIG. 12B. At this point, what remains is the annular fixation ring well fixed within the glenoid fossa. In some embodiments, the fixation ring may not be fully counter-sunk, and be partially rather than fully inset, within the glenoid surface, and/or stand proud of the glenoid surface. With time, the fixation ring can have some bony ingrowth.

[0048] As shown in FIG. 13A, in some embodiments, an implant such as a disc, e.g., a metallic disc (e.g., as shown in FIGS. 7-9 for example) can then be placed into the

previously implanted fixation ring 100 including a groove 108 configured to fit a new snap ring 400 as previously described. The implant 1300 can include a glenosphere 1302 with an offset peg 1303 configured to fit with baseplate 1304 with shaft 1306 (schematically shown in section view), and snap ring 400. The baseplate can have a longitudinal axis A2 that is offset from the longitudinal axis of the glenosphere A1 in some embodiments. FIG. 13B illustrates the reverse implant assembled and deployed within the glenoid cavity. Methods as disclosed herein can have several non-limiting potential advantages, including the following:

1. an outer diameter adapted to provide for a snap ring fit between the disc and annular ring in the same manner as the PE component and the annular ring;
2. a peg, pin, screw or other fixation means which is adapted to fit deeper into the central portion of the glenoid fossa to provide additional fixation means,
3. a central tapered hole into which a reverse ball articulating component can be placed and rigidly fixed; and
4. several peripheral holes through which screws can be driven to further increase the rigidity of fixation between the fixation disc and bone.

[0049] Following the removal of the anatomic, e.g., PE component, the surgeon can further prepare the glenoid fossa for the reverse fixation disc by drilling a centrally positioned hole. The hole can be adapted to receive a pin, post, screw, or other feature which is integrally attached to the medial aspect of the fixation disc. As the fixation disc can be positioned within the annular ring, the central fixation protrusion can be positioned within this hole in the glenoid bone such that further fixation rigidity is obtained.

[0050] Following the placement of the fixation disc in the annular ring, the surgeon can drill additional holes in the glenoid bone through peripheral holes in the fixation disc, which provides the ability to drive fixation screws through the fixation disc into the glenoid bone, even further improving rigidity, in addition to providing rotational stability. Due to the size constrains of the components, it can be advantageous to design the annular ring in a fashion that provides sufficient clearance through which these fixation screws can pass. To this end, the annular ring can be designed such that at on its periphery are several (four) indents of circular shape that provides clearance for passing of the peripheral screws.

[0051] Once the fixation disc is well fixed to the glenoid bone, the spherical articular component is introduced to the fixation disc. On its medial aspect, the articular component can have a cone-shaped protrusion which can be adapted to fit rigidly into a cone shaped hole centrally located within the fixation disc. This can provide a rigid fixation means by which the articular component is fixed to the fixation components using a technique and mechanism well known in the art.

[0052] Some embodiments of the modular, convertible shoulder system as disclosed for example herein can include several unique advantages not considered elsewhere, including but not limited to one or more of the following:

- The use of an annular fixation ring can further improve the fixation potential of inset glenoid technology as described herein. The ring can increase the rigidity of the overall PE glenoid construct, reducing its deflection under load, and improves fixation rigidly.
- The outer aspect of the annular ring can provide a surface which adheres to bone biologically and mechanically which provides further improvement of the rigidity of the fixation over time and in response to load in consideration of Wolf's law.
- This improved rigidity and fixation can be provided with no sacrifice of the 3mm minimum material thickness of the PE component, so that joint mechanics can be maintained with no change in the overall stack height of the anatomic prosthesis.
- The attachment mechanism between the PE articular and annular ring can be reversible in situ, meaning the PE component can be removed from the annular ring which the ring remains in the bone, and can be performed in a manner which is nondestructive to the ring or the surrounding bone.
- The annular ring can be shaped so as to provide a receptacle into which a reverse articulation can be inserted and rigidly fixed.
- The ring can provide clearance so that further rigidity can be obtained by passing screws through the reverse fixation disc, annular ring, and bone.

- The fixation disc can provide a female receptacle into which the articular sphere's attachment post can be positioned. Providing a female receptacle is shown in some cases to be an easy surgical technique and very robust attachment mechanism.

Inset/Onlay Glenoid Implant

[0053] In some embodiments, an improved glenoid implant can be configured to lie both inset in a subchondral bone pocket in the glenoid, as well as on subchondral bone so that there is additional surface for the humeral head to articulate with in cases of perceived or real joint laxity.

[0054] The most common failure mechanism of glenoid implants is loosening due to a rocking horse motion which can be related to joint laxity. This joint laxity can sometimes allow the humeral head to undesirably articulate at the margins of a glenoid implant. This potential complication can occur with both inset glenoid implants as well as conventional onlay glenoid implants.

[0055] In some embodiments, such as for a circular inset glenoid, providing additional material for articulation can prevent subluxation while still providing enhanced inset fixation. This same fixation argument can be beneficial with respect to onlay glenoids which only provide fixation at small, discrete locations (e.g., peripheral and central pegs or keels).

[0056] Standard onlay glenoids use small, discrete fixation methods. Some designs include 1, 2 or more peripheral pegs which are small in diameter and allow for very small (<0.5mm) cement mantle fixation. Other designs may use porous coated peripheral pegs. Typically, the central peg of most glenoids use cementless fixation through fins packed with morcellized bone or porous coated cylindrical pegs. Each of these designs provide no fixation for the majority of the backside surface, thereby allow the plastic glenoid material to move up or down in relation to the loading of the humeral head.

[0057] By providing a large fixation surface covering the majority of the implant backside, any rocking horse motion is advantageously greatly minimized or even eliminated. Such embodiments can be used in a large number of total shoulder arthroplasty surgery

procedures. Further details of glenoid implants that can be used or modified for use with those as disclosed herein can be found, for example, in U.S. Pat. No. 8,778,028 to Gunther et al. and/or U.S. Pat. App. No. 15/952,063 to Ball, both of which is hereby incorporated by reference in its entirety. In some embodiments, an inset glenoid implant configured to reversibly connect with and press-fit into a partial or completely porous ring can be very clinically advantageous.

[0058] FIGS. 14-17 illustrate embodiments of a hybrid inset and onlay glenoid implant. FIG. 16 illustrates a side view of an embodiment of a glenoid implant 10 with a backside peg 12. The peg could be a single peg 12 situated centrally on the medial (back) side of glenoid implant 10 and in some cases can be a cylindrical peg shape that extends outwardly from glenoid implant 10 away from the back of the implant 16. The glenoid implant 10 can also include a lateral articulating surface 20 against which the head of a humerus or humeral component can move. Some embodiments include an extended onlay body portion 19 having a width or diameter than is greater than an inset body portion 17 having including the lateral articulating surface 20 and a medial surface 21 on the onlay body portion 19 that is meant to lay on the glenoid surface G. In some embodiments, the width or diameter is about or at least about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, or more greater than the width or diameter of the inset body portion 17, or ranges incorporating any two of the aforementioned values. The extended articular surface 20 can lie off axis with the medial surface 16 of the inset body portion 17 as shown in FIG. 16, or parallel in some embodiments, and be coaxial or non-coaxial. The periphery of the extended articular surface 20 and the medial surface 16 can be circular, non-circular such as an oval, or other shapes. FIG. 15 illustrates a top view illustrating the extended articular surface 20 of the onlay body portion 19, with the medial surface 21 (not shown) resting on top of the glenoid. FIG. 15 illustrates a completely inset glenoid implant with the extended articular surface 20 removed for clarity or not present, and the lateral surface 15 of the inset body portion 17 is shown. FIG. 16 illustrates a side view of the glenoid implant of FIG. 14.

[0059] In some embodiments, disclosed is a method of treating a patient, including identifying a patient having a glenoid surface; reaming a cavity into the glenoid surface; and inserting a glenoid implant having an inset body portion and a peg, the inset

body portion having a bearing surface on a peripheral edge thereof into the cavity, such that at least a portion of, or the entire peripheral edge of the inset body portion resides below the adjacent glenoid surface and the portion residing below the adjacent glenoid surface is circumferentially surrounded by cortical bone of the glenoid, while an onlay body portion having a diameter or width greater than the inset body portion has an extended lateral articulating surface for articulation with a humerus or a humeral component, and a medial surface that rests on top of the glenoid surface.

Porous Coated Convertible Glenoid Implant

[0060] In some embodiments, disclosed herein are implants that can use porous coating as a fixation method and optionally allow for conversion to a reverse shoulder arthroplasty during a revision surgery. The use of cement during a total shoulder arthroplasty procedure adds additional cost and time to the surgery. Any design that can effectively provide short and long term cementless fixation can advantageously simplify the procedure and reduce overall cost and risk to the patient. The porous coating could be, for example, poly-ether-ether-ketone (PEEK), a biostable and biocompatible thermoplastic polymer, hydroxyapatite (or other crystalline phases of HA), metals, or combinations thereof. Some embodiments can include HA coated PEEK implants, but can also include any polymer of the poly-aryl-ether-ketone family such as, but not limited to, poly-ether-ketone (PEK) and poly-ether-ketone-ether-ketone-ketone (PEKEKK), or others such as UHMWPE. In some embodiments, the coating can be applied via a plasma spray process. Prior to coating PEEK (or other similar polymers) with HA (or other crystalline phases of HA), the surface of the PEEK can be textured to provide a more suitable surface for HA deposition. Texturing of the surface further enhances the bond strength between the coating and the PEEK and also enhances fixation of the PEEK between the adjacent vertebrae, due to bony ingrowth, upon resorption of the coating. The surface of the porous coating may be textured into microstructured, macrostructured, microporous or macroporous morphologies. Texturing can be accomplished, for example, by grit blasting using a suitable media such as alumina, or by machined grooves or threads, or any other method that may allow for texturing of the surface. Alternatively, a metal porous coating, such as titanium or its alloys, stainless steel alloys,

cobalt-chromium (Co—Cr) alloys, tantalum alloys, zirconium alloys, nitinol, or other metals and/or metal alloys can be used. One example of a suitable titanium-based material is commercially pure (CP) titanium. Examples of different grades of CP titanium are specified in ASTM F67 as grades 1-4. One example of a suitable titanium alloy is a titanium-aluminum-vanadium (Ti—Al—V) alloy. In one embodiment, the Ti—Al—V alloy is Ti—Al6-V4, or Ti-6-4, which includes 6% aluminum and 4% vanadium and is sometimes referred to as grade 5 titanium alloy. In some embodiments, the porosity can be between about 20% and about 80%, such as about 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, or ranges including any two of the aforementioned values. In some embodiments, individual pore sizes may range from about 100 μm to about 1000 μm, and such as from about 200 μm to about 300 μm in some cases.

[0061] By adding one or more porous coated elements to the underside of a glenoid implant, short and long term fixation can be created. Conventional devices either created a modular implant with a plastic glenoid articular surface implant fitting in to a metal stem and metal underside with porous coating and/or a porous stem compression molded to a plastic glenoid articular surface.

[0062] The use of a modular, metal backed implant can be deficient in multiple areas. First, the addition of metal backing required a reduction in polyethylene thickness. This increased the contact stresses in the plastic leading to early failures. Second, the poor mechanical lock between the plastic and metal backing, along with a non-polished metal surface, created wear debris that led to glenoid bone osteolysis and implant failure.

[0063] The use of porous stem compression molded to the articular plastic only provides stem fixation of the implant. Any loading that occurred off the axis of the stem creates a bending moment about the metal/plastic compression molded interface leading to wear debris generation and implant failure.

[0064] Some embodiments include a metal/plastic modular glenoid implant using porous coating fixation. The porous structure, e.g., ring can be attached to the inferior periphery of the plastic glenoid implant as shown in FIGS. 17-20. As illustrated in FIG. 17 glenoid implant 498 can include a body 401 that can be made of metal or plastic for example, and include a large diameter lateral portion 403 and a smaller diameter medial portion 405

(shown in FIG. 19), lateral articulating surface 402, medial surface 404 (shown in FIG. 19), central peg 406, and a porous ring 408 directly adjacent to both the peripheral edge of the medial surface 405 of the metal or plastic component and the medial surface of the large diameter lateral portion 403 of the body 401. The ring 408 can include a central aperture circumscribing a portion of the central peg 406 and a peripheral edge that can generally mirror the peripheral edge of the metal or plastic component, and have a maximal outer diameter that is the same as or substantially the same as that of the metal or plastic component. In some embodiments, the porous ring 408 can include one, two, three, four, five, or more spaced-apart radially inward indentations 410 that can be utilized, for example, for fixation after later optional conversion to a reverse glenoid. FIG. 18 is a side view of the implant of FIG. 17.

[0065] FIG. 18A schematically shows a side sectional view of a porous coated ring 1802, with a snap ring 1804 that can be present for assembly to the implant 1800. One potential issue that could be encountered is if the bearing surface of the implant 1800 (e.g., polyethylene bearing surface) wears, it could produce a metal on metal interaction. As such, compared with FIG. 18A, the ring 1806 thickness could be asymmetrically reduced in the posterior glenoid relative to the anterior glenoid, as shown in FIG. 18B, wherein the anterior surface of the ring 1806 is angled, e.g., not parallel to the backside of the glenoid. In some embodiments, the thickness of the ring 1806 in the posterior of the glenoid is about or at least about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, or 90% less than the thickness of the ring 1806 in its anterior portion, or ranges including any two of the aforementioned values.

[0066] In some embodiments, the glenoid implants need not be convertible from anatomic to reverse. An implant could include a porous coated ring or band around the periphery of the implant body, partially or completely circumscribing the peripheral edge of the implant, somewhat similar to bands around a wine barrel. In some embodiments, the porous coating can be present in lieu of a metal backing component. In other words, a metal backing component can be absent in some embodiments and the porous ring forms the backside of the implant (other than the peg(s) or keel(s) in some cases).

[0067] In some embodiments, instead of a locking snap ring as shown in FIG. 18A, an interlocking assembly could be used to leverage the forces in the shoulder. FIG. 18C schematically illustrates a cross-section of an embodiment of a glenoid implant 1860 with a porous ring 1862. FIG. 18C schematically illustrates anatomic loads AL; outward forces (arrows at 1888) created by in-use loads; cement 1882 and forces 1884 present during cement cure; and an interlocking surface 1886 with can be present at an incline in some cases. The outward force can create more intimate contact with bone, potentially improving fixation and the bone response. The fixation ring 1890 can be split (e.g., having an incomplete ring defining a channel 1891) in some cases in order to assemble onto the implant, as illustrated in FIG. 18D.

[0068] The initial and long-term fixation of another embodiment of an implant 498' can also be enhanced by the optional use of a porous coated stem 499, as illustrated in FIGS. 19-20. In addition, if the glenoid implant ever needs to be revised/removed for a reverse shoulder arthroplasty, the metal ring can be disengaged from the plastic implant by removing the plastic, leaving the porous ring in the subchondral bone. This ring can then be engaged with a metal reverse shoulder arthroplasty baseplate, thus providing immediate strong fixation between the ring and the metal baseplate.

[0069] By using a porous coated metal structure, e.g., a ring on the underside of the plastic implant, any off-axis loads can be advantageously readily counter-acted by the large diameter ring fixed into the subchondral bone. The ring is in some embodiments only used on the periphery of the plastic, thus keeping the plastic (or plastic plus porous structure) at a minimum thickness of about 3mm which is the normal amount required for successful implant longevity, or at least about 2mm, 2.5mm, 3mm, 3.5mm, 4mm, or more.

[0070] The ring can be attached in multiple ways to the polyethylene including press-fit or compression molded (e.g., without any adhesive or cement) and has the ability to be removed after implantation and reattached to a metal reverse arthroplasty baseplate.

[0071] It can be a difficult procedure to convert a primary shoulder arthroplasty to a reverse shoulder implant during a revision surgery. Not only is the original plastic implant difficult to remove, but the initial fixation of the reverse metal baseplate must begin to form

at the completion of surgery. Having a component of the reverse implant already well-fixed enhances the overall integrity of the reverse shoulder construct immediately post-op.

Humeral Head with Textured Underside

[0072] Some embodiments can include texturing of the underside of a humeral head. FIGS. 21 and 22 illustrate embodiments of bottom views of humeral heads 800, 900. This can include both texturing along with the method of implanting a textured humeral head so that it contacts the resected humeral bone. The texturing can include a layer of porous material along a flat base head underside. It also, alternatively or in addition, could include creating non-planar surfaces such as concentric annular rings 802 which can have circumferential 804 and/or axially 806 oriented channels therebetween as shown in FIG. 21, sinusoidal waves, elongated grooves 902 as shown in FIG. 22, or other desired patterns.

[0073] In some embodiments, systems and methods involving a humeral head can advantageously include an underside with an enlarged surface area relative to a flat underside to contact the resected surface of the humeral head thereby distributing loads incurred during gleno-humeral articulation and allowing for bone in-growth into the humeral head underside. In some embodiments, the enlarged surface area is about or at least about 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 100%, or more relative to a flat underside humeral head, or ranges incorporating any two of the aforementioned values.

[0074] Bone resorption tends to occur in the areas surrounding a humeral stem implant. This resorption occurs due to a lack of load transmission from the implant in to the bone. By purposefully engaging contact between a large portion of the humeral head and the resected bone surface, compressive and tensile load transfer can occur, thus eliminating the possibility of bone resorption around the implant.

