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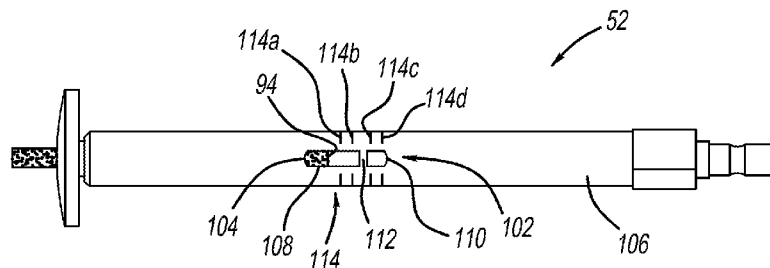
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(54) Title: PATIENT-SPECIFIC GLENOID DEPTH CONTROL

**FIG - 10**

(57) Abstract: A system for reaming a bone including a guiding wire (50) configured to be attached to the bone; a tubular depth guide (90) configured to cover at least a portion of the guiding wire, the tubular depth guide including a first end configured to abut the bone, and a second end opposite the first end; a reaming device (52) including an elongate recess (96) therein that extends between a reaming tool (97) of the reaming device and an interior of the reaming device; a depth control window (102) formed in an exterior surface of the reaming device; wherein the elongate recess is configured to receive each of the guiding wire and depth guide therein; the elongate recess includes a reduced diameter section that defines a shoulder (100), the shoulder is designed to abut the second end of the tubular depth guide to control a depth to which the bone is reamed, and the depth control window provides visual access to the second end of the tubular depth guide to determine whether a reaming depth has been reached.

PATIENT-SPECIFIC GLENOID DEPTH CONTROL

INTRODUCTION

5 **[0001]** In shoulder arthroplasty various guides and instruments are used to determine an alignment axis and guide an implant for anatomic or reverse shoulder arthroplasty. The present teachings provide various patient-specific and other instruments for use in shoulder arthroplasty.

SUMMARY

10 **[0002]** The present teachings provide various patient-specific instruments for anatomic and reverse shoulder arthroplasty.

[0003] Specifically, the present teachings provide a system for reaming a bone, including a patient-specific guiding wire configured to be attached to the bone, and a tubular depth guide configured to cover at least a portion of the patient-specific guiding wire. The tubular depth guide includes a first end configured to abut the bone, a second end opposite the first end, and has a patient-specific length. The system also includes a reaming device including an elongate recess therein that extends between a reaming tool of the reaming device and an interior of the reaming device, and a depth control window formed in an exterior surface of the reaming device, wherein the elongate recess is configured to receive each of the guiding wire and depth guide therein, and during reaming of the bone, the depth control window is configured to provide visual access to the second end of the tubular depth guide to determine whether a patient-specific reaming depth has been reached.

25 **[0004]** The present teachings also provide a method for reaming a bone, including attaching a guiding wire to the bone, and covering at least a portion of the guiding wire with a tubular depth guide. The tubular depth guide includes patient-specific length extending between a first end configured to abut the bone and a second end opposite the first end. The method also includes reaming the bone with a reaming device. The reaming device includes an elongate recess therein that is configured to receive each of the guiding wire and depth guide therein and extends between a reaming tool of the reaming device

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and an interior of the reaming device, and the reaming device including a depth control window formed in an exterior surface of the reaming device. Lastly, the method includes viewing the second end of the tubular depth guide through the depth control window to determine whether a patient-specific reaming depth has been reached.

[0005] The present teachings also provide a method for reaming a glenoid for an arthroplasty, including positioning a patient-specific glenoid guide proximate the glenoid, the glenoid guide including a first primary drill guide extending along a first axis and a second primary drill guide extending along a second axis; selecting one of the first and second axes for orienting a guiding wire, and positioning a guiding wire in the glenoid that extends along the selected axis; positioning a tubular depth guide over the guiding wire such that a first end of the depth guide abuts the bone and the guiding wire extends outward from a second of the depth guide; positioning a reaming device over the guiding wire, and reaming the glenoid along the selected axis, the reaming device including an elongate recess therein that is configured to receive each of the guiding wire and depth guide therein and extends between a reaming tool of the reaming device and an interior of the reaming device, and the reaming device including a depth control window formed in an exterior surface of the reaming device; and viewing the second end of the tubular depth guide through the depth control window to determine whether a patient-specific reaming depth has been reached

[0006] Further areas of applicability of the present teachings will become apparent from the description provided hereinafter. It should be understood that the description and specific examples are intended for purposes of illustration only and are not intended to limit the scope of the present teachings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The present teachings will become more fully understood from the detailed description and the accompanying drawings.

