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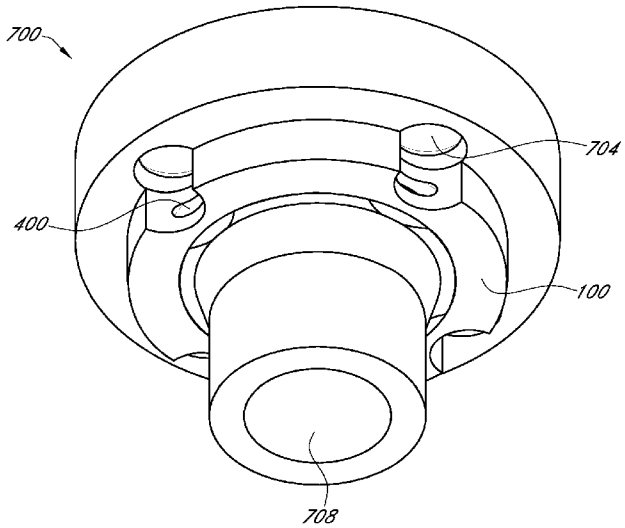


FIG. 8

(57) Abstract: Disclosed are prosthesis systems and methods that provide ways 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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TOTAL SHOULDER PROSTHESIS HAVING INSET GLENOID IMPLANT CONVERTIBLE FROM ANATOMIC TO REVERSE

[0001] This application claims the benefit under 35 U.S.C. § 119(e) as a nonprovisional of U.S. Prov. App. No. 62/485839 filed on April 14, 2017, 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.

SUMMARY

[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.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] 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.

[0015] FIG. 2 illustrates an upper perspective view of an embodiment of a support, e.g., an annular ring 100.

[0016] 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.

[0017] 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.

[0018] 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.

[0019] 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.

[0020] 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.

[0021] 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.

[0022] 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.

DETAILED DESCRIPTION

[0023] 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.

[0024] 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.

[0025] 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).

[0026] 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.

[0027] 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.

[0028] 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).

[0029] 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.

[0030] 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.

[0031] 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.

[0032] 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.

[0033] 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.

[0034] 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.

[0035] 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.

[0036] 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.

[0037] 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.

[0038] 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.

[0039] 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.

[0040] 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.

[0041] 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.

[0042] 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. 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 "insetting an implant into a glenoid cavity" includes "instructing the insetting of an implant into the glenoid cavity." 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 to a snap ring attached to a fixation ring, the snap ring and 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 method of converting an anatomic to a reverse shoulder prosthesis, comprising:

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.

7. The method of Claim 6, wherein inserting the removal tool comprises driving pins of the removal tool through the lateral articulating surface of the anatomic glenoid articular implant.

8. A reversible anatomic shoulder replacement system, comprising:

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.

9. The system of Claim 8, wherein the groove comprises anti-rotation tabs.

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

11. The system of Claim 10, wherein the peripheral edge of the fixation ring comprises an osteoinductive or osteoconductive surface.

12. The system of Claim 8, wherein the groove is a circumferential groove.

13. The system of Claim 8, wherein the lateral surface comprises polyethylene.

14. A reverse shoulder replacement kit for an anatomic shoulder replacement system, comprising:

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.