[0075] Prior devices either ignored the possibility of bone resorption or included a collar of metal at the proximal aspect of the implant to distribute the loads. The collars used on other devices is typically either too small or too large. The majority of devices using a collar employ a small diameter configuration. The small diameter was used to allow for the use of skirts on concentric and eccentric humeral heads. The skirt is used to extend the

articular surface of the humeral head implant and to provide a more appropriate looking AP x-ray. These small collars are not large enough in diameter to appropriately transmit loads into the resected bone. The larger diameter collar design is also in use. This collar edge was exposed to the surrounding soft tissues which led to irritation as the tissues rubbed against the edges of the collar. In addition, the larger diameter collar did not allow for the humeral head articular region to extend below the collar.

[0076] By texturing the underside of the humeral implant and forcing contact with the resected bone at implant insertion, the head now can serve as the implant pseudo-collar, and an actual collar is not required. This allows for load transmission at the furthest margins without creating any sharp features. It also allows for the humeral head articular region to extend all the way down to the resected bone surface.

Additional Glenoid Embodiments

[0077] FIG. 23A illustrates a perspective view of an embodiment of a fixation support, e.g., a fixation ring 2000 that can be fixed at least partially or entirely within a prepared glenoid cavity as previously described. The fixation support 2000 can be generally annular and include a plurality of spaced apart indents or slots 2014 along the peripheral side edge 2009 of the support 2000. The indents 2014 can be configured to prevent or inhibit rotation of the support 2000 as well as be sized and configured to fit bone fragments or other debris within from the reaming process and during implantation of the support 2000 and assist in preventing fracturing of the reamed glenoid cavity. Also illustrated are apertures 2002 spaced proximate the peripheral edge 2009 of the support 2000 configured to house screws or other fixation elements. The support 2000 can also include one or more apertures, such as central aperture 2006 configured to house a peg or keel of the glenoid implant 2080, such as via press-fit. However, other ways to house the glenoid implant 2080 such as threaded surfaces, barbs, and the like can The fixation support 2000 could include upper surface 2007, lower surface 2011, and peripheral side edge 2009 as previously described. In some embodiments, upper surface 2007 can be a machined surface, and lower surface 2011 and peripheral side edge 2009 could be porous surfaces. The glenoid implant 2080 can removably interface with the support 2000 as schematically illustrated in FIG. 23B, and be

exchanged for a different implant, such as a reverse implant 2077 as schematically illustrated in FIG. 23C.

[0078] In some embodiments, the fixation support does not include a snap ring.

[0079] FIGS. 23D-23F schematically illustrates views of an anatomic glenoid implant 2100 configured to mate with a porous fixation ring (not shown). FIG. 23D is a side view, FIG. 23E is a close-up side view, and FIG. 23F is a perspective view. Glenoid implant 2100 can be partially or fully inset within a reamed glenoid cavity in some embodiments as described for example elsewhere herein. Glenoid implant 2100 can include a medial surface 2110 including one or more backside pegs, such as central peg 2102. Glenoid implant 2100 can also include a plurality of screws 2112 for additional fixation within the cavity. Glenoid implant can also include lateral articulating surface 2108, as well as a "two step" stepped thickness including first, lateral peripheral edge 2106 and second, medial peripheral edge 2104 with a surface 2105 that can include features such as barbs and/or threads for example, and be configured to reversibly mate with a fixation ring (not shown). Medial peripheral edge 2104 can have a diameter that is less than that of lateral peripheral edge 2106 in some embodiments such that the fixation ring can circumscribe the medial peripheral edge 2104 but not the lateral peripheral edge 2106. In some embodiments, the diameter of the medial peripheral edge 2104 can be between about 1mm and about 2mm less than about, or about 1.5mm less than about the diameter of the lateral peripheral edge 2106. In some embodiments, the diameters of each of the medial peripheral edge 2104 and the lateral peripheral edge 2106 can be constant or substantially constant (e.g., discrete steps). In some embodiments, the medial peripheral edge 2104 (and the corresponding fixation ring) can have a thickness/depth of about 3mm, such as between about 2mm and about 4mm, or between about 2.5mm and 3.5mm in some embodiments. In some embodiments, the outer diameter of the medial peripheral edge 2104 or the lateral peripheral edge 2106 can be from about 20mm to about 30mm, such as about 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, or 30mm, or ranges including any of the foregoing values. In some embodiments, the thickness of the glenoid implant measured at a corner as shown in FIG. 23E by distance D can be between about 2mm and about 3.5mm, such as about 2.7mm in some embodiments. As illustrated in FIG. 23F,

glenoid implant 2100 can also include channels or grooves 2120 on the medial surface 2110 configured to house cement for additional fixation if desired.

[0080] FIGS. 23G-23H schematically illustrate a glenoid implant 2100 with smaller diameter medial peripheral edge 2104 and larger diameter lateral peripheral edge 2106 that can be as previously described, with a ledge 2121 extending between the medial peripheral edge 2104 and the lateral peripheral edge 2106 and configured to abut a lateral-facing surface of a fixation ring. The medial peripheral edge 2104 of the glenoid implant 2100 can include reverse barbs 2185 as illustrated. As shown in FIG. 23H, fixation ring 2190 can include barbs 2186 made of oversized metal or other elements and configured to reversibly press into the medial peripheral edge 2104 of the glenoid implant 2100 (either with or without reverse barbs). The lateral peripheral edge 2106 of the glenoid implant 2100 can be barb-less as illustrated. Fixation ring 2190, or portions thereof can be porous as previously described herein.

[0081] FIGS. 23I-23K schematically illustrate a glenoid implant 2100 with smaller diameter medial peripheral edge 2104 and larger diameter lateral peripheral edge 2106 that can be as previously described. The medial peripheral edge 2104 of the glenoid implant 2100 can include threads 2198. As shown in FIG. 23J, fixation ring 2190 can include threads 2199 configured to reversibly mate with the threads 2198 of the medial peripheral edge 2104 of the glenoid implant 2100. In some embodiments, the threads 2199 of the fixation ring 2190 can be self-tapping, in which the medial peripheral edge 2104 of the glenoid implant need not be threaded, as the self-tapping threads 2199 of the fixation ring 2190 can "bite" or otherwise transform the medial peripheral edge 2104 of the glenoid implant 2100. The lateral peripheral edge 2106 of the glenoid implant 2100 can be thread-less as illustrated. Fixation ring 2190, or portions thereof can be porous as previously described herein.

[0082] Various other modifications, adaptations, and alternative designs are of course possible in light of the above teachings. Therefore, it should be understood at this time that within the scope of the appended claims the invention may be practiced otherwise than as specifically described herein. It is contemplated that various combinations or subcombinations of the specific features and aspects of the embodiments disclosed above

may be made and still fall within one or more of the inventions. For example, some embodiments can include one, two, or more of a hybrid inset-onlay glenoid implant, a porous ring structure, and/or a textured underside humeral implant. Further, the disclosure herein of any particular feature, aspect, method, property, characteristic, quality, attribute, element, or the like in connection with an embodiment can be used in all other embodiments set forth herein. Accordingly, it should be understood that various features and aspects of the disclosed embodiments can be combined 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 present inventions herein disclosed should not be limited by the particular disclosed embodiments described above. Moreover, while the invention is susceptible to various modifications, and alternative forms, specific examples thereof have been shown in the drawings and are herein described in detail. It should be understood, however, that the invention is not to be limited to the particular forms or methods disclosed, but to the contrary, the invention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the various embodiments described and the appended claims. Any methods disclosed herein need not be performed in the order recited. The methods disclosed herein include certain actions taken by a practitioner; however, they can also include any third-party instruction of those actions, either expressly or by implication. For example, actions such as "reaming a glenoid implant" includes "instructing the reaming of a glenoid implant." The ranges disclosed herein also encompass any and all overlap, sub-ranges, and combinations thereof. Language such as "up to," "at least," "greater than," "less than," "between," and the like includes the number recited. Numbers preceded by a term such as "approximately", "about", and "substantially" as used herein include the recited numbers (e.g., about 10% = 10%), and also represent an amount close to the stated amount that still performs a desired function or achieves a desired result. For example, the terms "approximately", "about", and "substantially" may refer to an amount that is within less than 10% of, within less than 5% of, within less than 1% of, within less than 0.1% of, and within less than 0.01% of the stated amount.

WHAT IS CLAIMED IS:

1. A method of performing a reversible anatomic shoulder replacement procedure, comprising:

reaming a cavity into the glenoid; and

inserting an anatomic glenoid articular implant into the glenoid cavity, the glenoid anatomic articular implant comprising a medial surface configured to mate with the glenoid cavity, a central peg extending medially from the medial surface, a lateral surface configured to articulate with a humeral component; and an intermediate component between the lateral surface and the medial surface, the intermediate component having an outer diameter reversibly attached via press fitting to a fixation ring at least partially comprising a porous surface, the fixation ring at least partially implanted within the glenoid cavity.

2. The method of Claim 1, wherein the anatomic glenoid articular implant is partially inset into the glenoid cavity.

3. The method of Claim 1, wherein the anatomic glenoid articular implant is fully inset into the glenoid cavity.

4. The method of Claim 1, wherein the cavity comprises a circular cavity.

5. The method of Claim 1, wherein the cavity comprises an oval cavity.

6. A reversible anatomic shoulder replacement system, comprising:

a fixation ring configured to be positioned within the glenoid cavity, the fixation ring at least partially comprising a porous coating, the fixation ring also comprising a peripheral edge comprising an outer diameter; and

an anatomic articular implant comprising a medial surface configured to mate with the glenoid cavity, a central peg extending medially from the medial surface, a lateral surface configured to articulate with a humeral component; a medial peripheral edge; and a lateral peripheral edge, the medial peripheral edge comprising a substantially constant diameter that is less than a substantially constant diameter of the lateral peripheral edge, the fixation ring comprising an inner diameter sized and configured to circumscribe the medial peripheral edge of the implant,

wherein the fixation ring is configured to be at least partially implanted within the glenoid cavity.

7. The system of Claim 6, wherein the fixation ring comprises anti-rotation features on an outer diameter of the fixation ring.

8. The system of Claim 6, wherein the peripheral edge of the fixation ring is configured to facilitate bone ingrowth.

9. The system of Claim 8, wherein the peripheral edge of the fixation ring comprises an osteoinductive or osteoconductive surface.