[0008] FIG. 1 is an exploded view of a prior art implant for reverse shoulder arthroplasty;

[0009] FIG. 2 is an environmental view of the prior art implant of FIG. 1;

5 **[0010]** FIG. 3A is an environmental view illustrating a guiding pin used during reaming in reverse shoulder arthroplasty;

[0011] FIG. 3B is an environmental view illustrating a guiding pin after reaming in reverse shoulder arthroplasty;

10 **[0012]** FIG. 4 is a perspective view of a prior art implant for anatomic shoulder arthroplasty;

[0013] FIG. 5 is perspective bottom view of a patient-specific glenoid guide for reverse and anatomic shoulder arthroplasty according to the present teachings;

15 **[0014]** FIG. 6 is a perspective view of a glenoid including a guiding pin and a depth guide used during reaming of the glenoid;

[0015] FIG. 7 is a perspective view of the depth guide illustrated in FIG. 6;

20 **[0016]** FIG. 8 is a cross-sectional view of a reamer during reaming of the glenoid with the guiding pin and depth guide illustrated in FIG. 6 received therein;

[0017] FIG. 8A is a close-up of FIG. 8 illustrating a portion of the reamer with the guiding pin and depth guide received therein; and

[0018] FIGS. 9-11 illustrate perspective views of the reamer according to a principle of the present disclosure.

25 **[0019]** Corresponding reference numerals indicate corresponding parts throughout the several views of the drawings

DETAILED DESCRIPTION

[0020] The following description is merely exemplary in nature and is in no way intended to limit the present teachings, applications, or uses.

[0021] The present teachings generally provide patient-specific surgical instruments that include, for example, alignment guides, drill guides, and other tools for use in shoulder joint replacement, shoulder resurfacing procedures and other procedures related to the shoulder joint or the various bones of the shoulder joint, including the glenoid face or cavity of the scapula, the humeral head and adjacent shoulder bones. The present teachings can be applied to anatomic shoulder replacement and reverse shoulder replacement. The patient-specific instruments can be used either with conventional implant components or with patient-specific implant components and/or bone grafts that are prepared using computer-assisted image methods according to the present teachings. Computer modeling for obtaining three-dimensional images of the patient's anatomy using medical scans of the patient's anatomy (such as MRI, CT, ultrasound, X-rays, PET, etc.), the patient-specific prosthesis components and the patient-specific guides, templates and other instruments, can be prepared using various commercially available CAD programs and/or software available, for example, by Object Research Systems or ORS, Montreal, Canada.

[0022] The patient-specific instruments and any associated patient-specific implants and bone grafts can be generally designed and manufactured based on computer modeling of the patient's 3-D anatomic image generated from medical image scans including, for example, X-rays, MRI, CT, PET, ultrasound or other medical scans. The patient-specific instruments can have a three-dimensional engagement surface that is complementary and made to substantially mate and match in only one position (*i.e.*, as a substantially negative or mirror or inverse surface) with a three-dimensional bone surface with or without associated soft tissues, which is reconstructed as a 3-D image via the aforementioned CAD or software. Very small irregularities need not be incorporated in the three-dimensional engagement surface. The patient-specific instruments can include custom-made guiding formations, such as, for example, guiding bores or cannulated guiding posts or cannulated guiding extensions or

receptacles that can be used for supporting or guiding other instruments, such as drill guides, reamers, cutters, cutting guides and cutting blocks or for inserting guiding pins, K-wire, or other fasteners according to a surgeon-approved pre-operative plan.

5 **[0023]** In various embodiments, the patient-specific instruments of the present teachings can also include one or more patient-specific tubular guides for receiving and guiding a tool, such as a drill or pin or guide wire at corresponding patient-specific insertion points and orientations relative to a selected anatomic or reverse axis for the specific patient. The patient-specific
10 instruments can include guiding or orientation formations and features for guiding the implantation of patient-specific or off-the-shelf implants associated with the surgical procedure. The geometry, shape and orientation of the various features of the patient-specific instruments, as well as various patient-specific implants and bone grafts, if used, can be determined during the pre-operative
15 planning stage of the procedure in connection with the computer-assisted modeling of the patient's anatomy. During the pre-operative planning stage, patient-specific instruments, custom, semi-custom or non-custom implants and other non-custom tools, can be selected and the patient-specific components can be manufactured for a specific-patient with input from a surgeon or other
20 professional associated with the surgical procedure.

[0024] Referring to FIGS. 1-2, a prior art reverse shoulder implant 10 is illustrated. The reverse shoulder implant 10 includes a humeral stem 12, a humeral tray 14, a humeral bearing 16, a glenosphere 18 and a baseplate 20 having a plate portion 22 and a central boss 24. The humeral stem 12 is
25 implanted in the humeral bone 26 and has a proximal end 28 coupled via a Morse taper connection to a male taper 30 extending from a plate 32 of the humeral tray 14. The glenosphere 18 can be modular and include a head 34 articulating with the bearing 16 and an offset double-taper component 36. The double-taper component 36 has a first tapered portion 38 coupled to a
30 corresponding tapered opening 40 of the head 34 and a second tapered portion 42 coupled to the central boss 24 of the glenoid baseplate 20. A central screw 44 passes through the baseplate 20 into the glenoid face 46 of the patient's

scapula. Peripheral screws 48 are used to lock the baseplate 20 in the glenoid face 46.