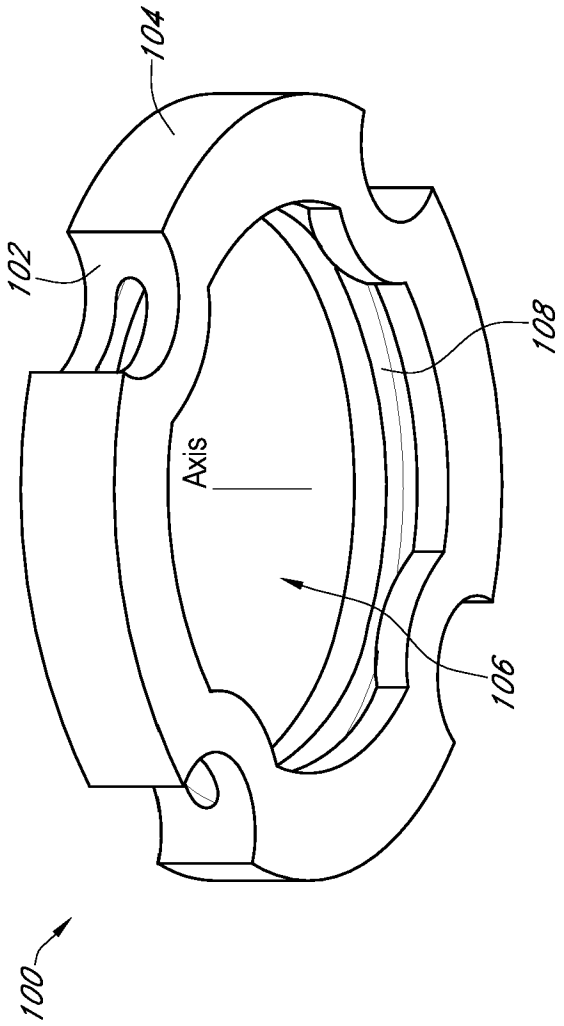


FIG. 1

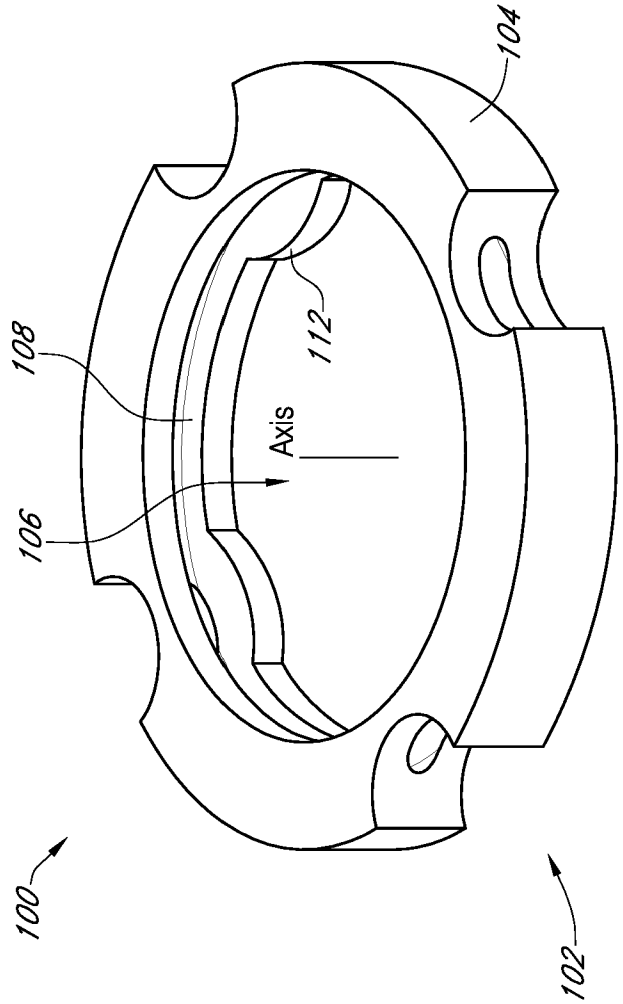


FIG. 2

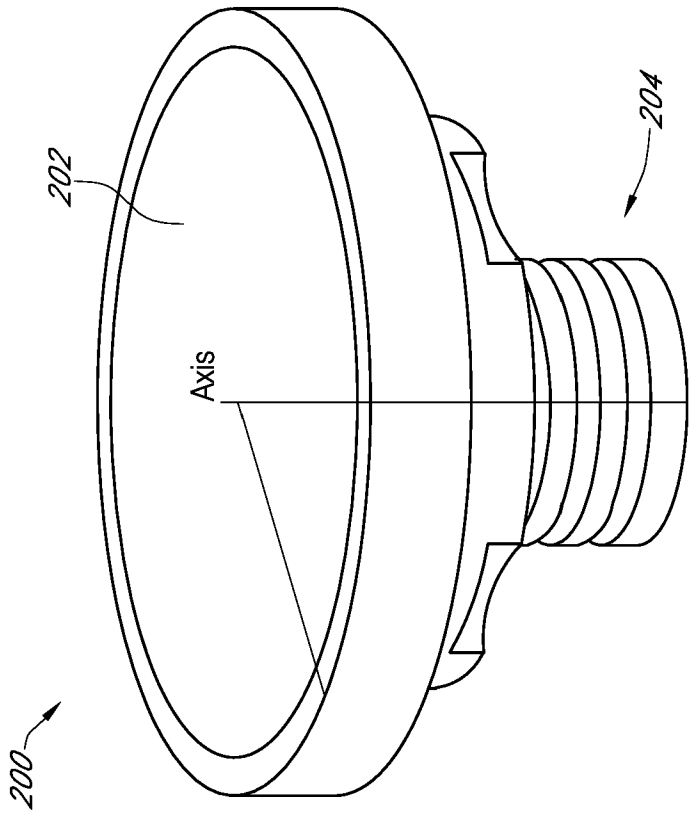


FIG. 3

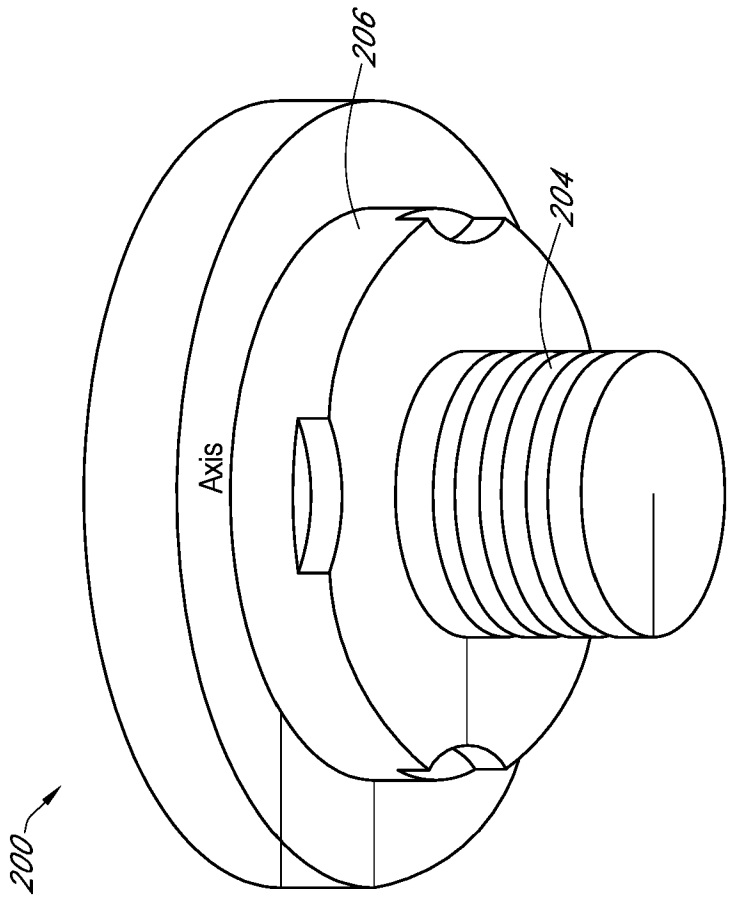


FIG. 4

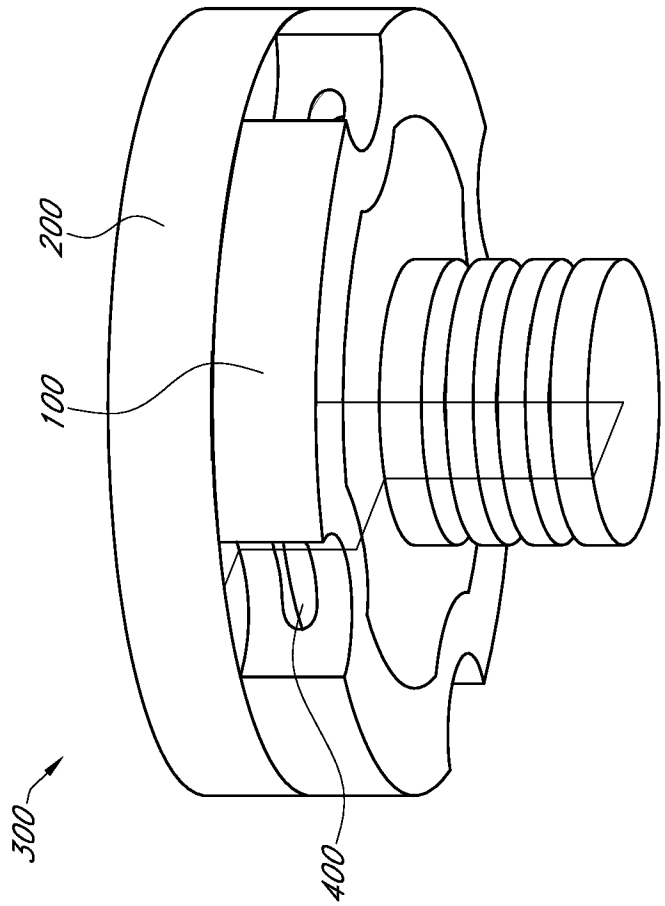


FIG. 5

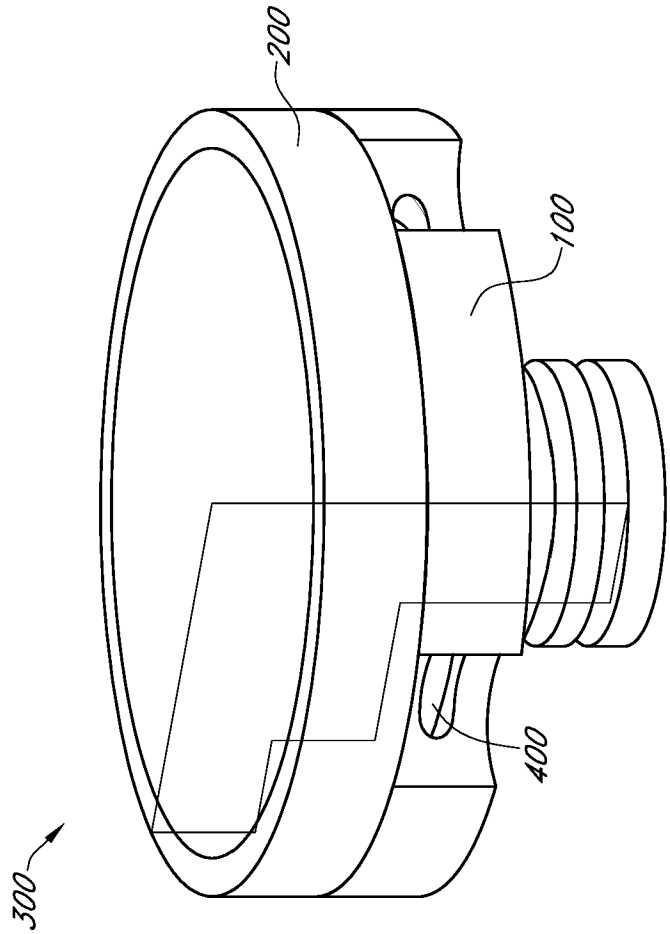


FIG. 6

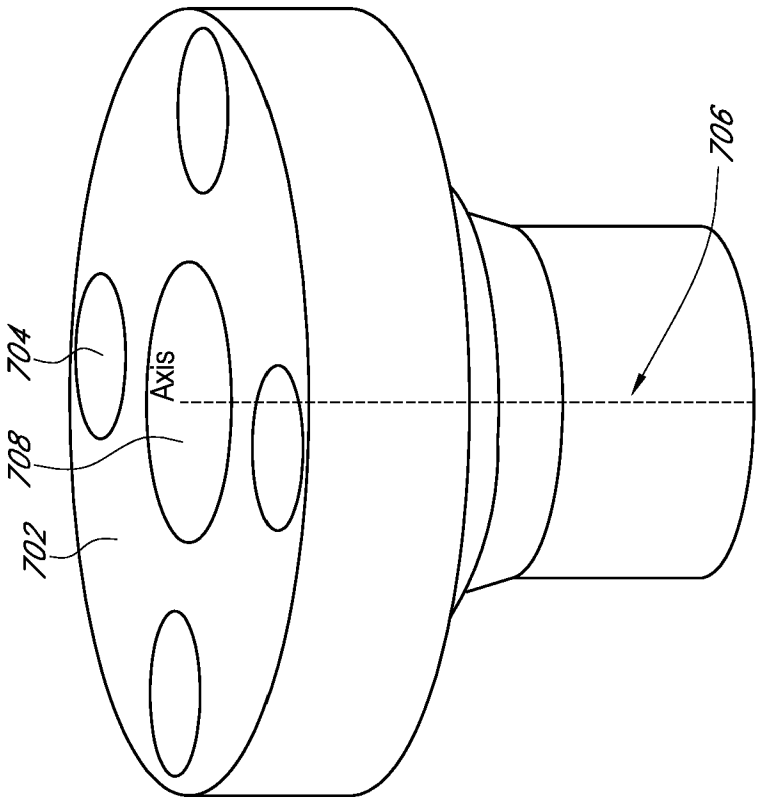


FIG. 7

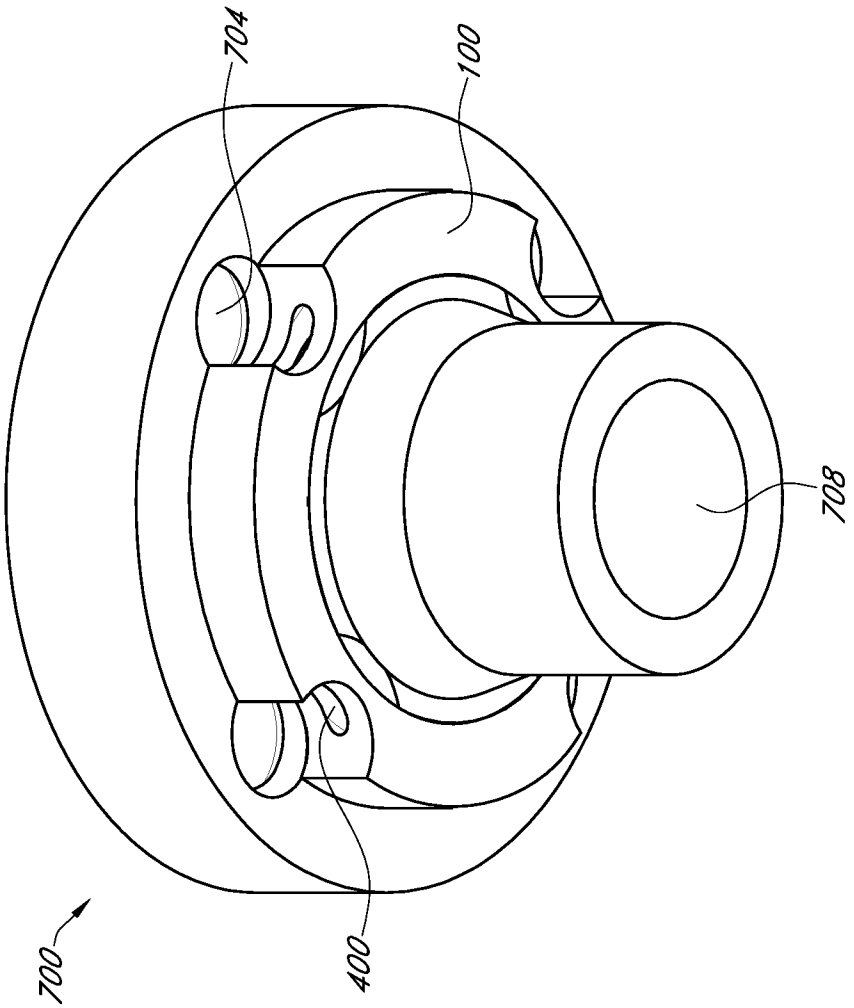


FIG. 8

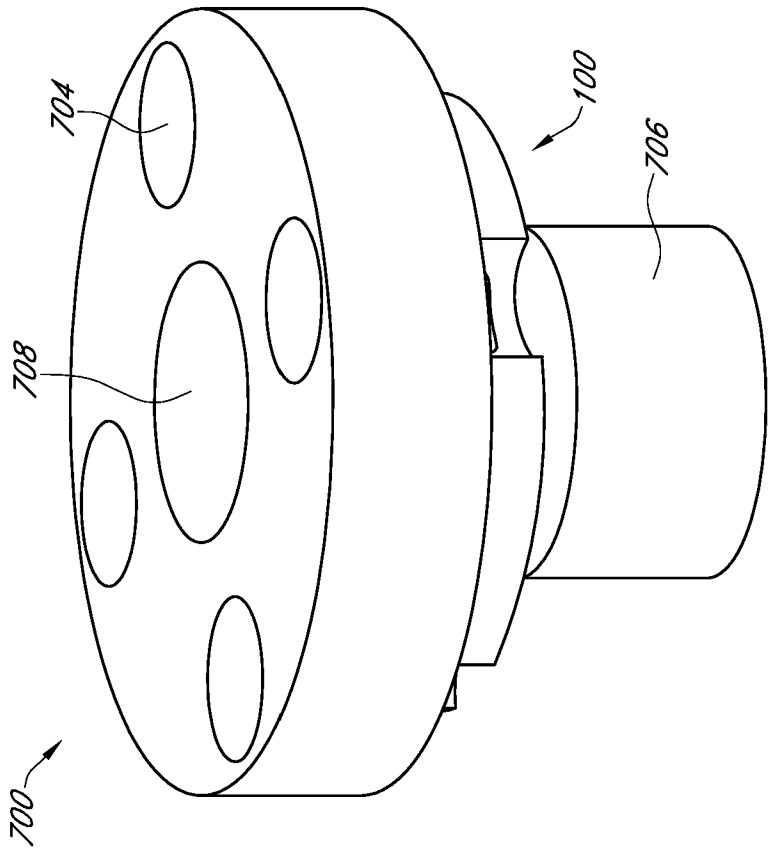


FIG. 9