10. The system of Claim 6, wherein the inner diameter of the fixation ring comprises barbs.

11. The system of Claim 6, wherein the inner diameter of the fixation ring comprises threads.

12. The system of Claim 11, wherein the threads are self-tapping threads.

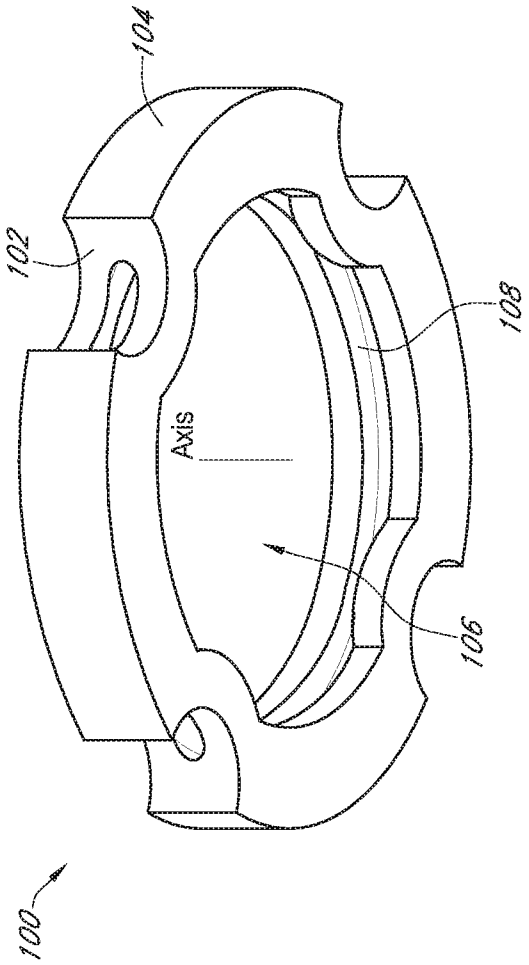

FIG. 1

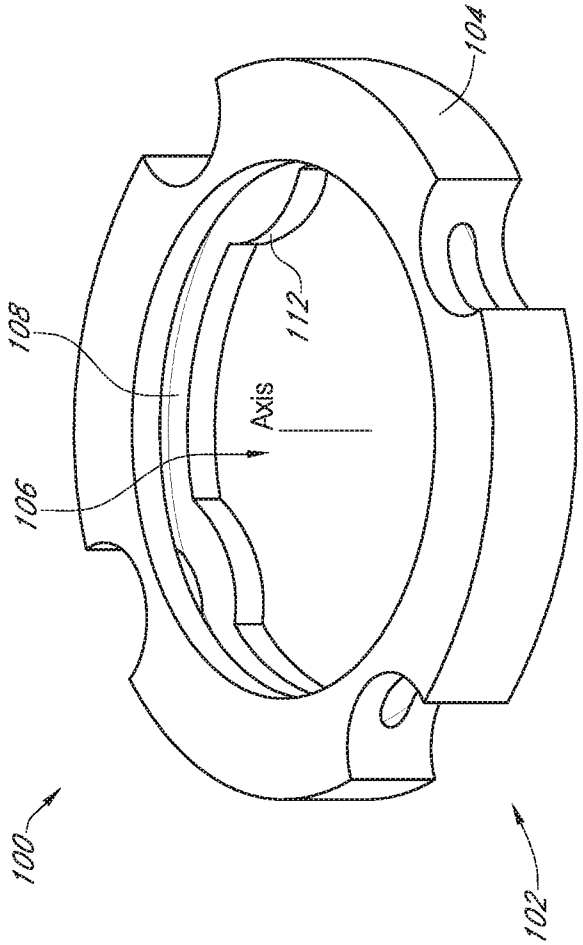

FIG. 2

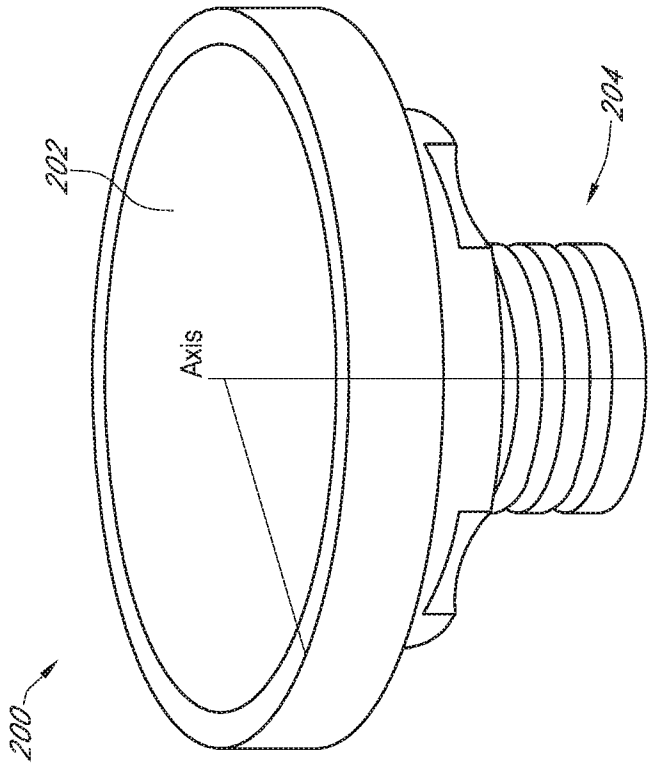

FIG. 3

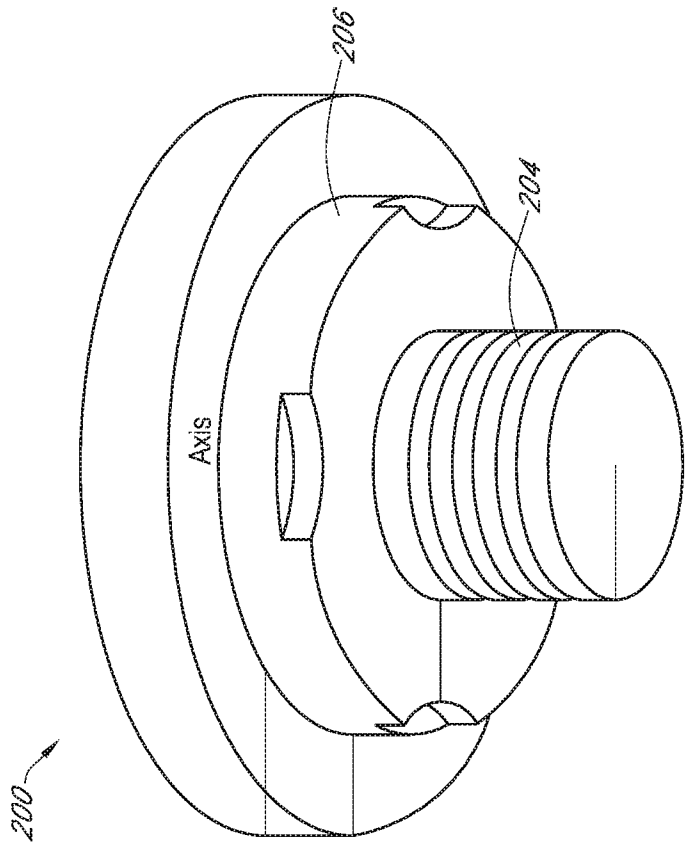

FIG. 4

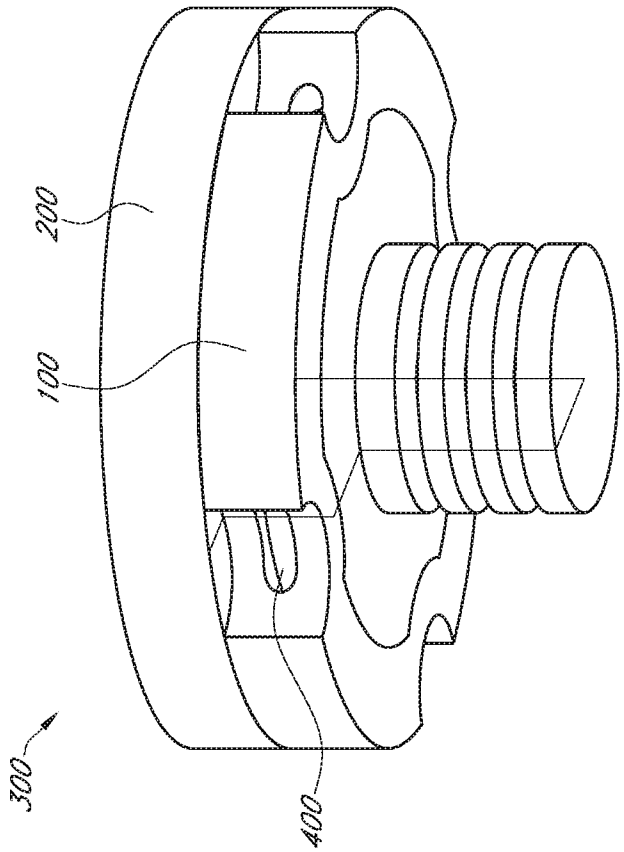

FIG. 5

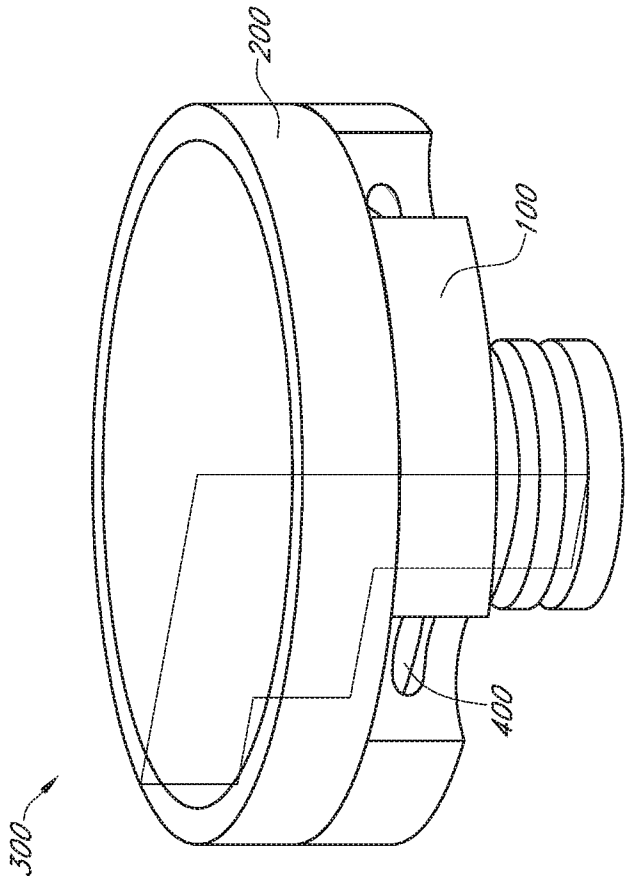

FIG. 6