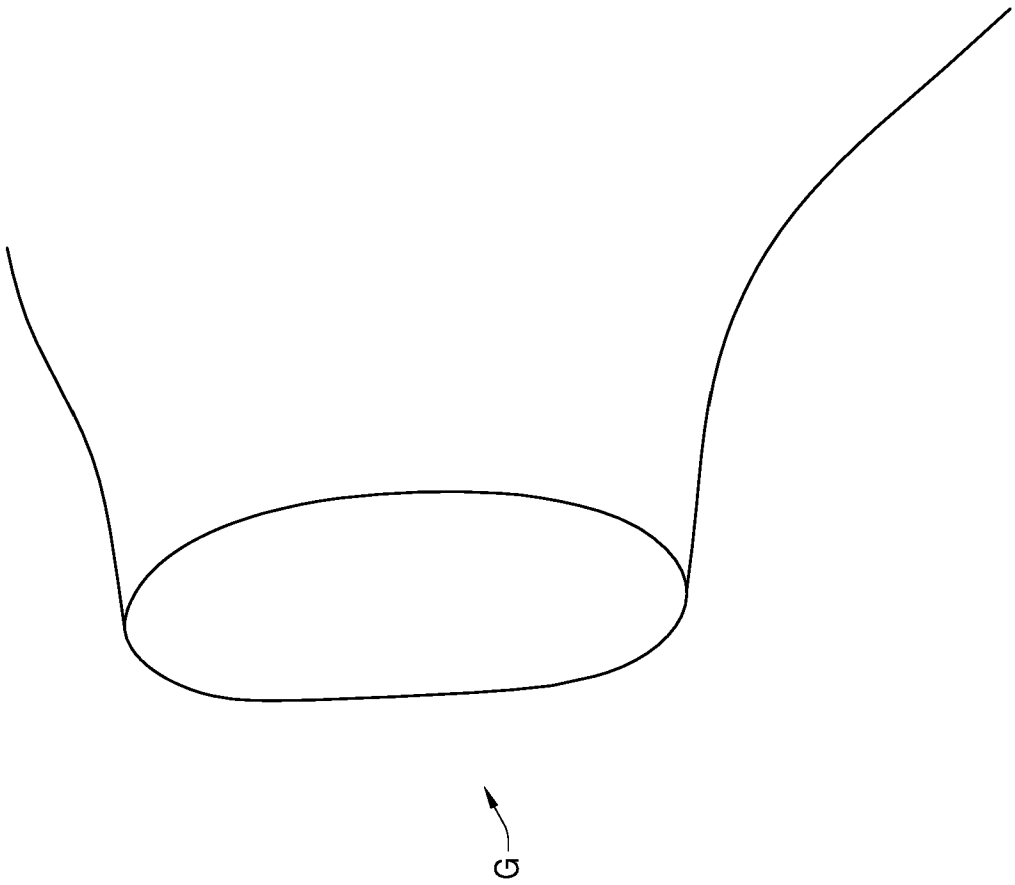


FIG. 10A

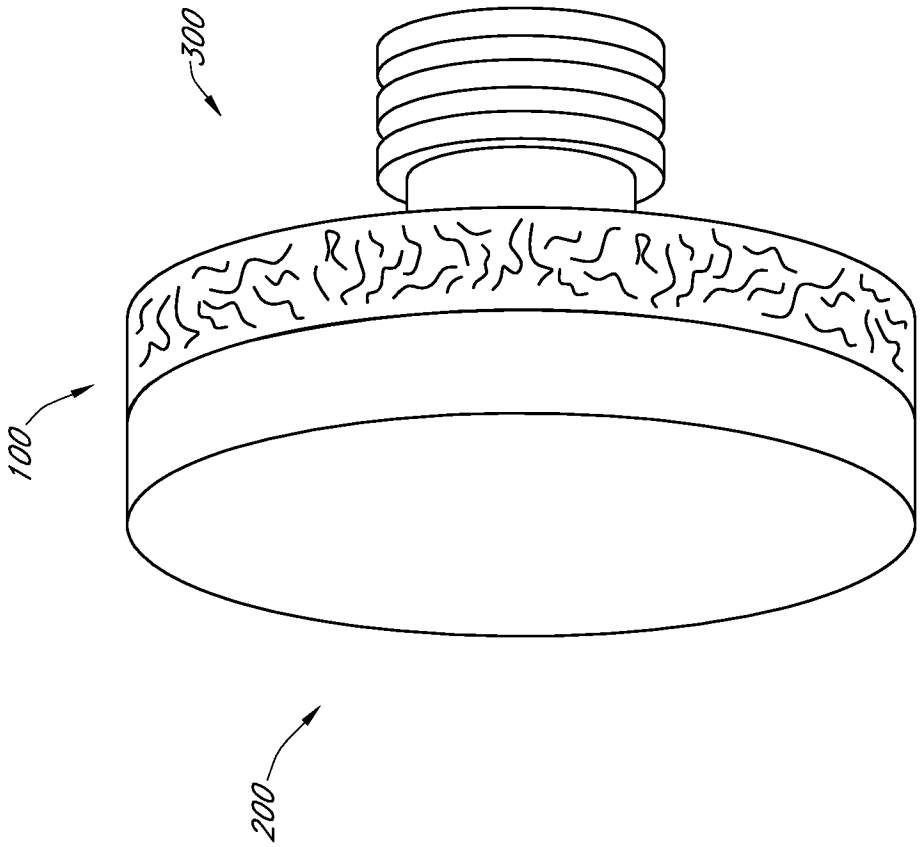


FIG. 10B

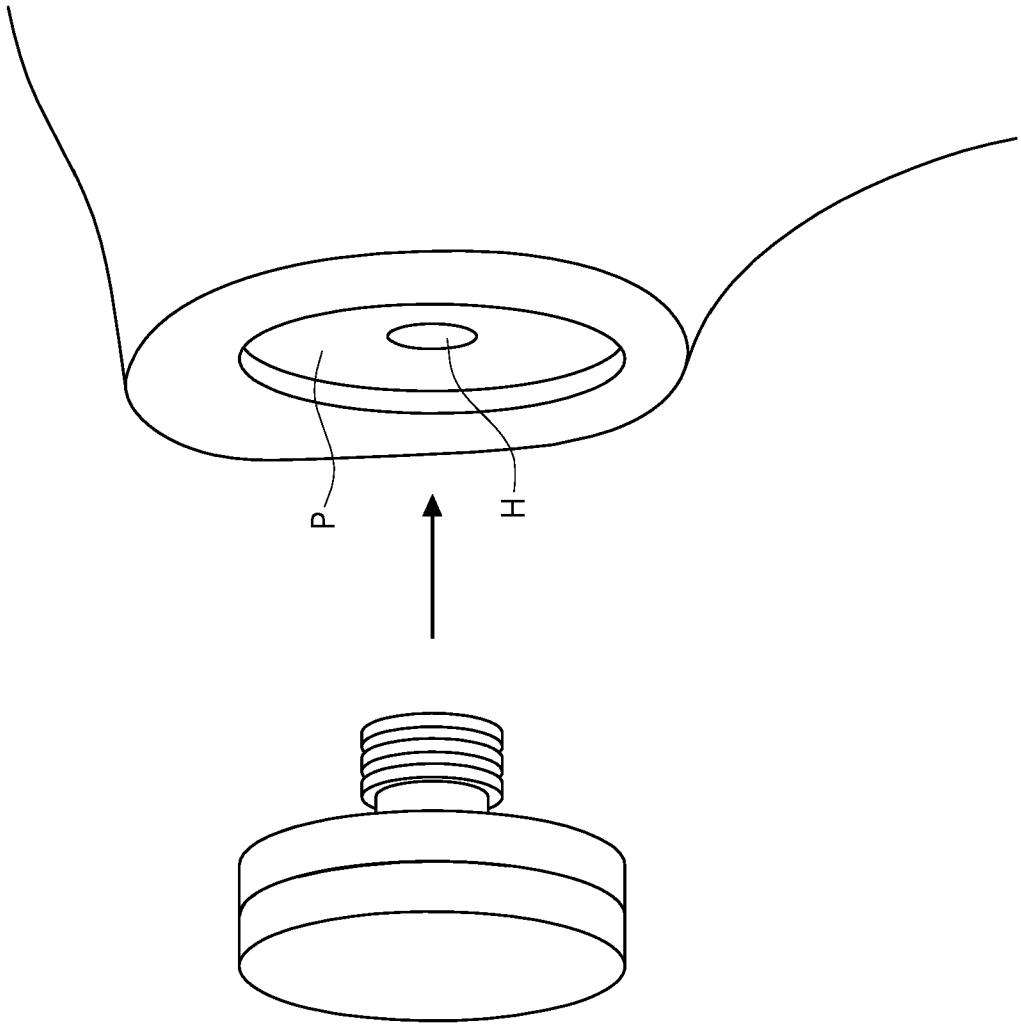


FIG. 10C

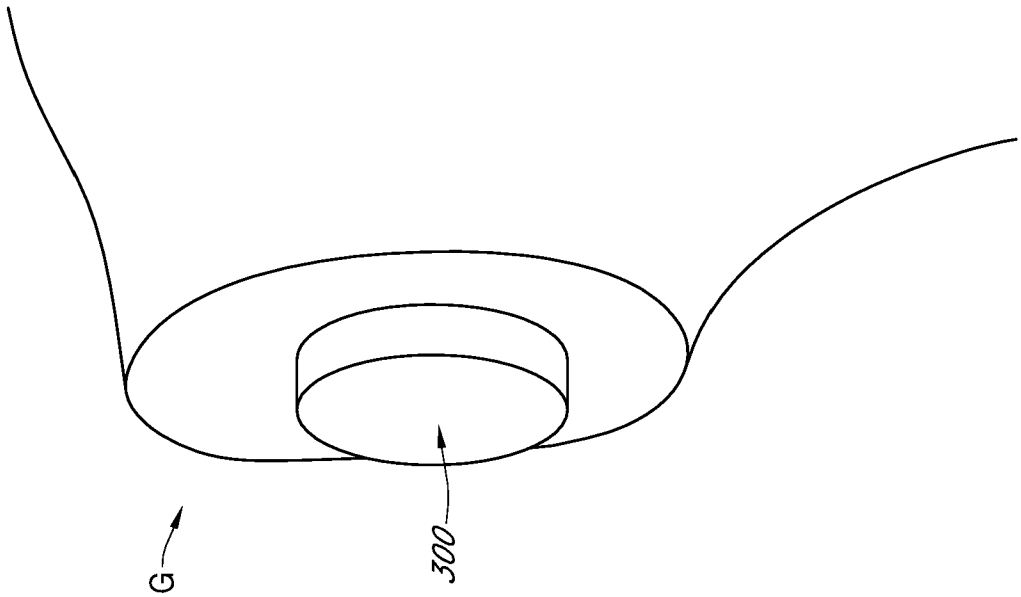


FIG. 11A

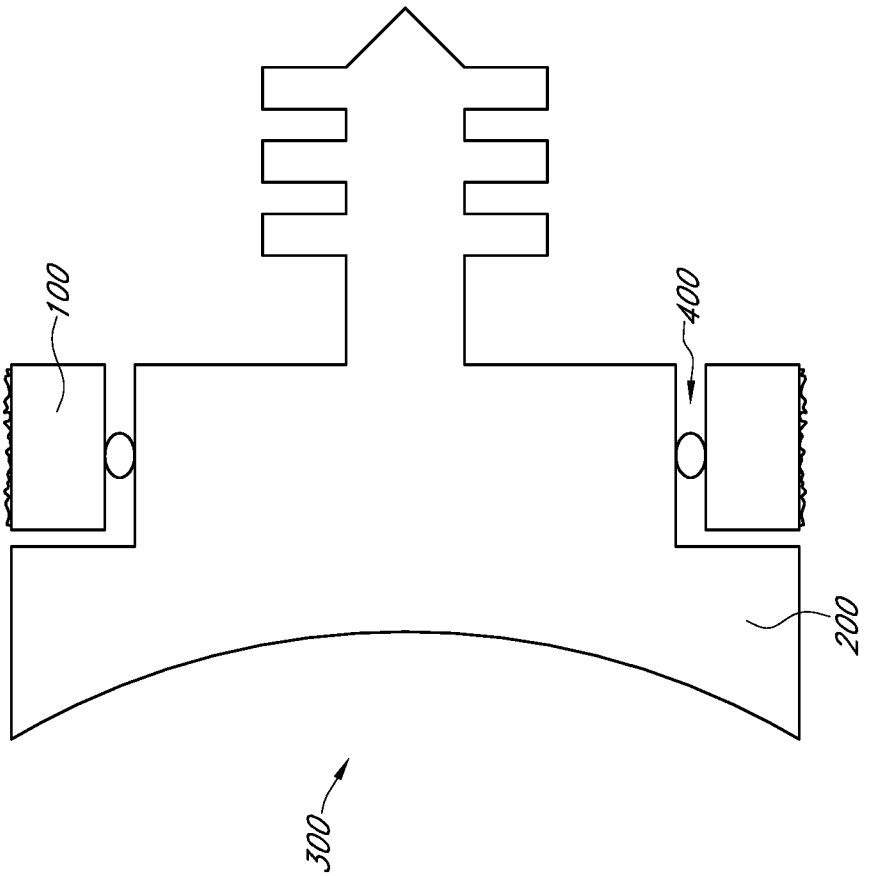


FIG. 11B

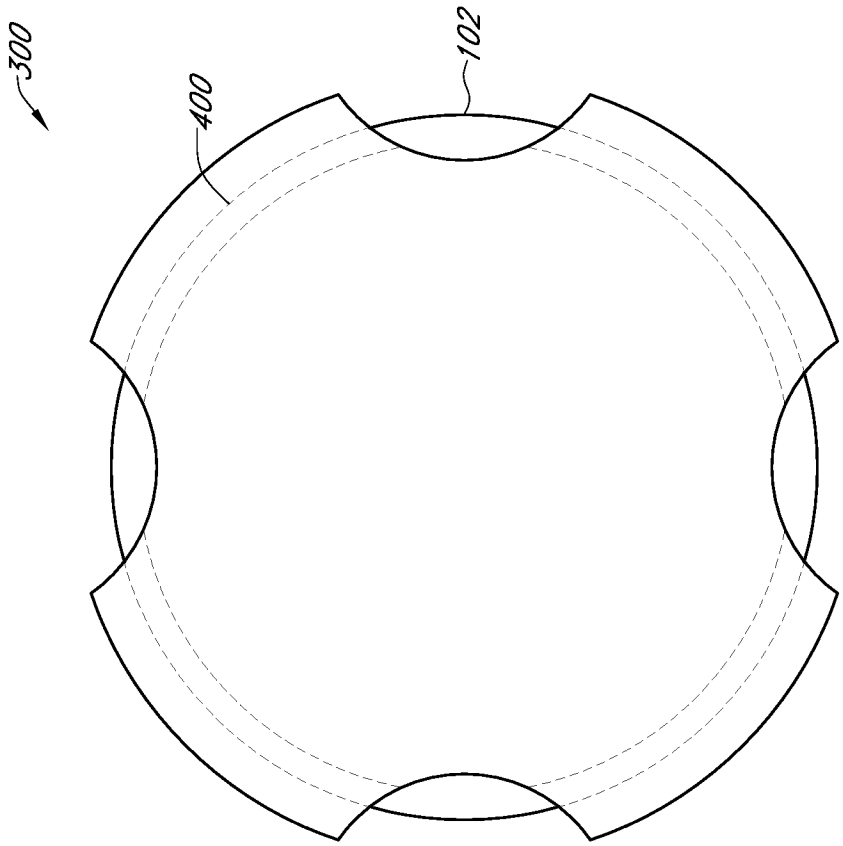


FIG. 11C

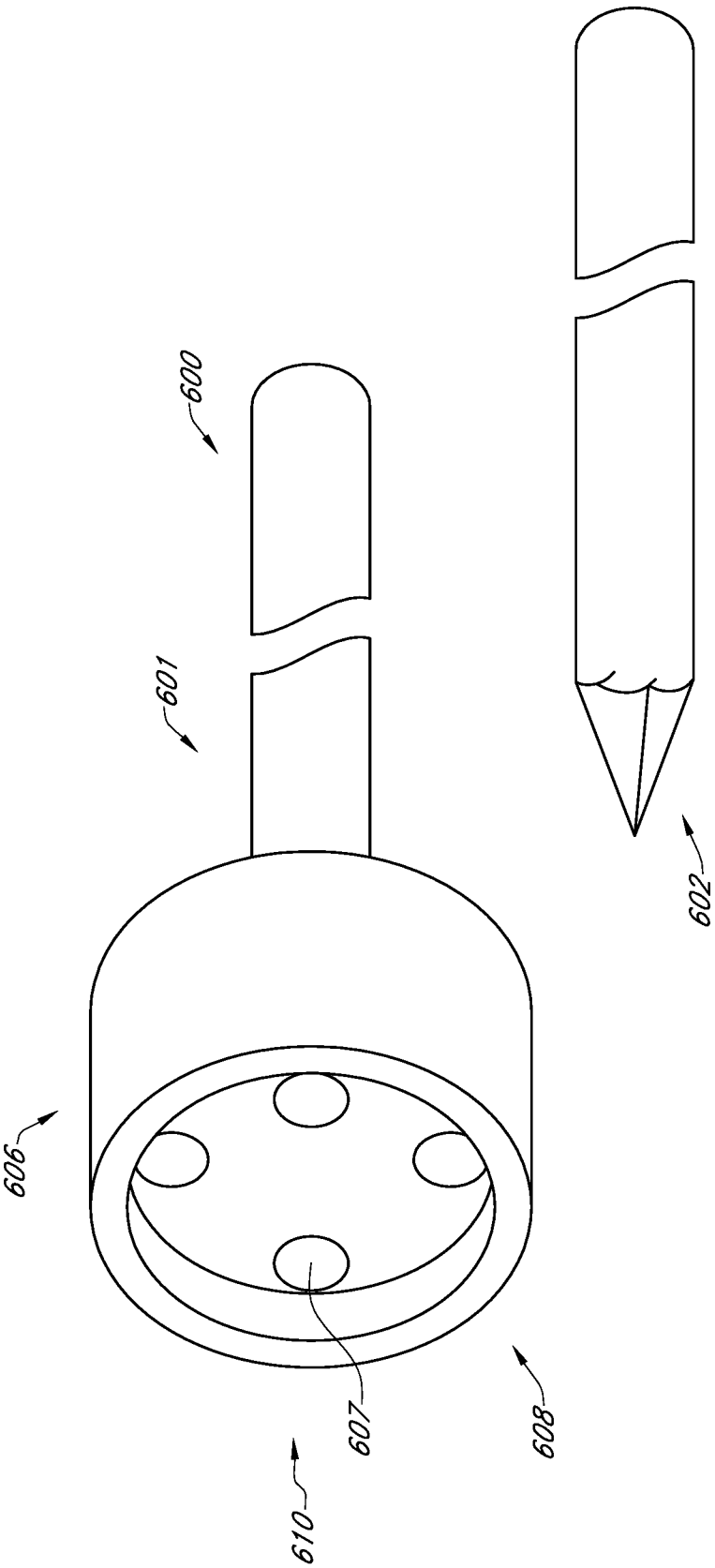


FIG. 11D

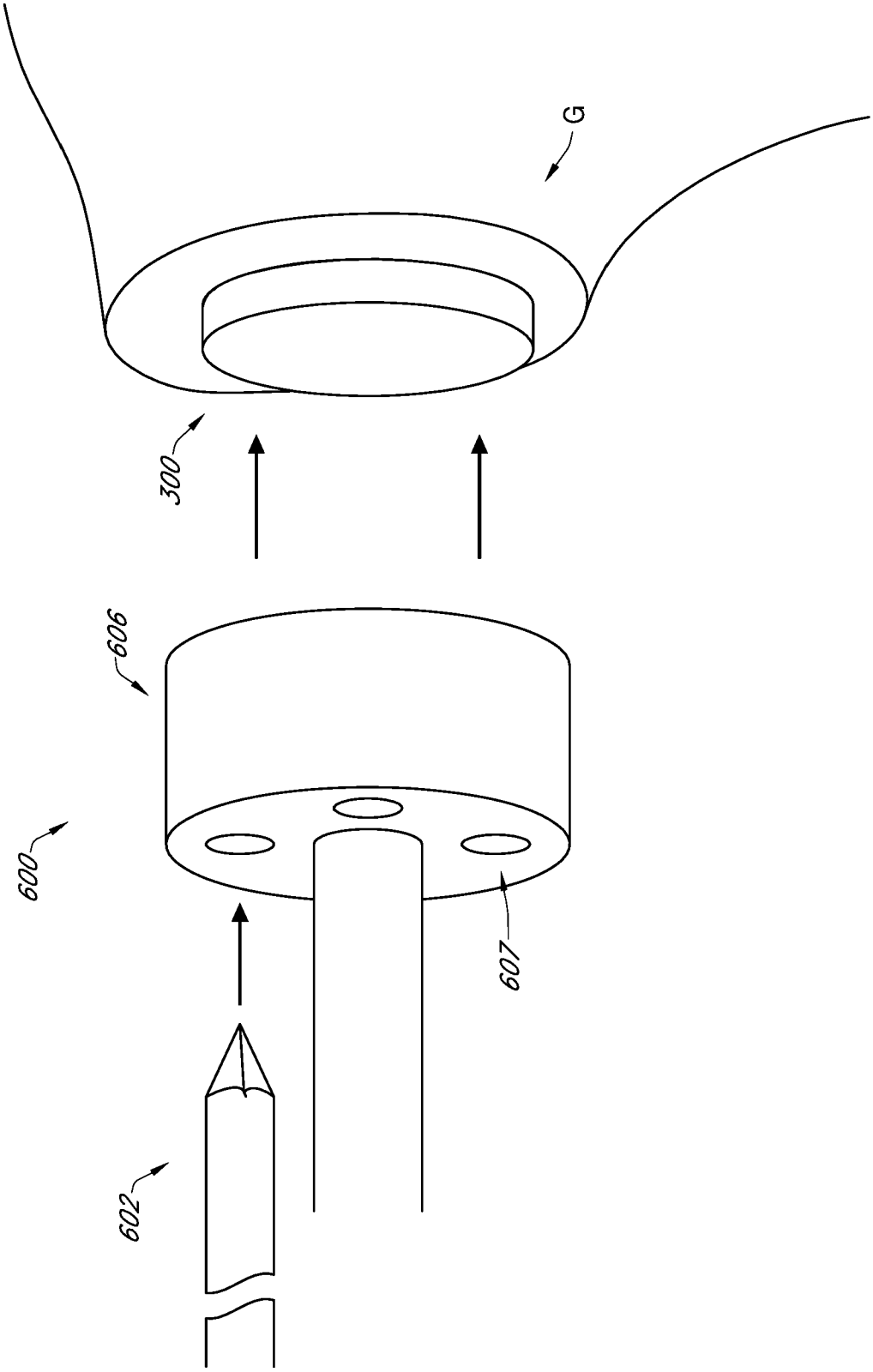


FIG. 12A

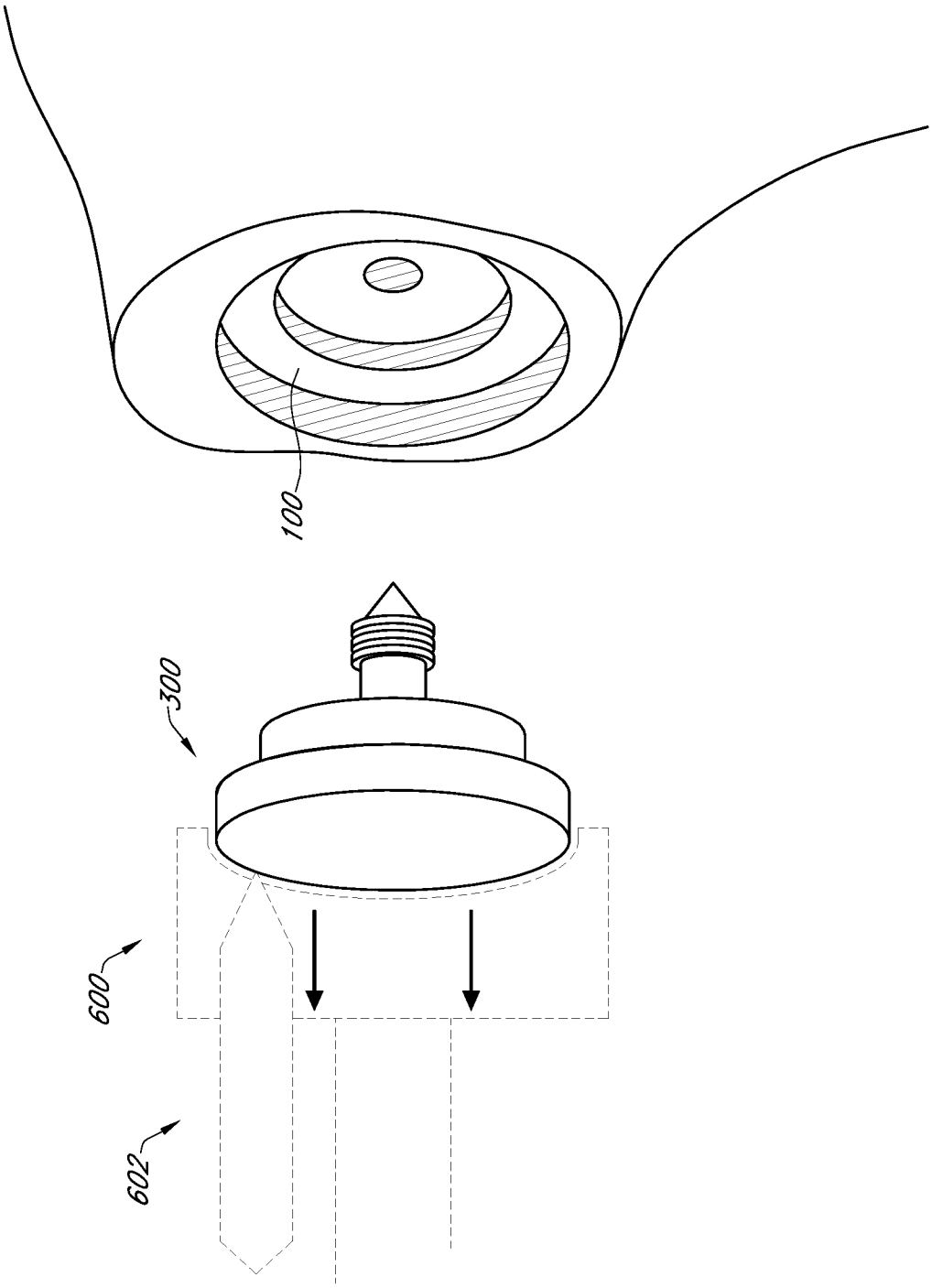


FIG. 12B