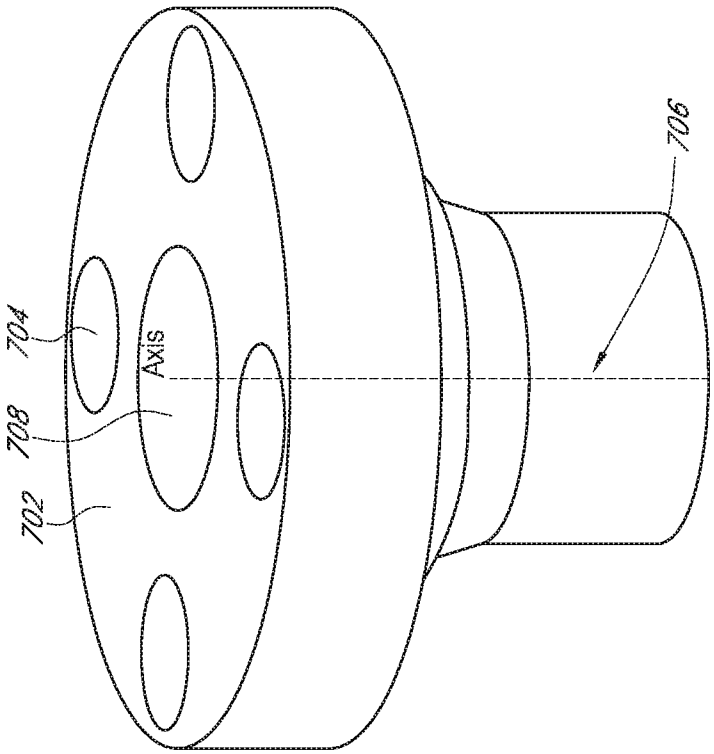

FIG. 7

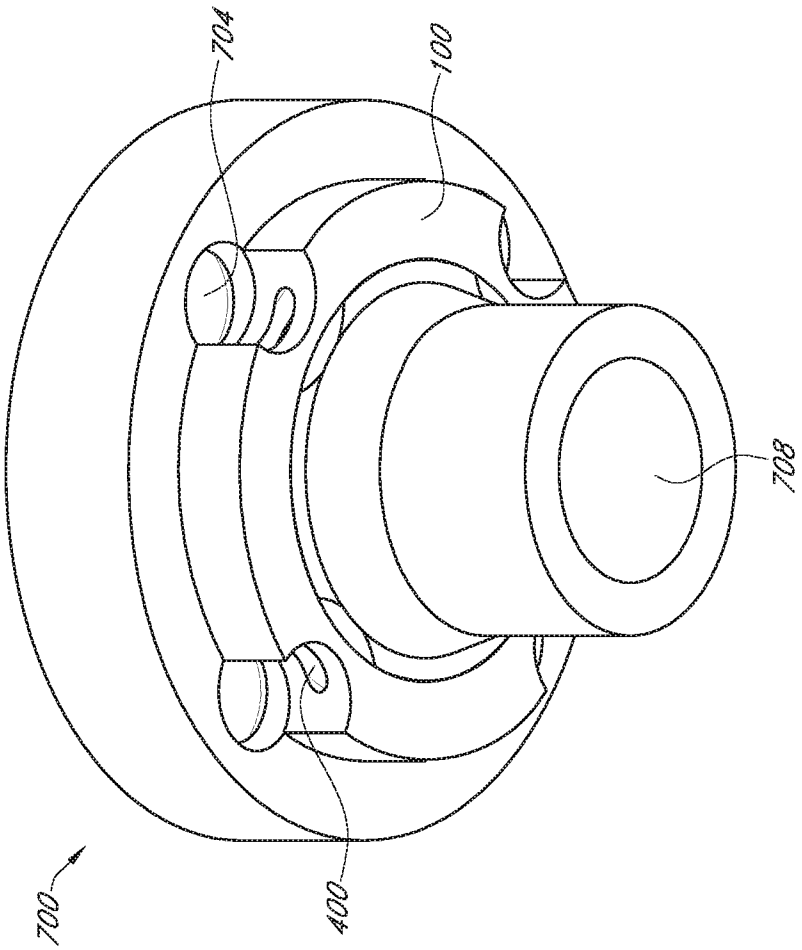

FIG. 8

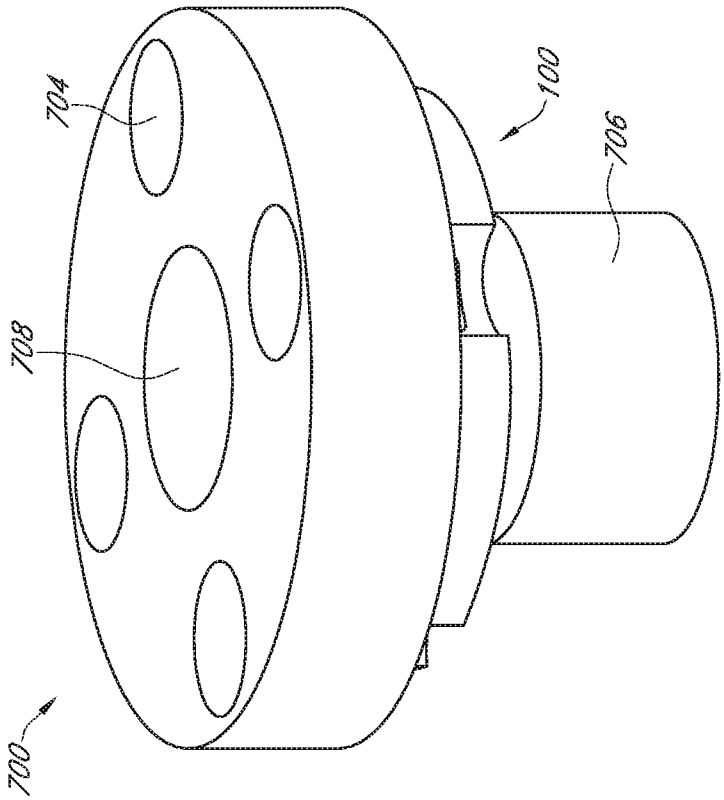

FIG. 9

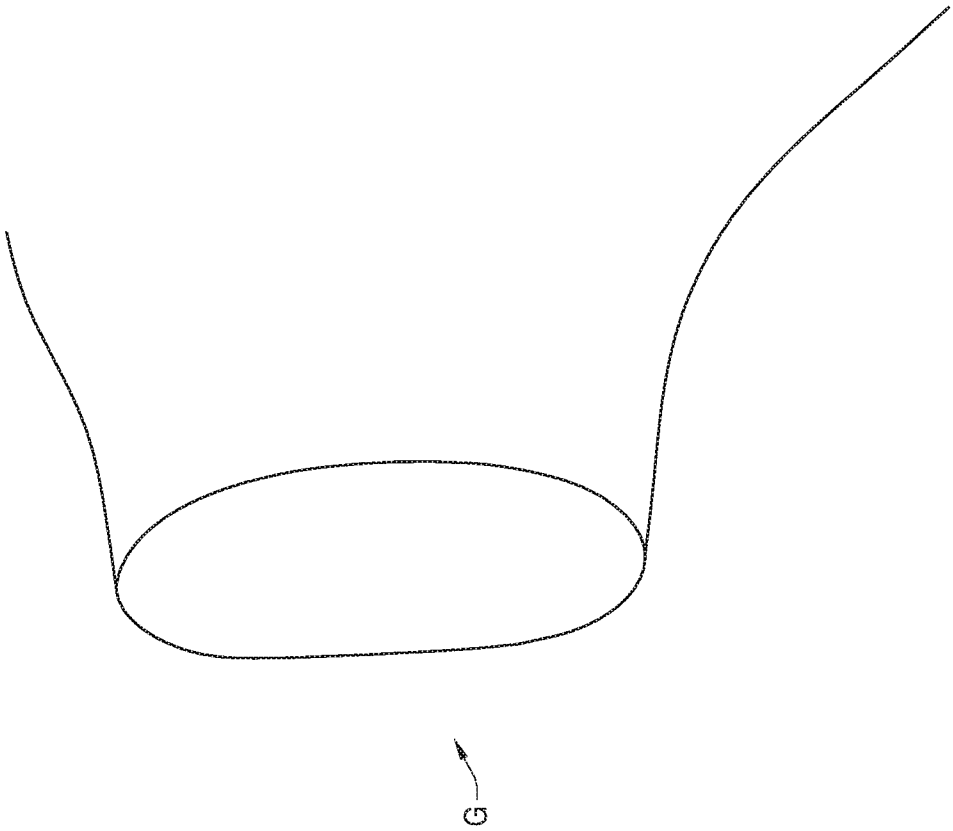

FIG. 10A

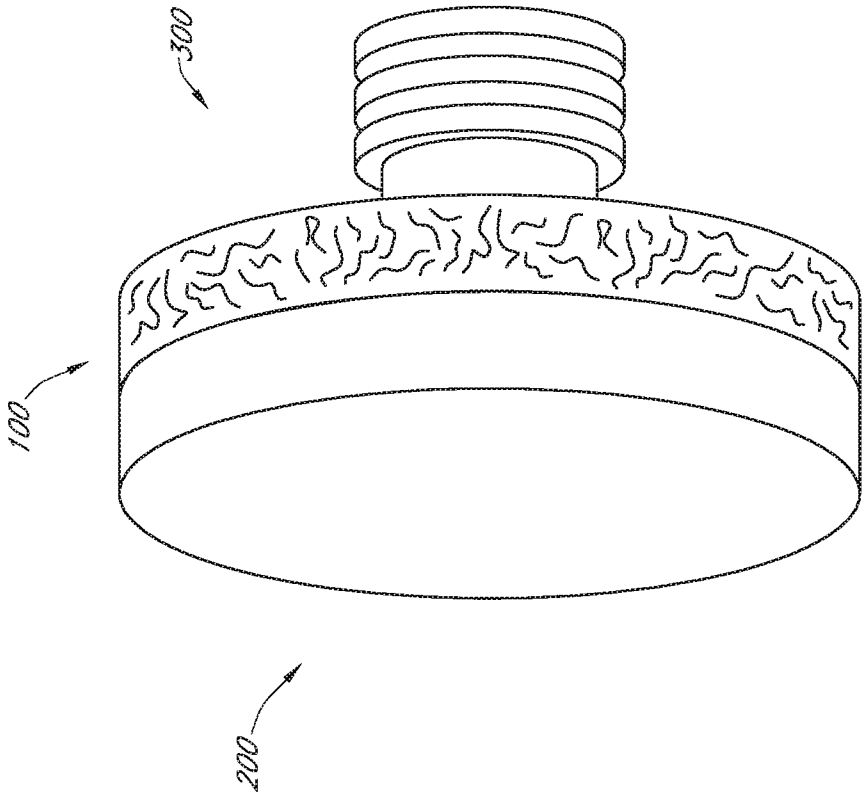

FIG. 10B

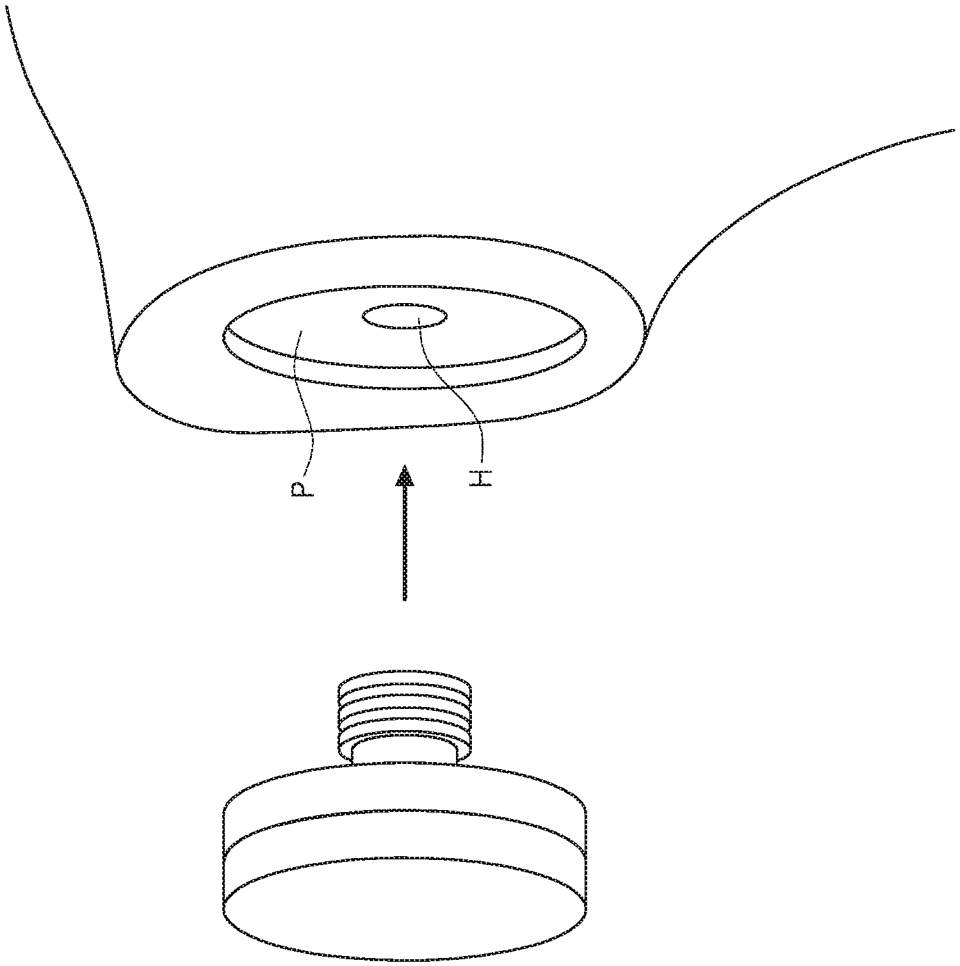

FIG. 10C

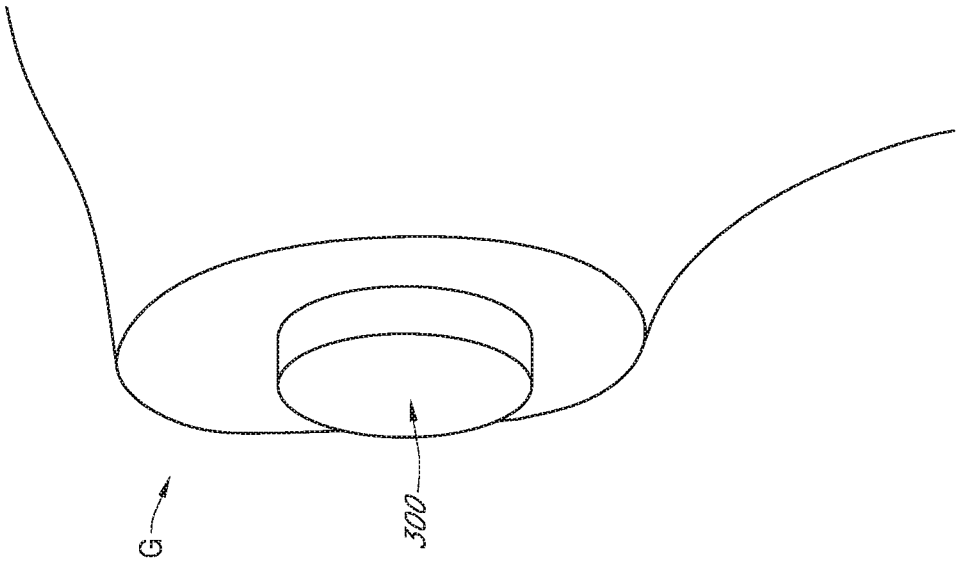

FIG. 11A

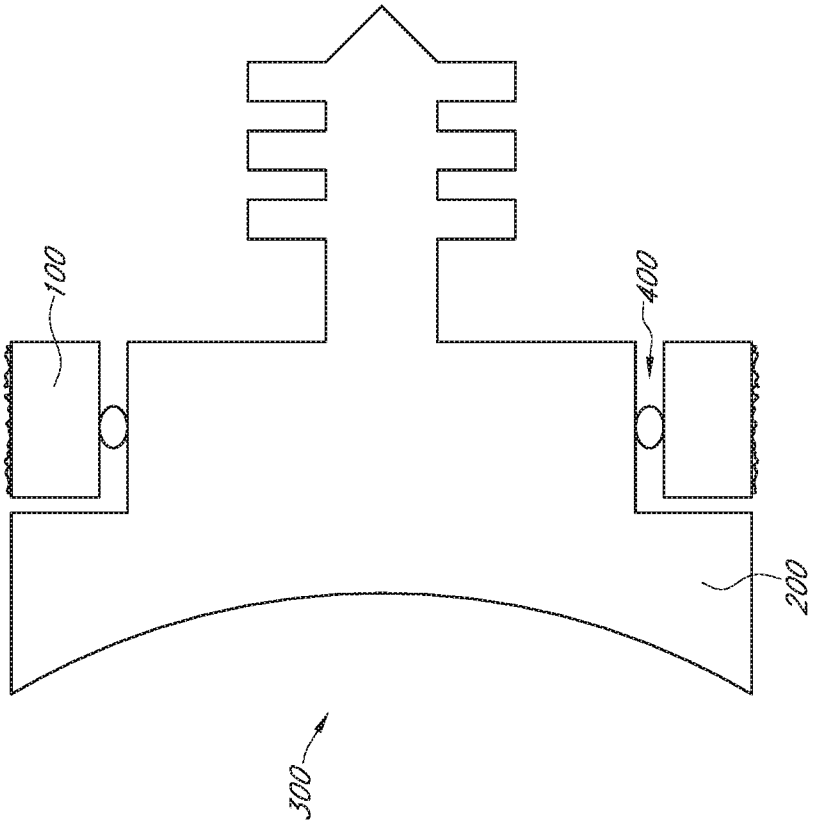

FIG. 11B

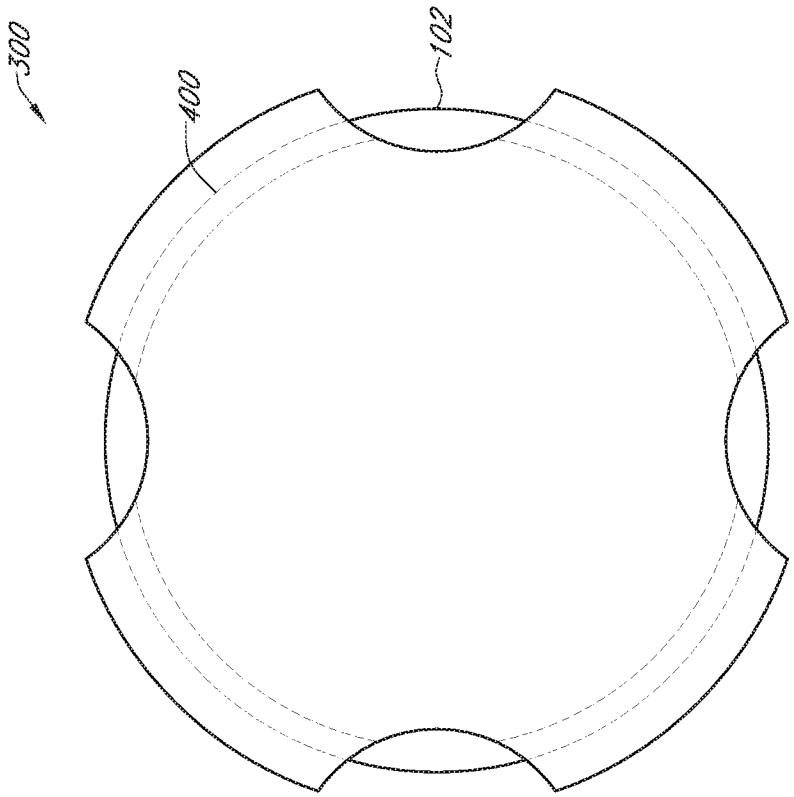

FIG. 11C

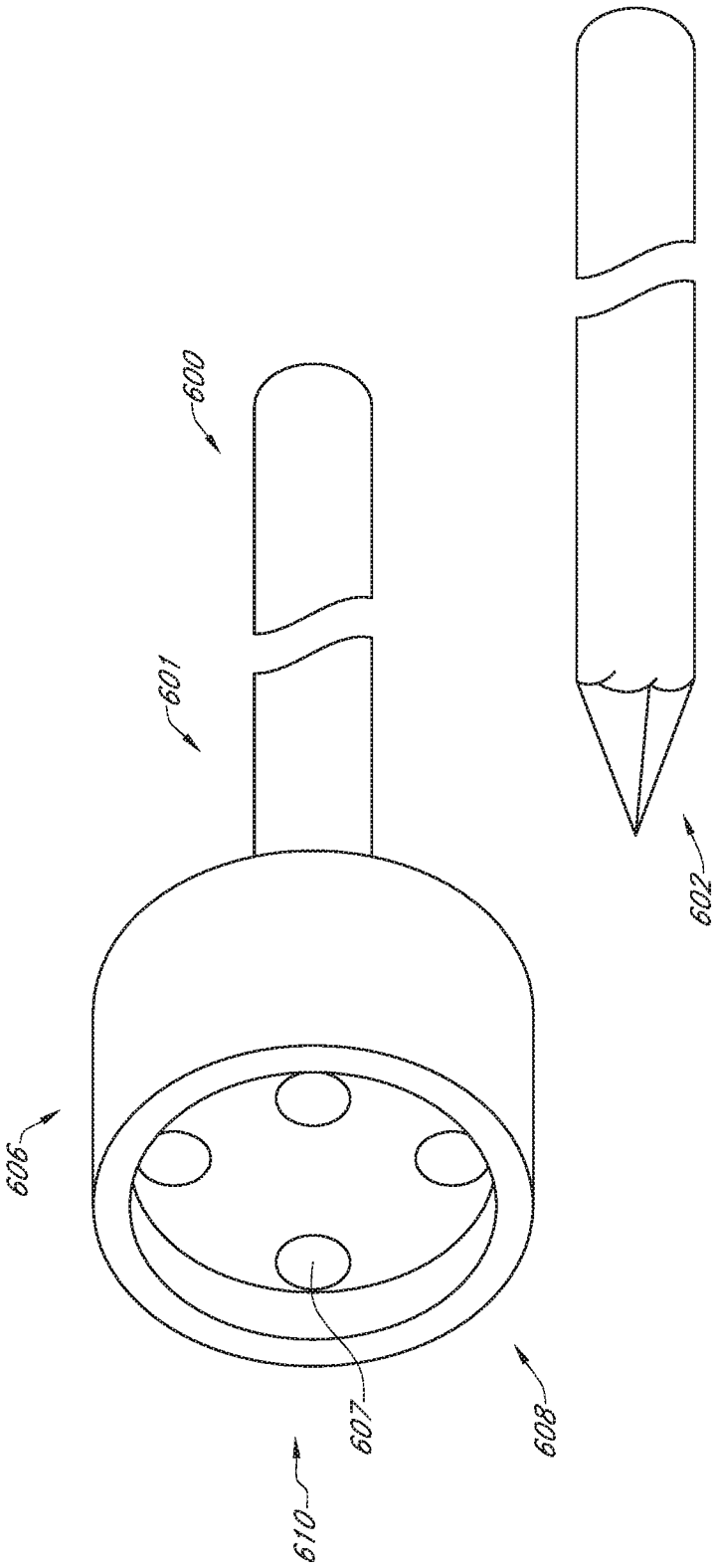

FIG. 11D

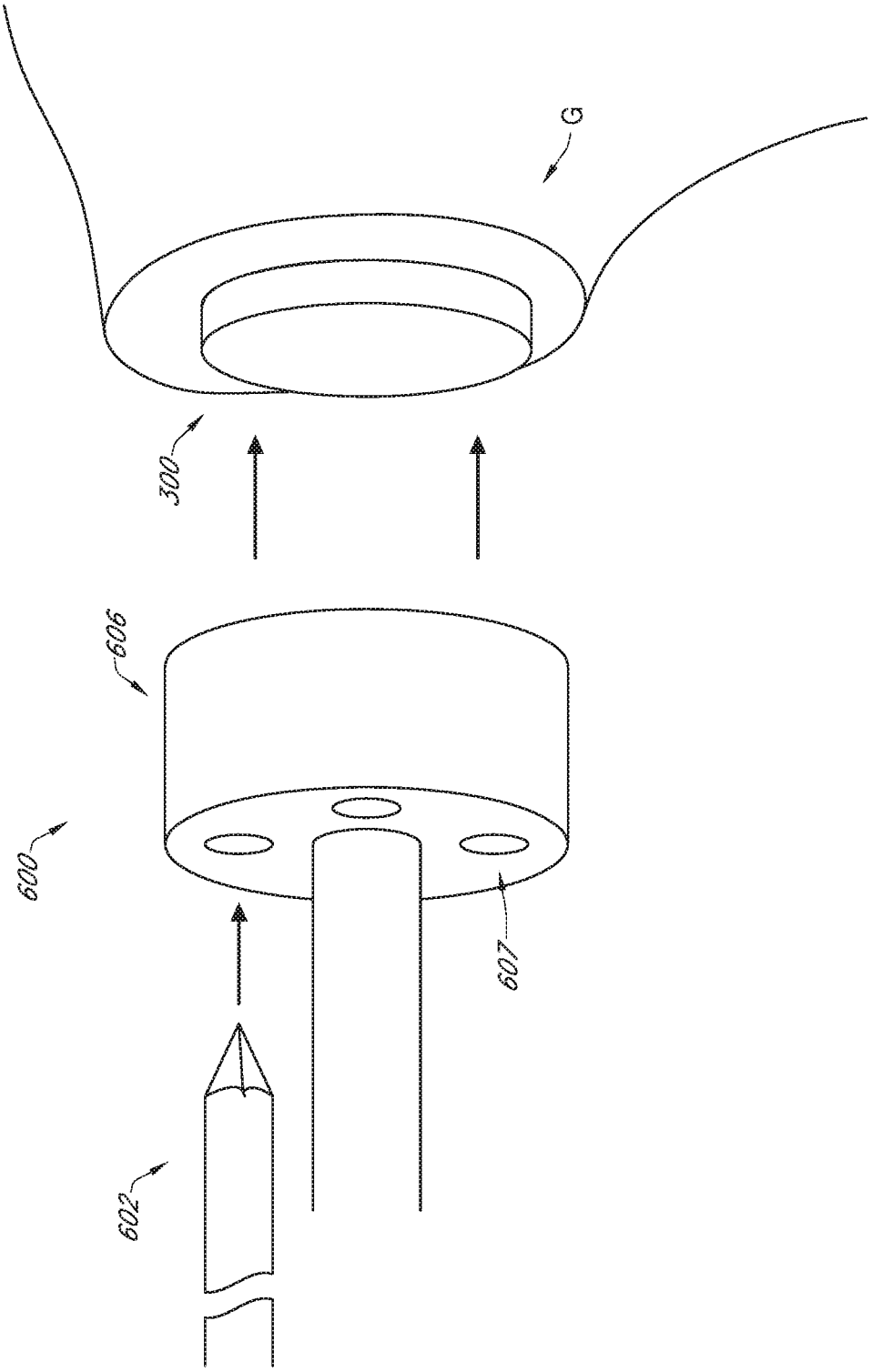

FIG. 12A

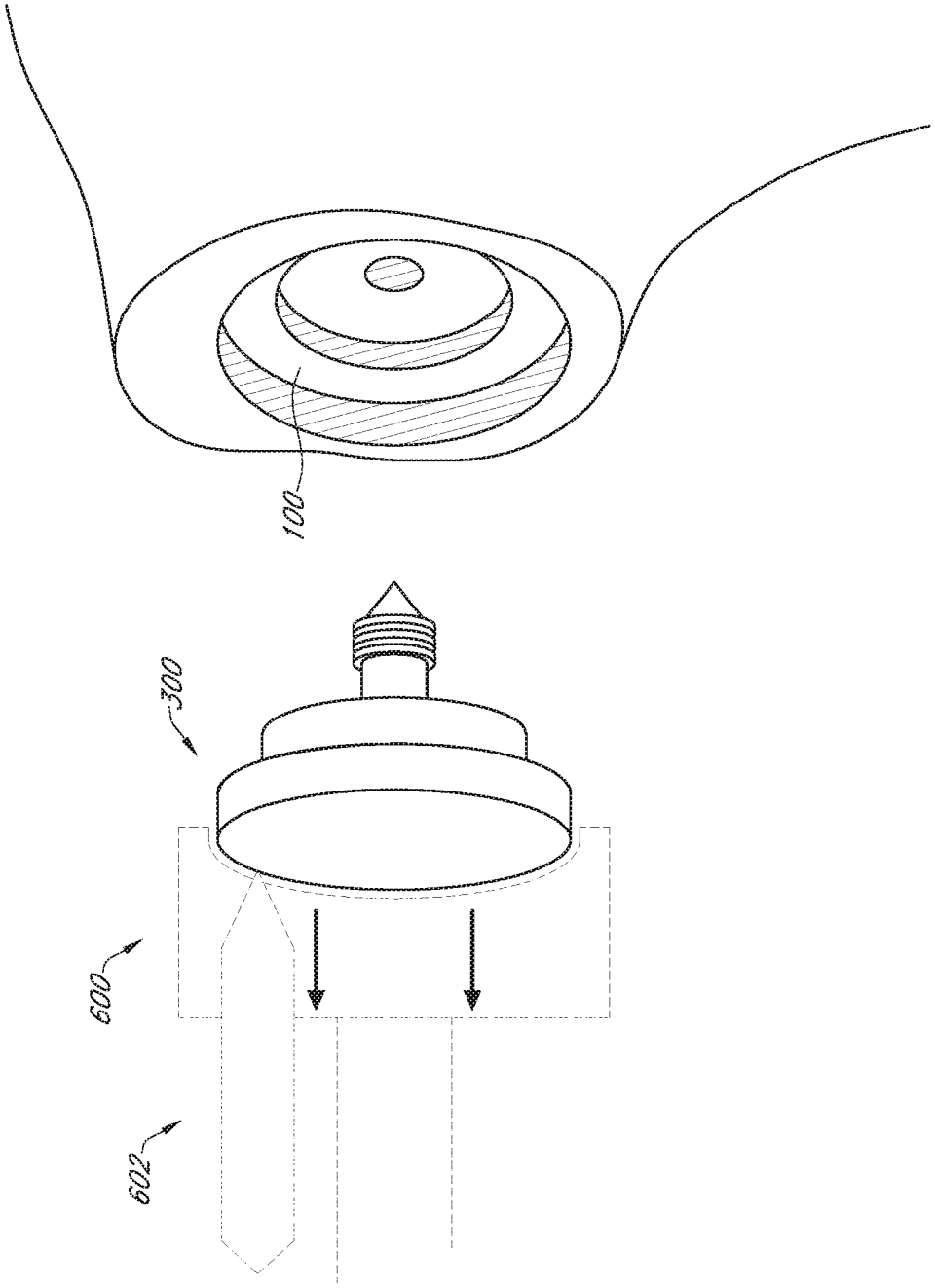

FIG. 12B

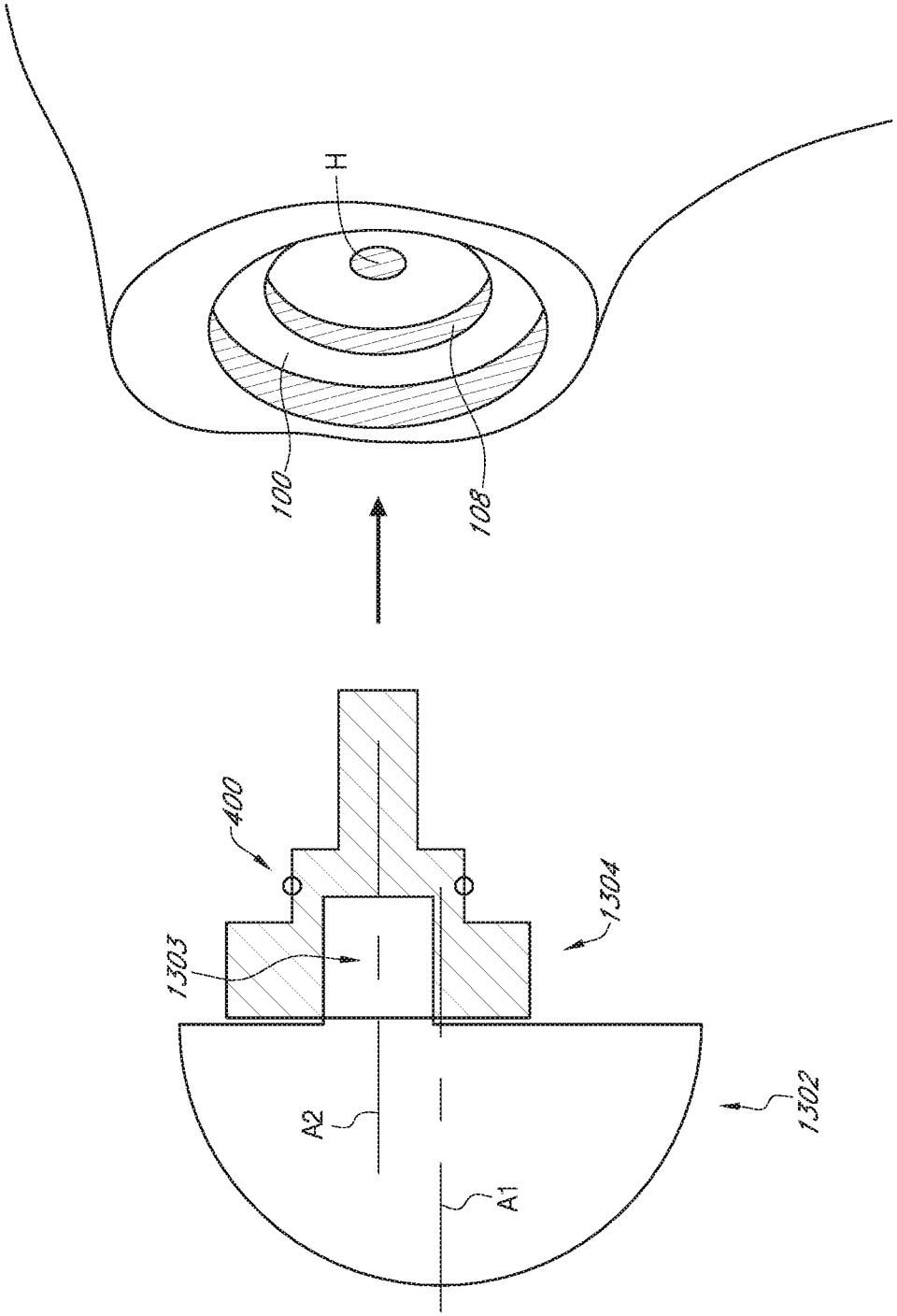

FIG. 13A

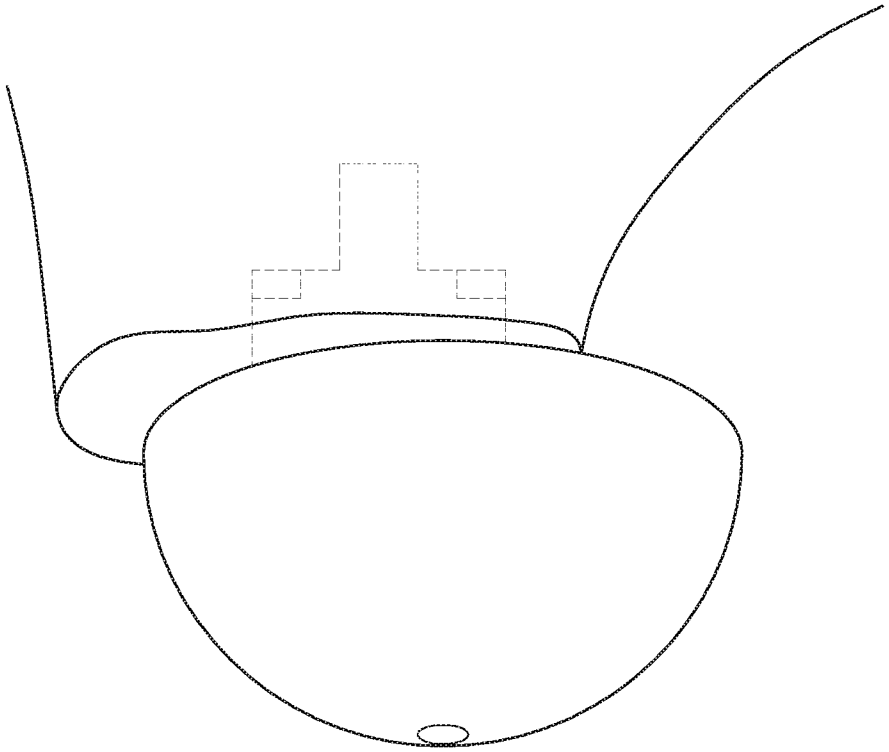

FIG. 13B

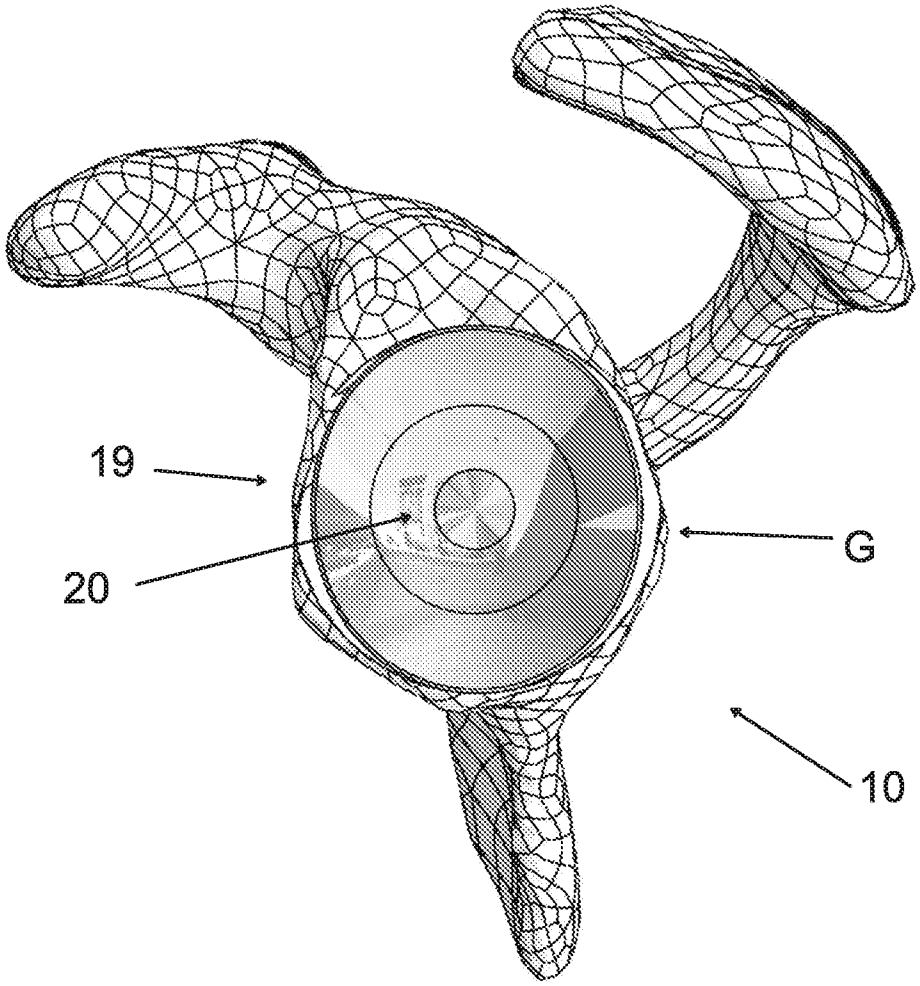

FIG. 14

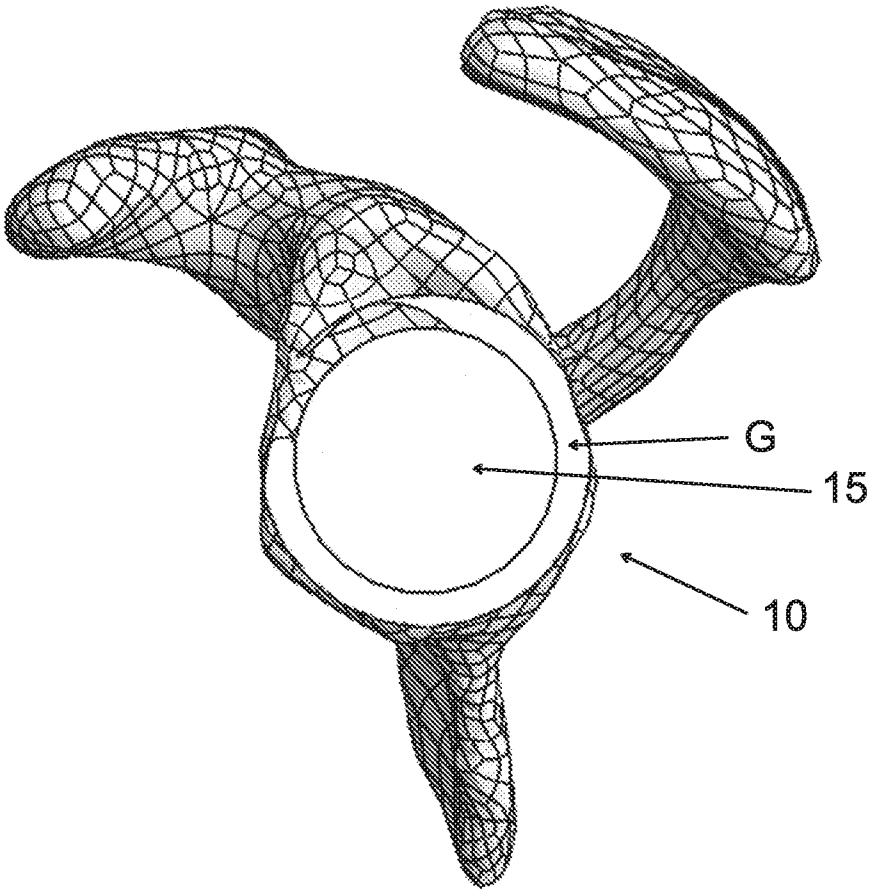

FIG. 15

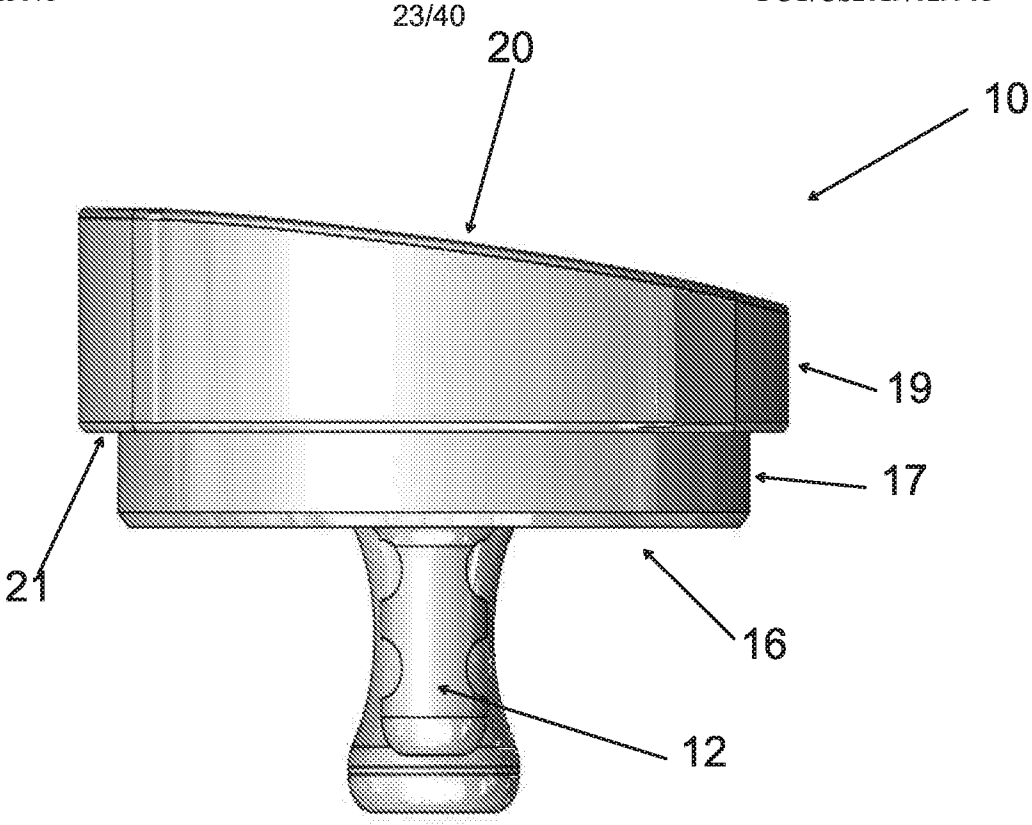

FIG. 16

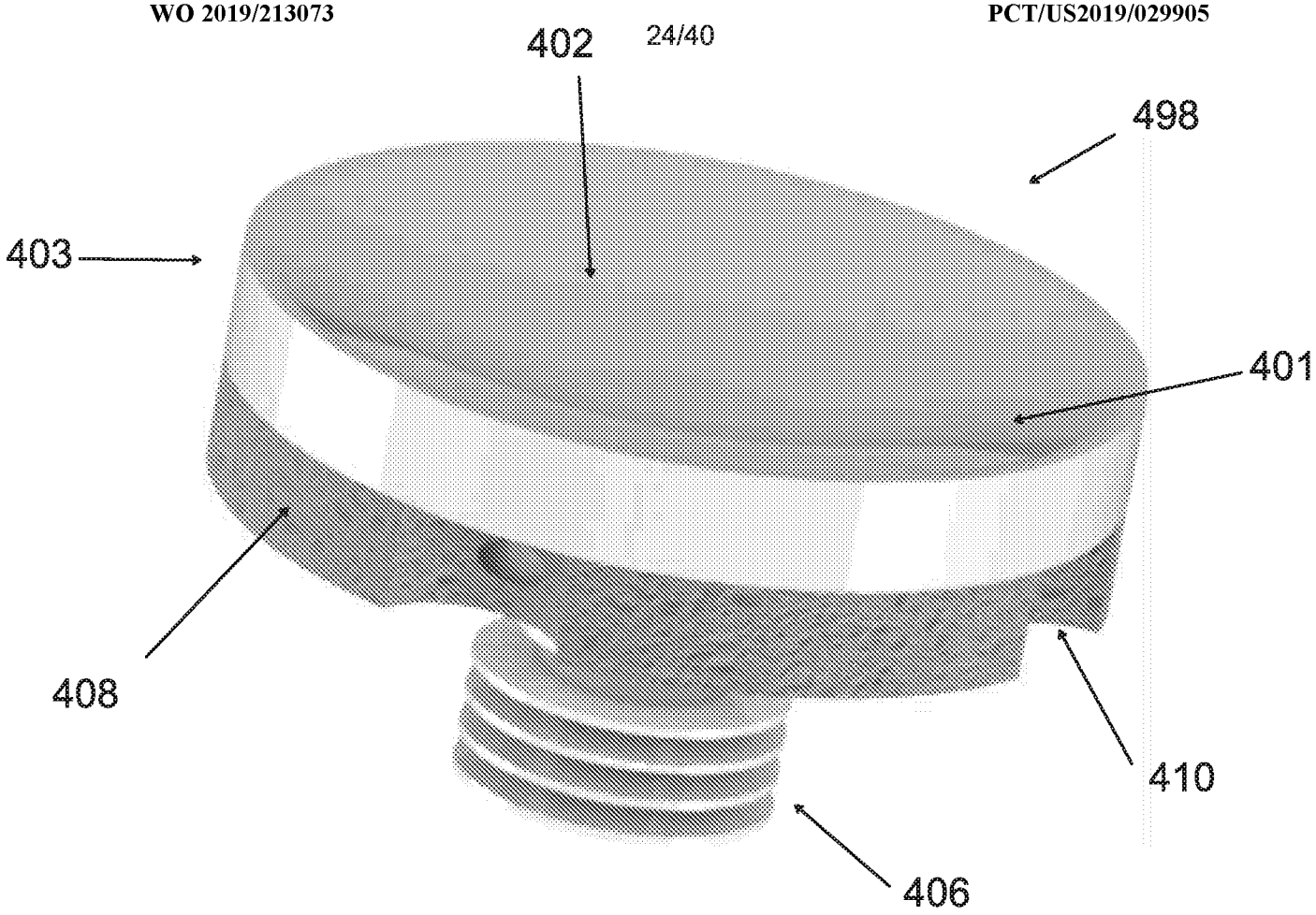

FIG. 17

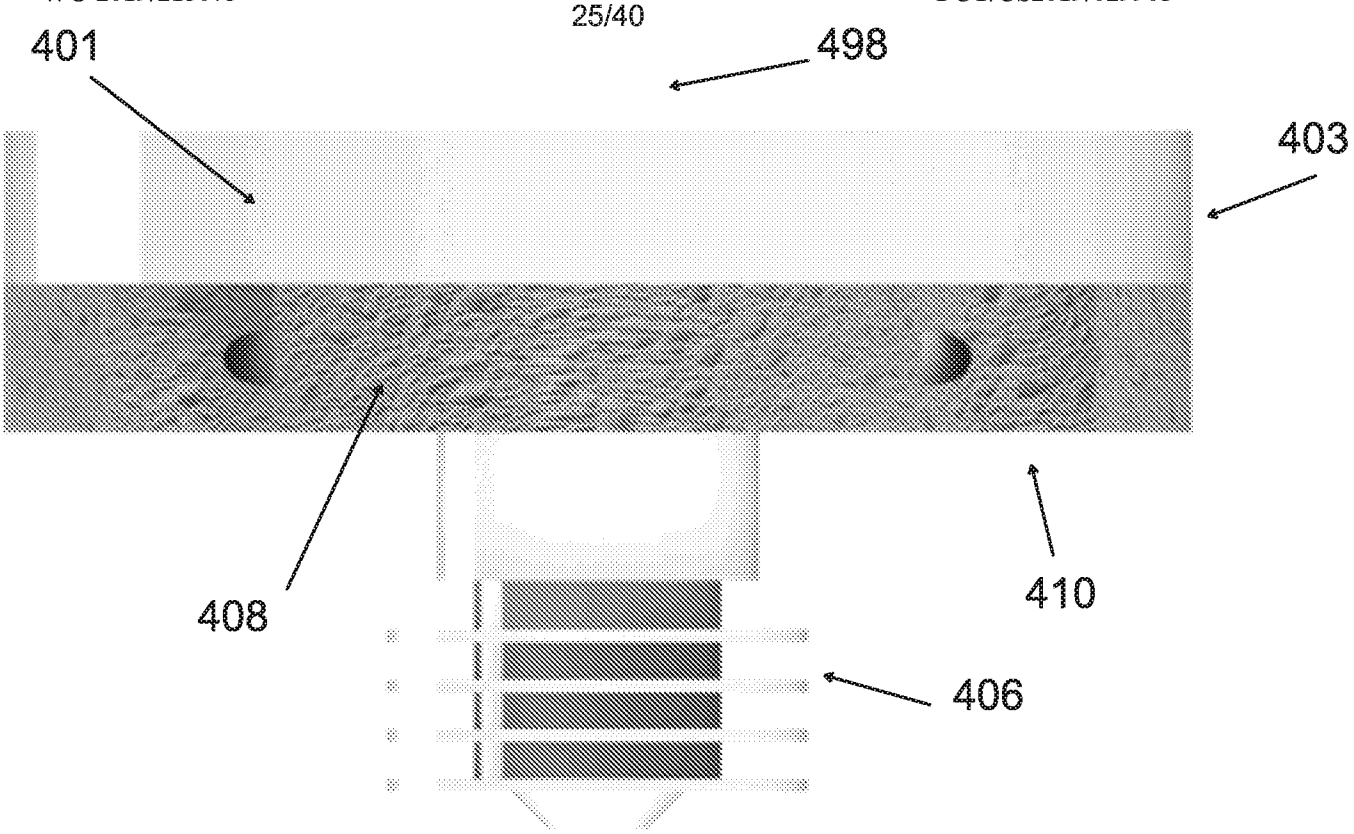

FIG. 18

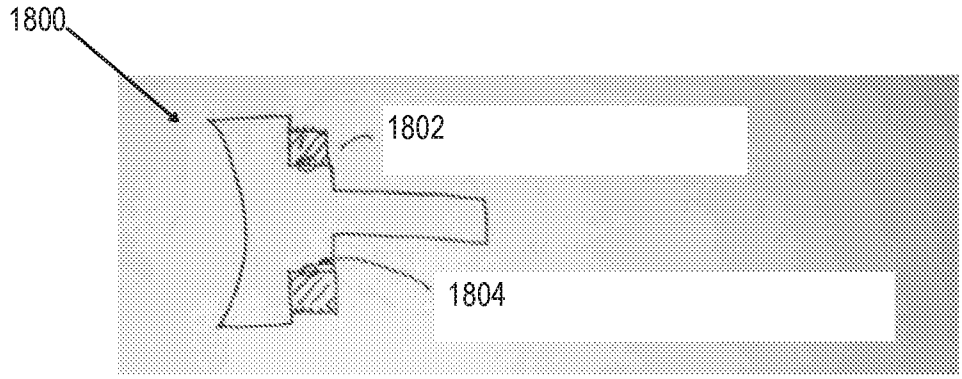

FIG. 18A

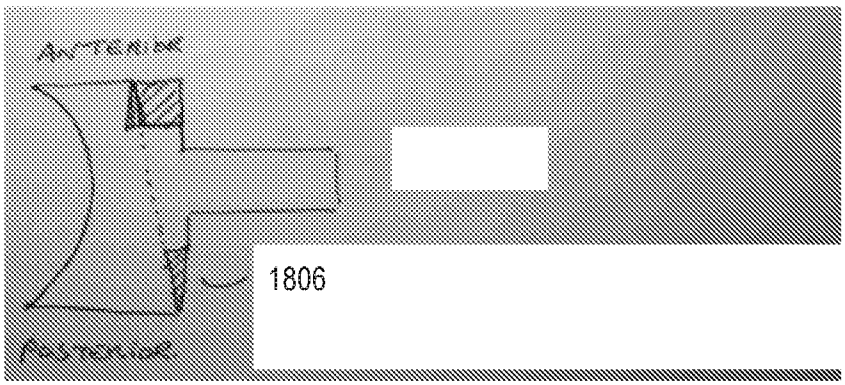

FIG. 18B

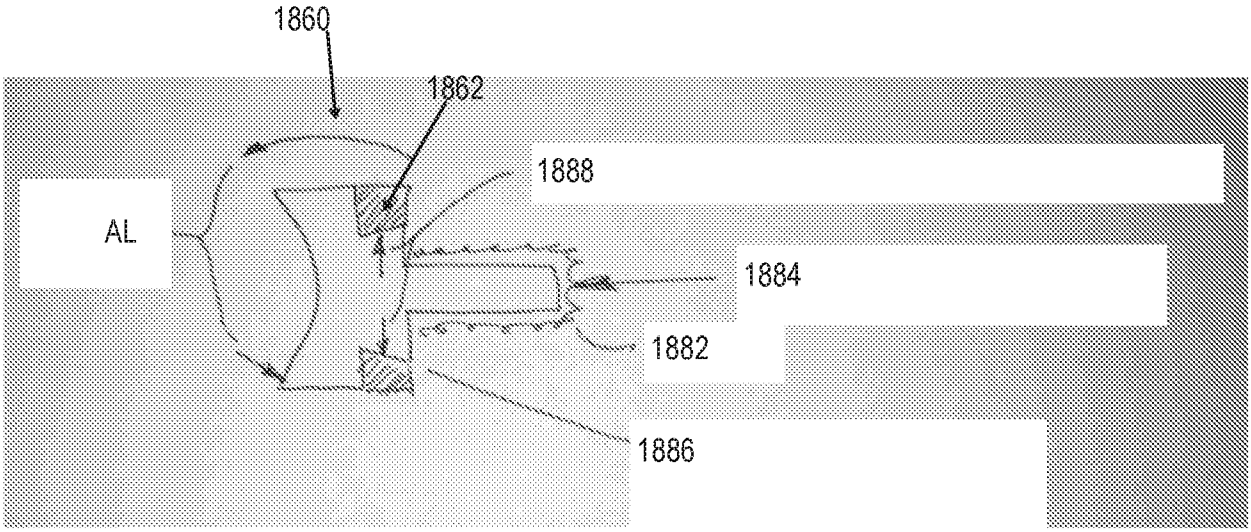