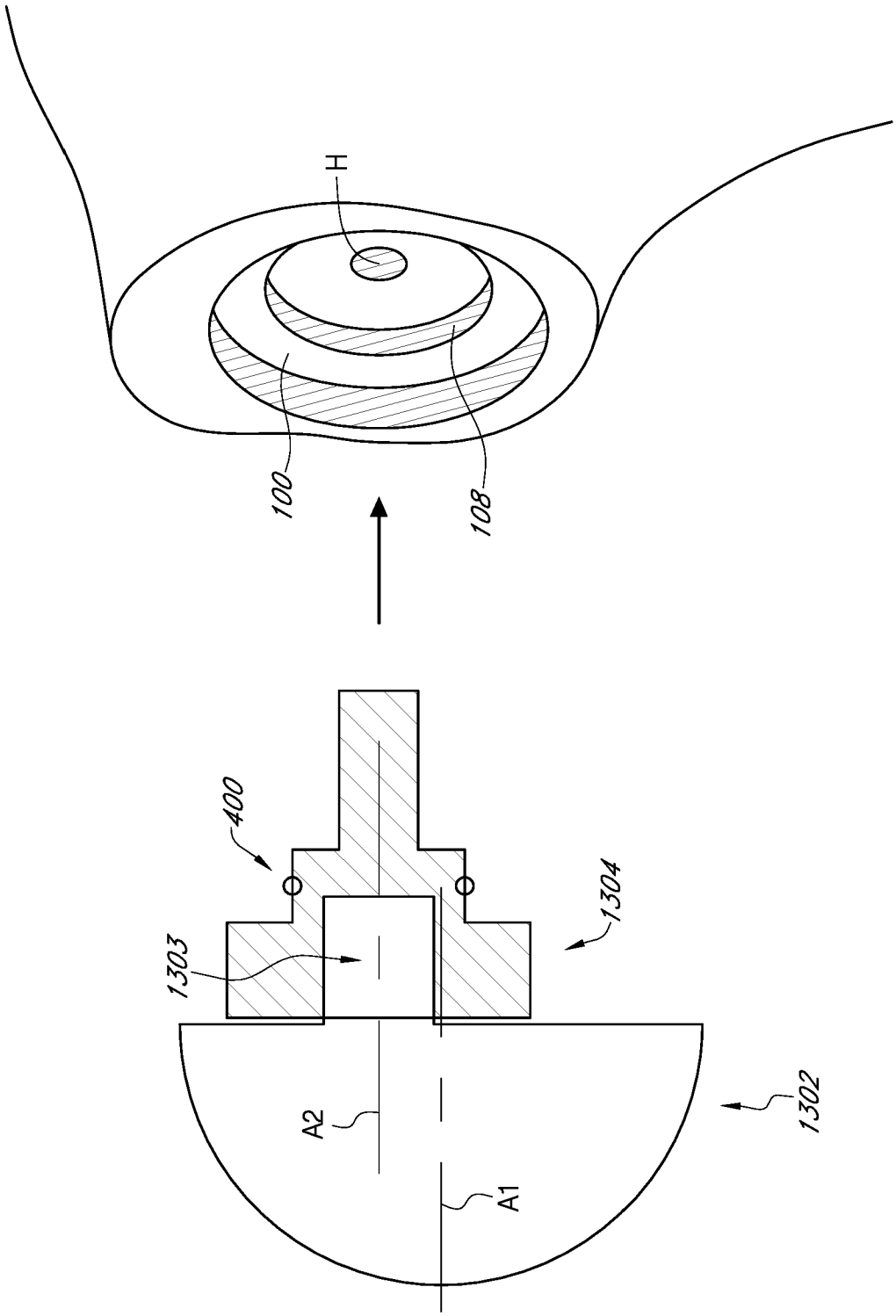


FIG. 13A

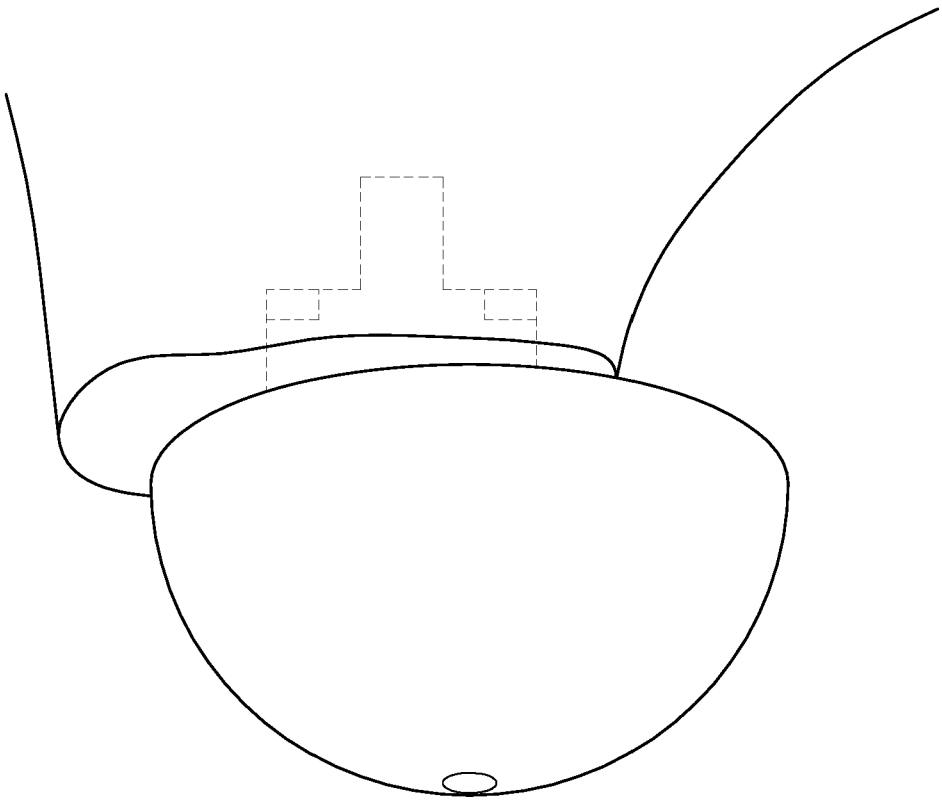


FIG. 13B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2018/027172

A. CLASSIFICATION OF SUBJECT MATTER

A61F 2/40(2006.01)i, A61F 2/46(2006.01)i, A61B 17/56(2006.01)i, A61F 2/30(2006.01)i

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)
A61F 2/40; A61F 2/46; A61B 17/56; A61F 2/30

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: shoulder prosthesis, reverse, fix, replace, remove