FIG. 18C

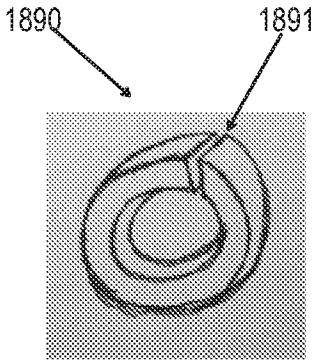

FIG. 18D

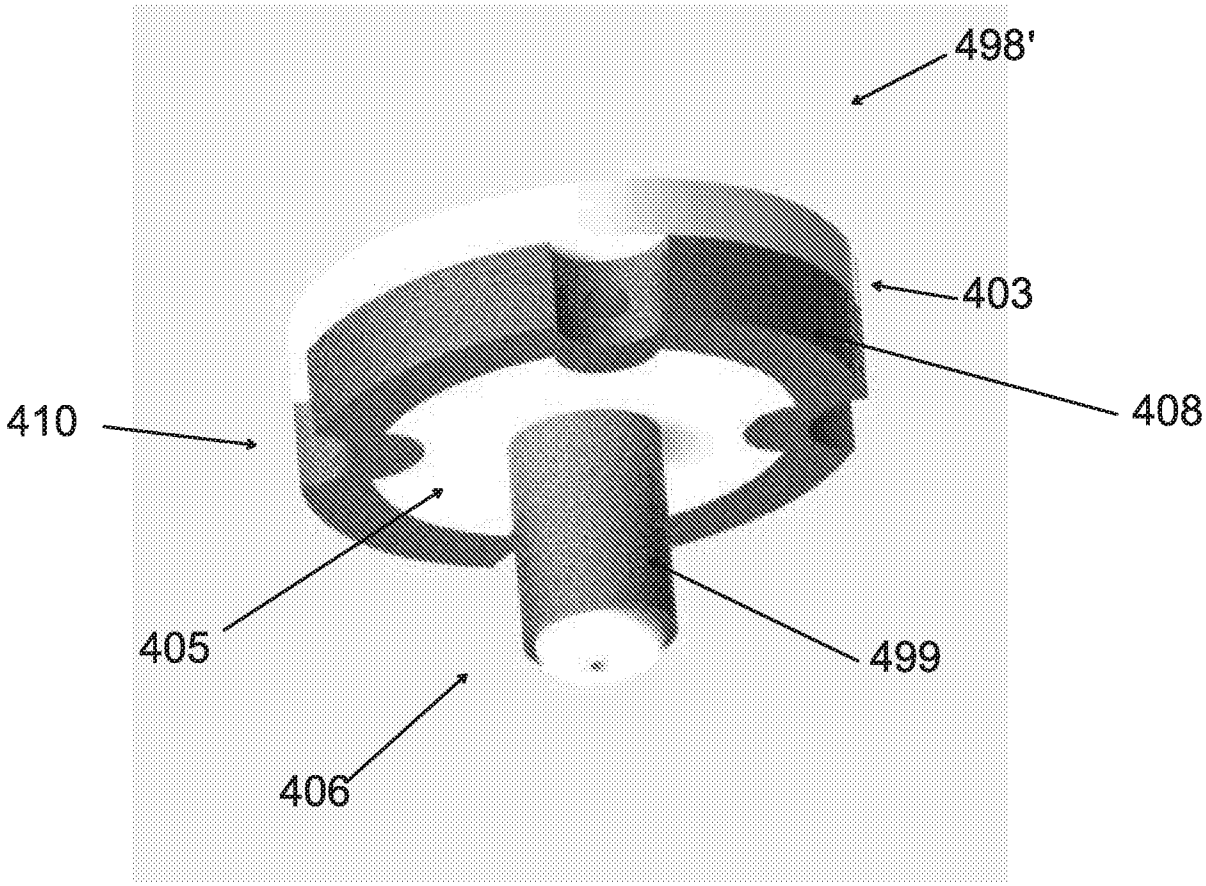

FIG. 19

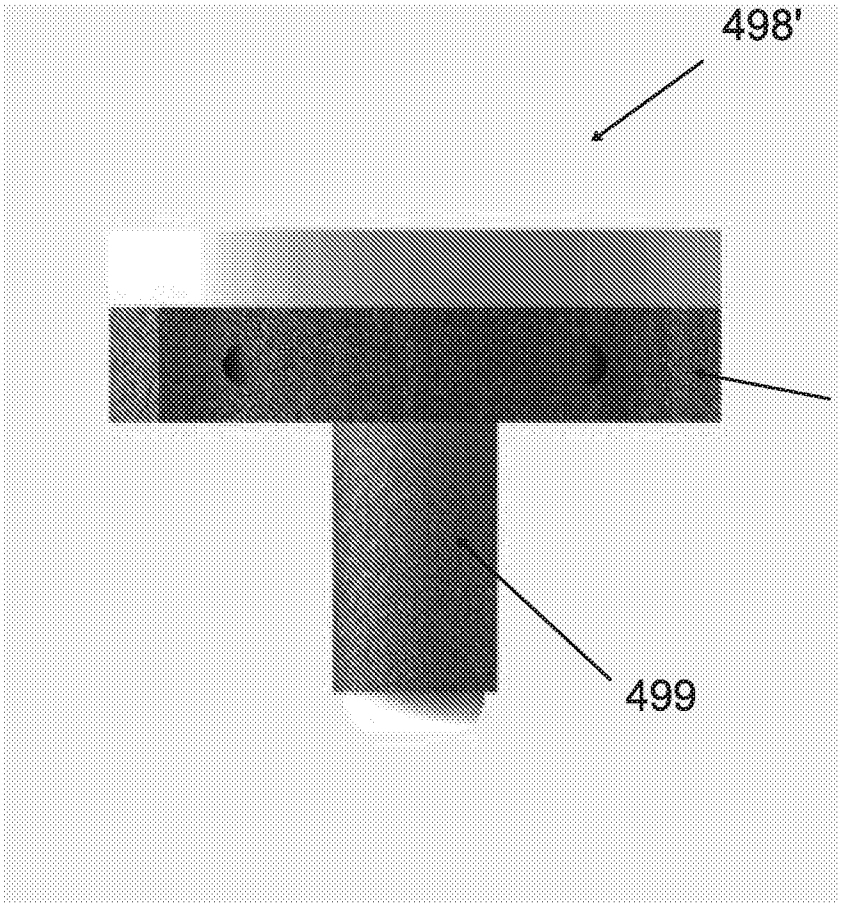

FIG. 20

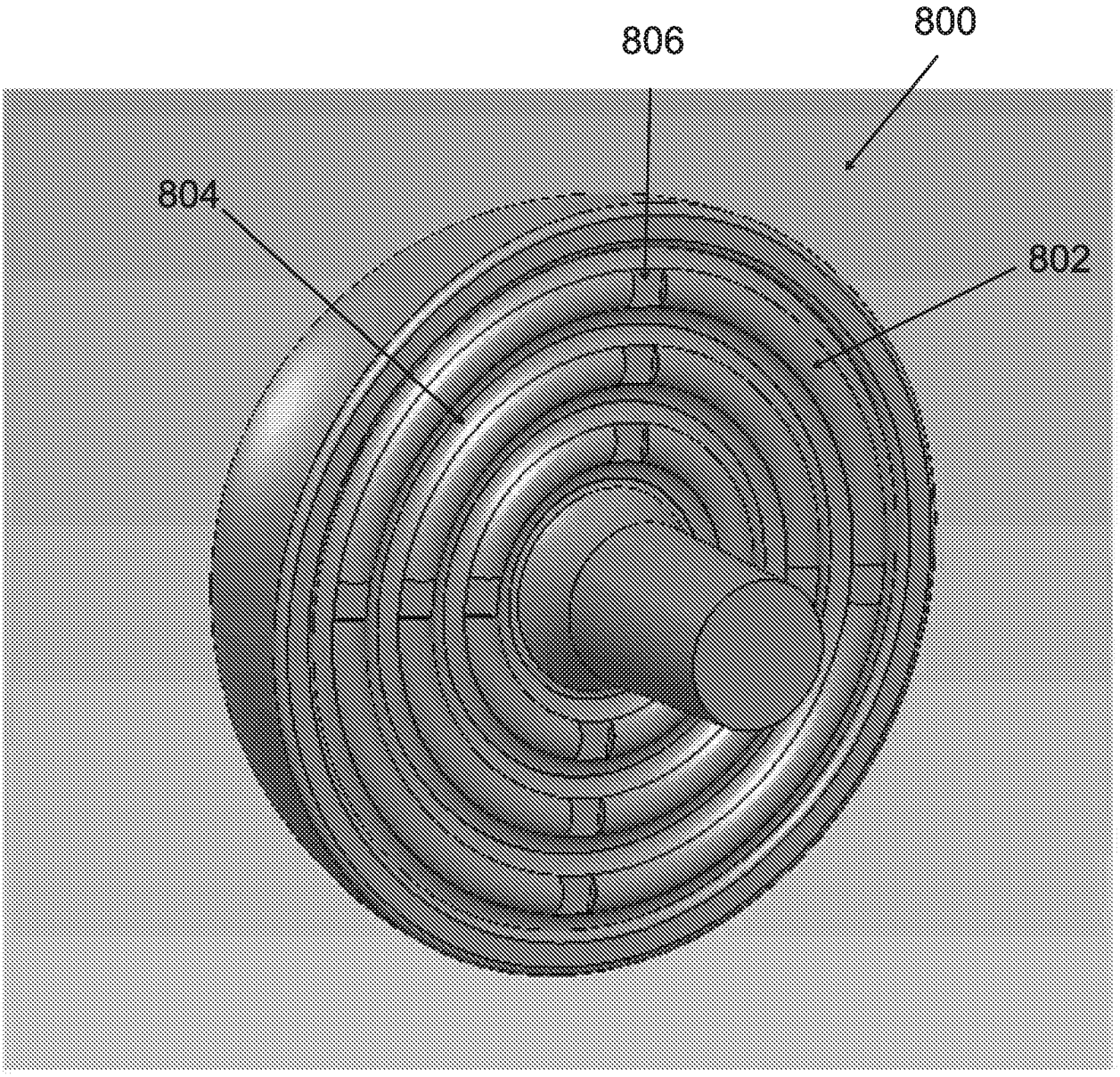

FIG. 21

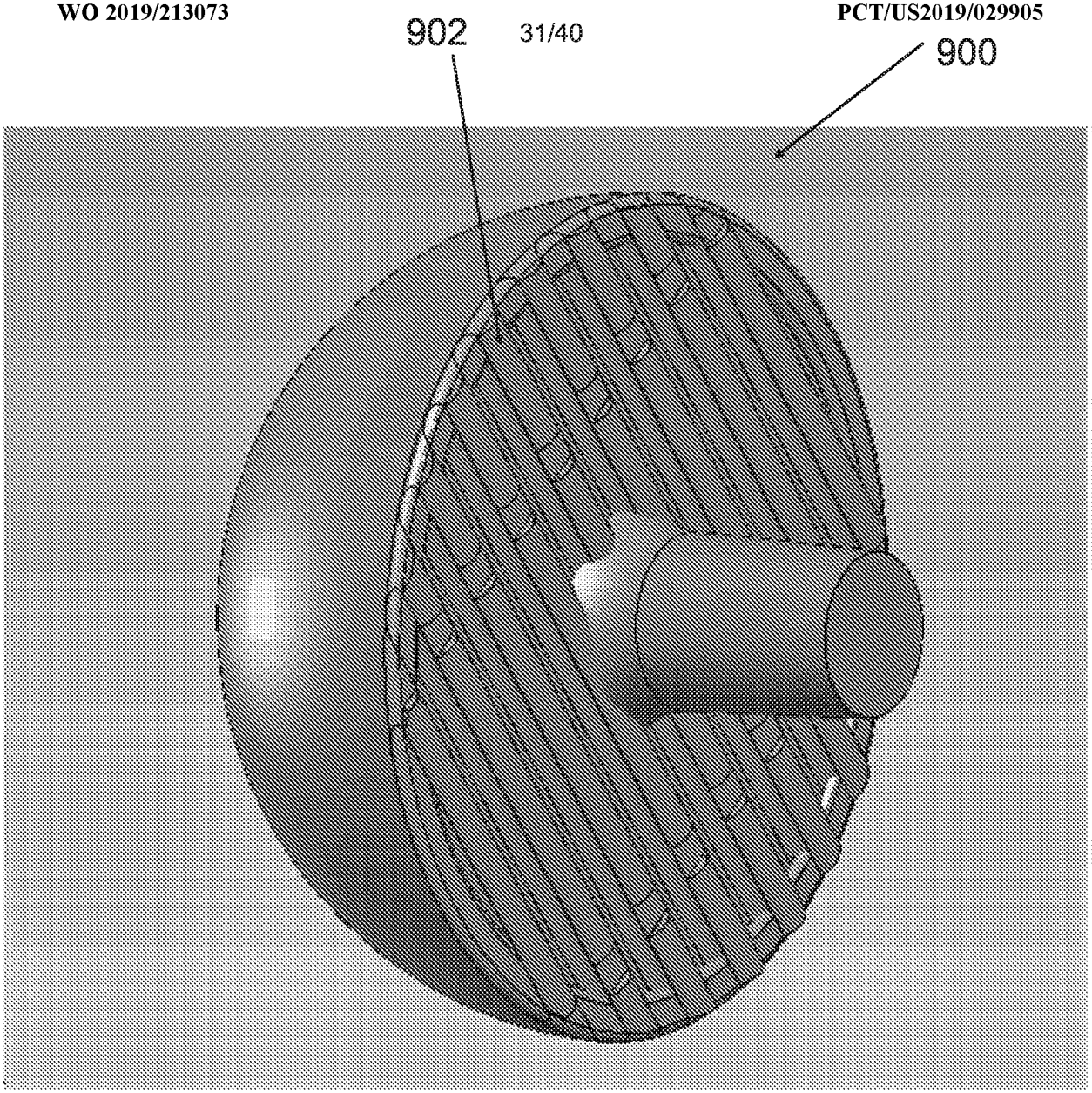

FIG. 22

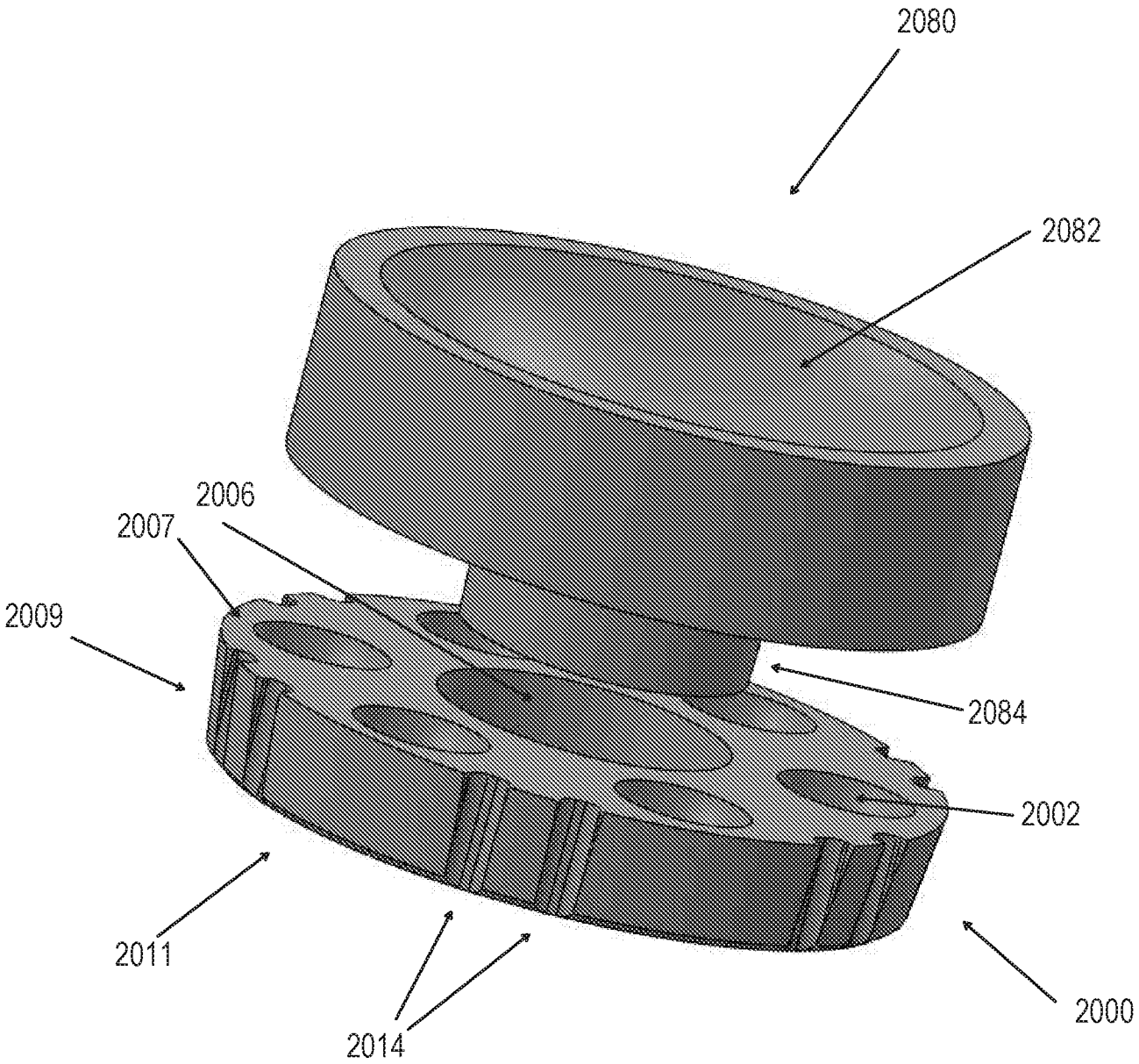

FIG. 23A

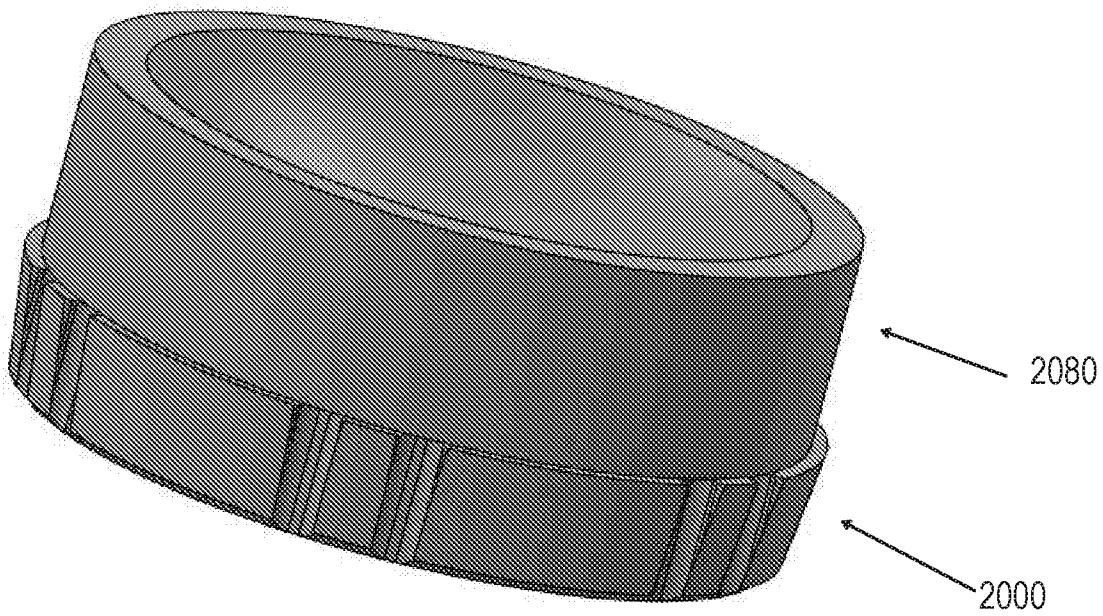

FIG. 23B

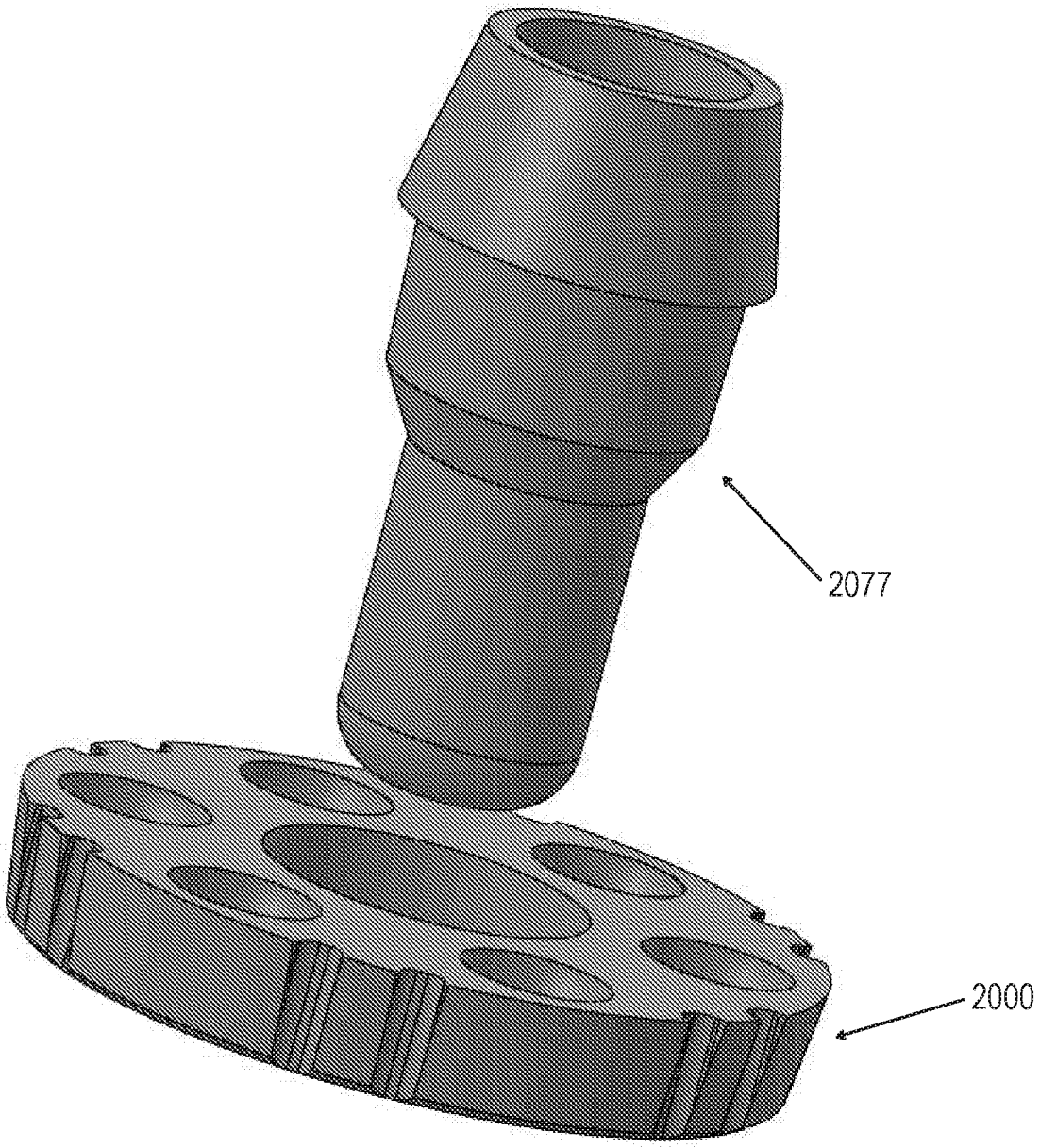

FIG. 23C

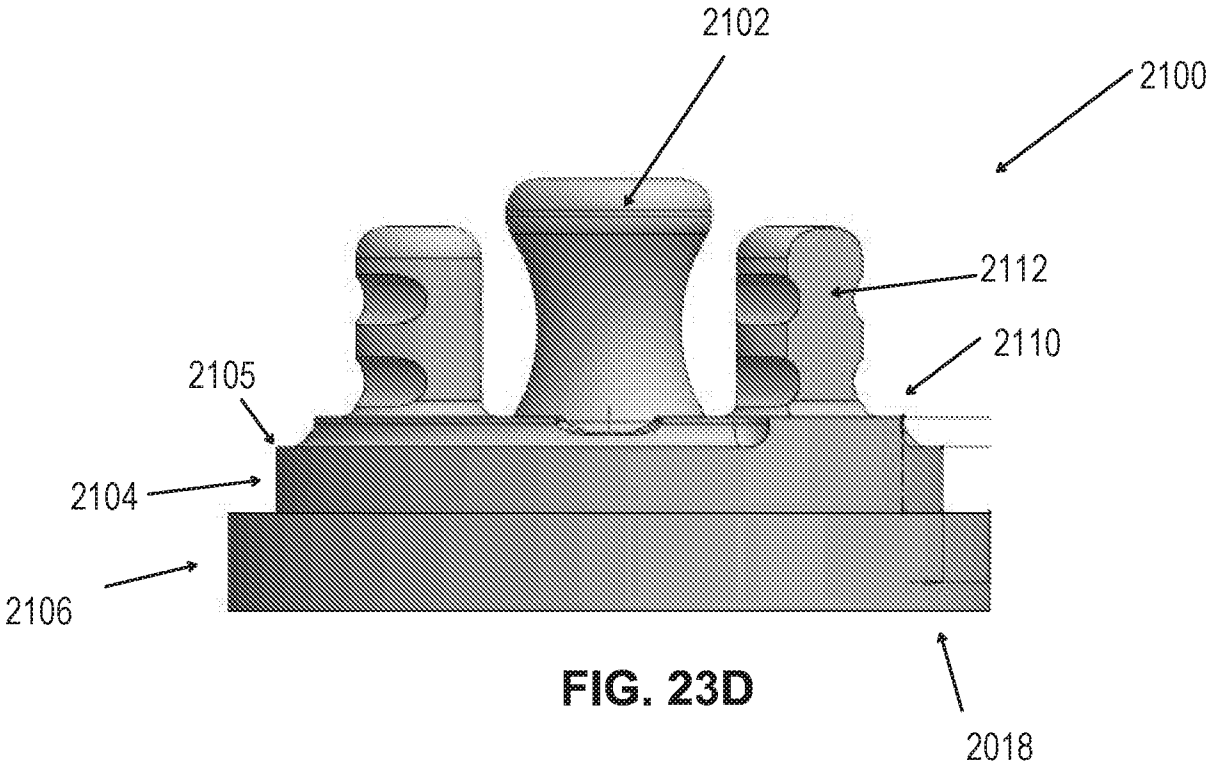

FIG. 23D

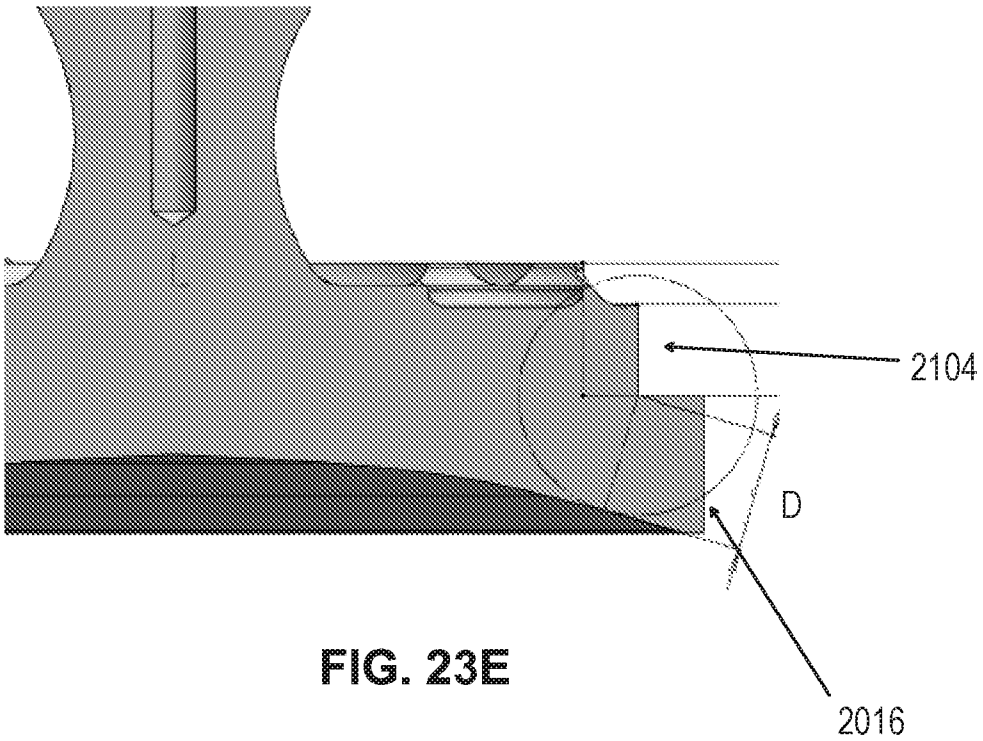

FIG. 23E

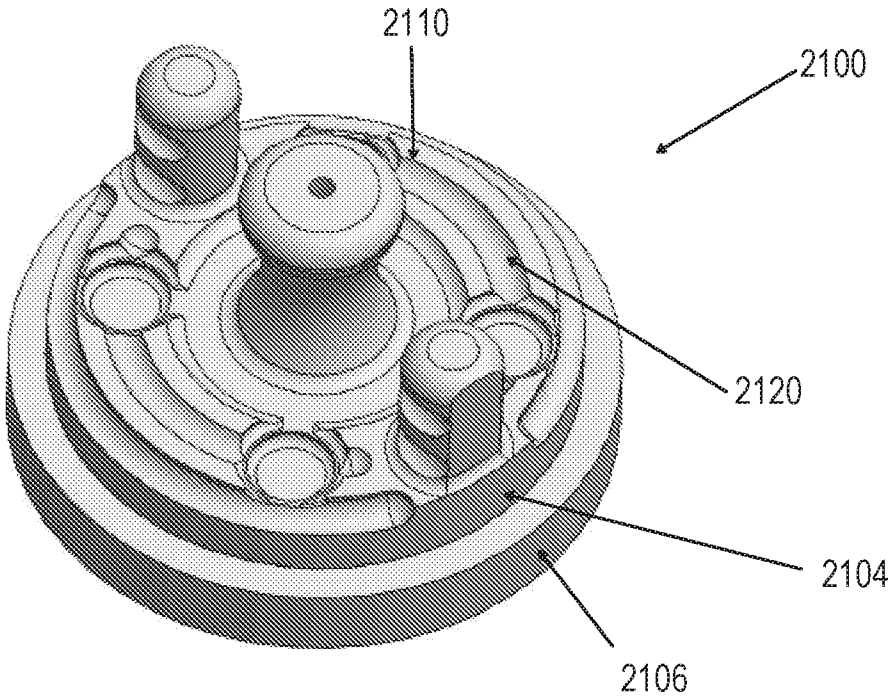

FIG. 23F

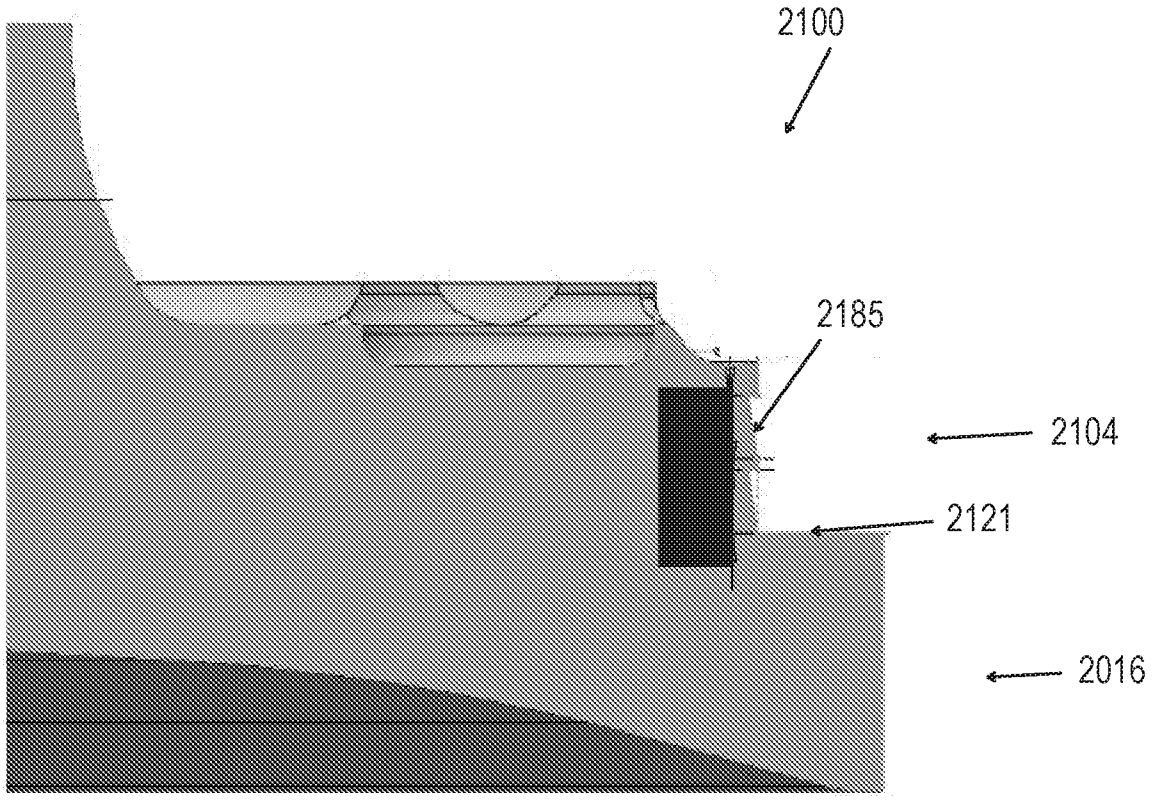

FIG. 23G

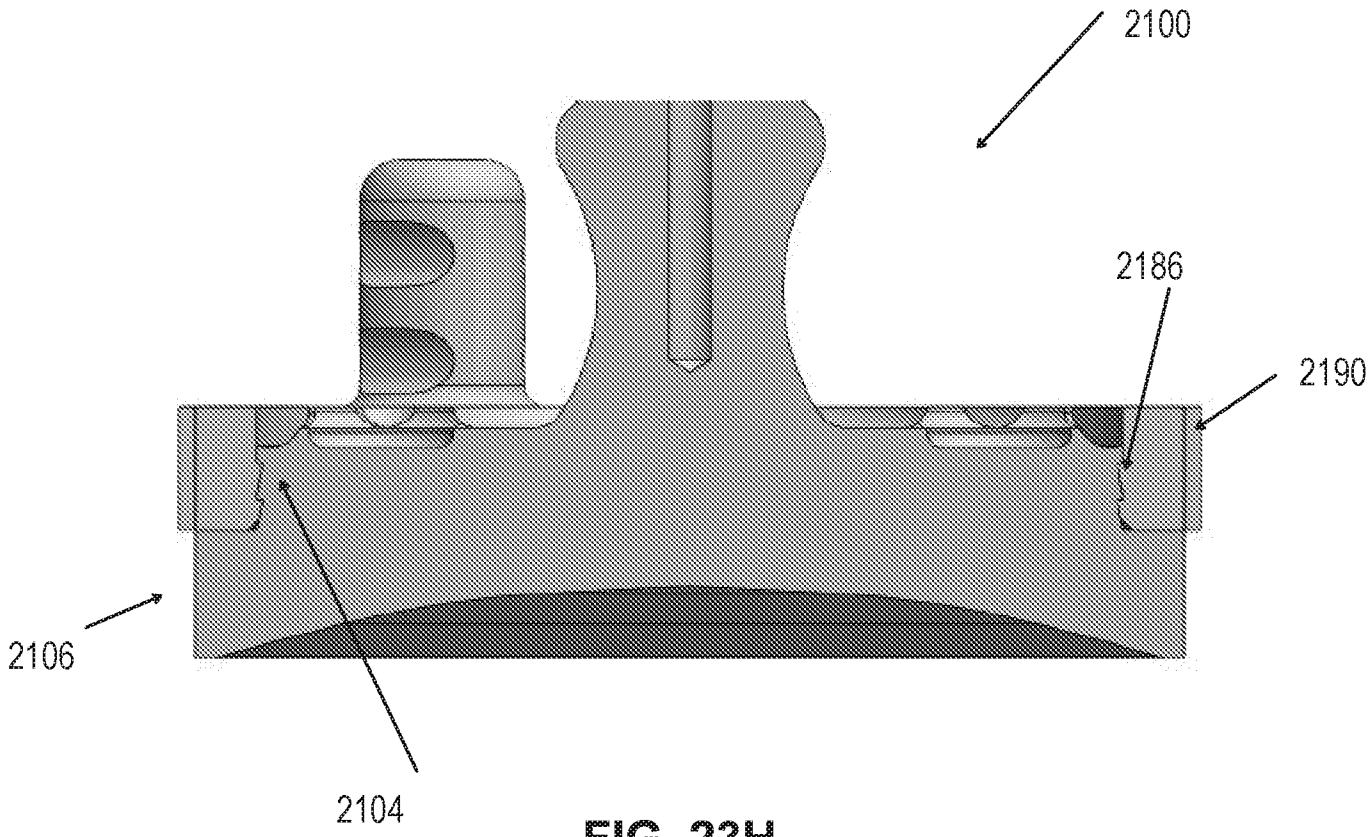

FIG. 23H

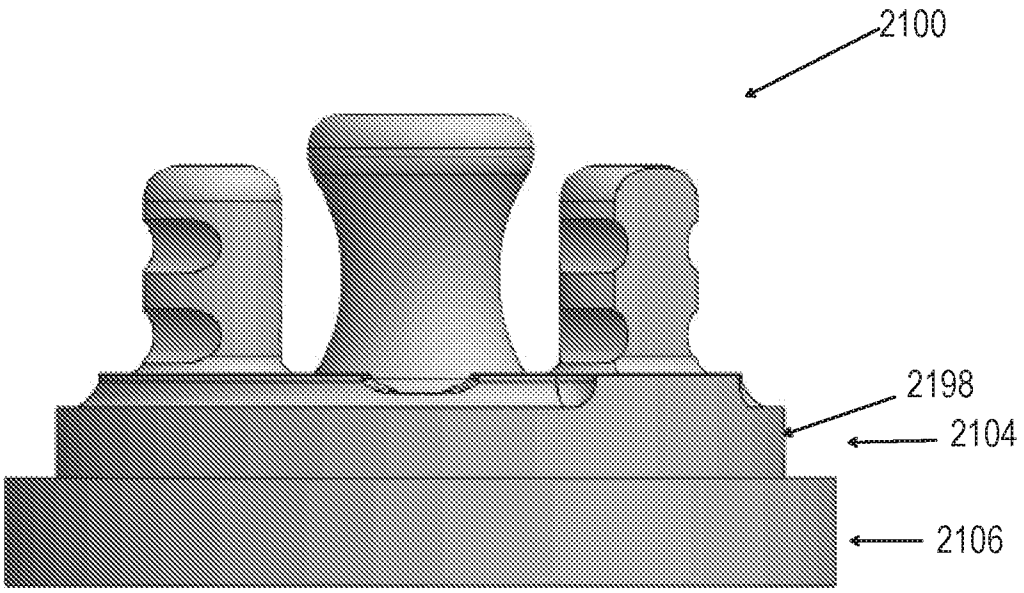

FIG. 23I

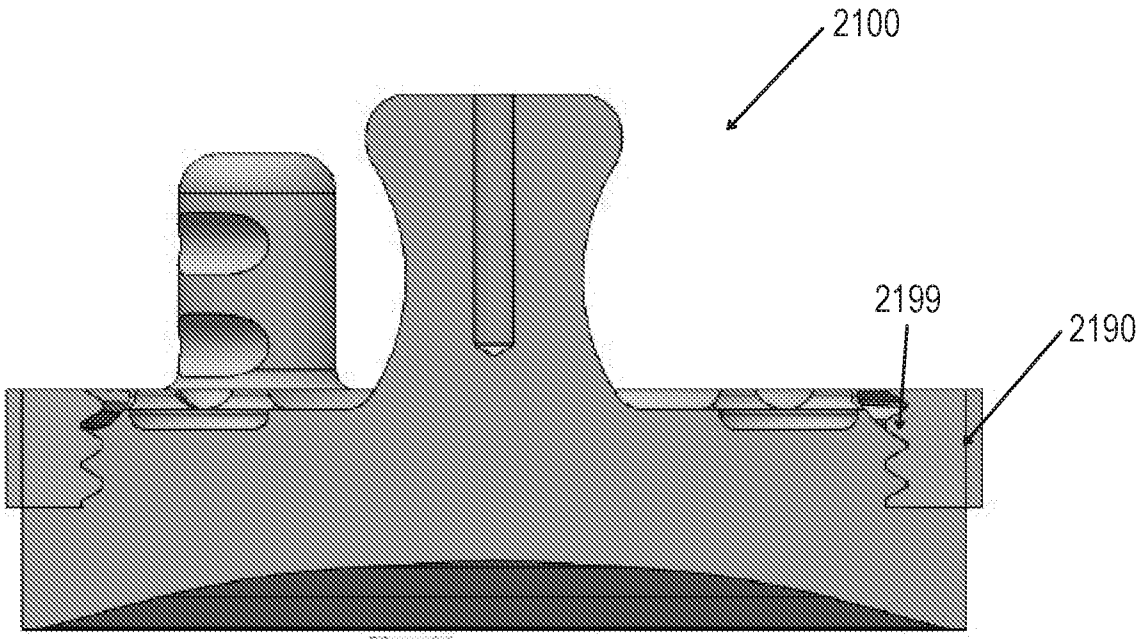

FIG. 23J

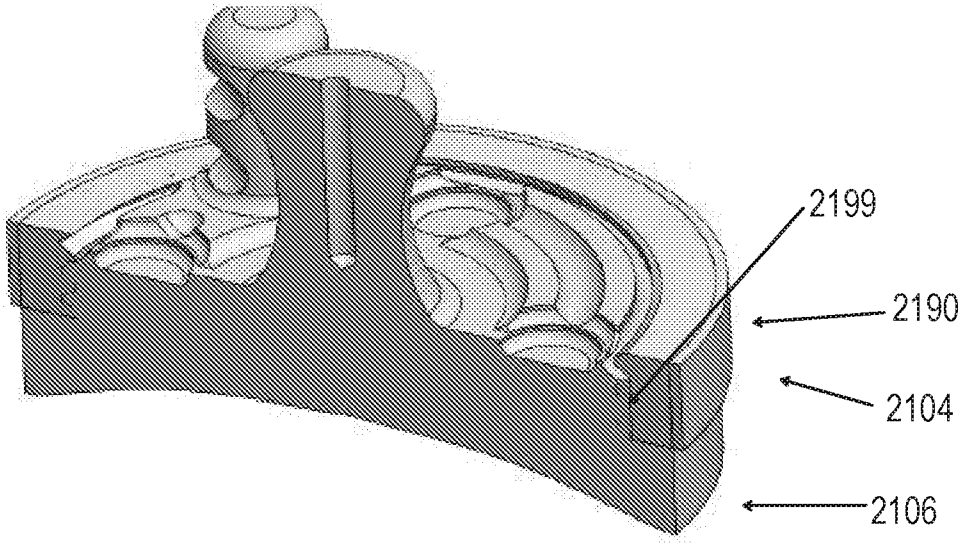

FIG. 23K

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2019/029905

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A61F 2/40; A61F 2/30; A61F 2/46 (2019.01)
CPC - A61F 2/4081; A61F 2/40; A61F 2/4059 (2019.05)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 623/19.11; 623/19.12; 623/19.13 (keyword delimited)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2017/0071749 A1 (DEPUY SYNTHES PRODUCTS INC) 16 March 2017 (16.03.2017) entire document	1-12
A	US 2009/0287309 A1 (WALCH et al) 19 November 2009 (19.11.2009) entire document	1-12
A	US 2014/0107794 A1 (DEPUY (IRELAND)) 17 April 2014 (17.04.2014) entire document	1-12

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 June 2019	18 JUL 2019
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300	Authorized officer Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774