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2015-0105861 A1 (SHOULDER INNOVATIONS, LLC.) 16 April 2015 See paragraphs [0008]-[0018], [0091]-[0113].	8-14
Y	US 2013-0197651 A1 (BIOMET MANUFACTURING CORP.) 01 August 2013 See paragraphs [0027]-[0034] and figures 3-8.	8-14
Y	US 2015-0265411 A1 (TORNIER ORTHOPEDICS IRELAND LTD.) 24 September 2015 See paragraphs [0031]-[0052], [0121]-[0137] and figure 1.	9,12
A	US 2012-0209392 A1 (LAURENT ANGIBAUD et al.) 16 August 2012 See paragraphs [0033]-[0050] and figures 10A-10C.	8-14
A	JP 2014-515651 A (ZIMMER GMBH) 03 July 2014 See figure 7 and claim 1.	8-14

☐ 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
22 August 2018 (22.08.2018)	**22 August 2018 (22.08.2018)**

Name and mailing address of the ISA/KR
International Application Division
Korean Intellectual Property Office
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HAN, Inho
Telephone No. +82-42-481-3362

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2018/027172

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		EP 2663263 A1	20/11/2013

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2018/027172

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☒ Claims Nos.: 1-7
because they relate to subject matter not required to be searched by this Authority, namely:
Claims 1-7 pertain to a method for treatment of the human body by surgery and thus relate to a subject matter which this International Searching Authority is not required, under PCT Article 17(2)(a)(i) and PCT Rule 39.1(iv), to search.

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required addtional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of any additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2018/027172

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		JP 05647373 B2	24/12/2014
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