[0025] FIG. 3A illustrates using a guiding pin 50 to guide reaming of the glenoid face 46 in reverse shoulder arthroplasty using a reaming device 52. FIG. 3B illustrates the guiding pin 50 through a hole 54 drilled through the glenoid face 46. The guiding pin 50 is used to guide placement of a reverse or anatomic implant, as discussed below.

[0026] Referring to FIG. 4, a prior art anatomic shoulder implant 56 is illustrated. The anatomic shoulder implant 56 includes a humeral stem 58, a glenosphere 60 and a bearing 62 with peripheral pegs 64 and a removable or non-removable central peg 66.

[0027] Referring to Figure 5, an exemplary patient-specific glenoid guide 68 is illustrated. Patient-specific guide 68 and operation thereof is fully described in U.S. Patent Application Serial No. 13/653,868 filed October 17, 2012, the entire disclosure of which is hereby incorporated by reference. The patient-specific glenoid guide 68 is configured to guide a guiding pin (such as the guiding pin 50 shown in FIGS. 3A and 3B) and provide an implant alignment orientation for reverse as well as anatomic shoulder arthroplasty at the surgeon's discretion.

[0028] The glenoid guide 68 has an upper (or outer) surface 70 and a lower (or inner) or anatomy-engaging and patient-specific surface 72 that references (substantially as a negative or inverse or mirror) the glenoid face 46 and may include all or a portion of the labrum, *i.e.*, the peripheral cartilaginous structure that encircles and deepens the glenoid face 46. Alternatively, the labrum can be completely removed such that the patient-specific glenoid surface 72 references and mirrors only the bone surface of the glenoid cavity or glenoid face 46. Optionally, the glenoid guide 68 can include a peripheral portion or peripheral lip 74 with a corresponding patient-specific peripheral surface 76 that engages a corresponding peripheral surface or glenoid rim around the scapula of the patient. A first (or anatomic) elongated tubular drill guide 78 can extend from the upper surface 70 of the glenoid guide 68 at a specific location and along a first axis A that is determined and designed according to the pre-operative plan

of the patient to define a patient-specific anatomic alignment axis and insertion point for a guiding pin 50.

[0029] A second (or reverse) elongated tubular drill guide 80 can extend from the upper surface 70 of the glenoid guide along a second axis B that is determined and designed according to the pre-operative plan of the patient to define a patient-specific reverse alignment axis and insertion point for a guiding pin 50. The reverse alignment axis B can have a predetermined inferior tilt relative to the anatomic alignment axis A, such as, for example, a ten-degree inferior tilt. The first and second drill guides 78, 80 define corresponding elongated bores for guiding a drill bit and/or inserting an alignment pin or guiding pin 50. Each drill guide 78, 80 can include elongated openings or viewing windows 82 therethrough. The anatomic drill guide 78 and the reverse drill guide 80 can include corresponding visual and /or tactile markings 84, 86 indicating their corresponding functions for easy identification and to avoid confusion. The markings can be, for example, elevated lettering using the words ANATOMIC for marking 84 and REVERSE for marking 86. Additionally, marking 88 can be provided with other patient-specific information, such as, for example, patient identification, procedure, etc.

[0030] Referring to FIGS. 3A, 3B, and 4, the glenoid guide 68 can be used for anatomic or reverse arthroplasty to drill a hole 54 into the glenoid face 46 through the anatomic or reverse drill guides 78, 80 and insert a guiding pin or other K-wire 50. The guiding pin 50 can be used to guide the predetermined alignment of the bearing 62 in the glenoid face 46 for implantation in anatomic arthroplasty. Alternatively, the guiding pin 50 can be used to guide the reaming and boring of the glenoid face 46 necessary before the predetermined alignment and implantation of the baseplate 20 shown in FIG. 2 in the glenoid face 46 for reverse arthroplasty.

[0031] Once guiding pin 50 has been inserted into glenoid 46, reaming device 52 can be used to ream glenoid 46 to form hole 54 in the glenoid 46. It is important to control reaming depth so that bearing 62 or baseplate 20 can be properly fitted with hole 54. In addition, it is important to control reaming depth so that the bone can be preserved, and so that joint tension can be more

accurately controlled. Accordingly, a patient-specific depth guide 90 that prevents reaming device 52 from reaming glenoid 46 to too great a depth can be used.

[0032] As best shown in Figures 6 and 7, depth guide 90 can be formed from a hollow tube 91 including a length L, a width W (outer diameter), and an inner diameter ID. Depth guide 90 can be formed from materials such as titanium, CoCr or steel. Alternatively, depth guide 90 can be formed from polymeric materials such as polyethylene, polypropylene, polystyrene, nylon, and polyether ether ketone (PEEK). Inner diameter ID is selected to receive guiding wire 50 snugly therein. Accordingly, after guiding pin 50 has been inserted into glenoid 46 and before reaming has begun, depth guide 90 can be placed over guiding wire 50 and moved to abut glenoid 46.

[0033] Depth guide 90 includes a first end 92 configured to abut glenoid 46, and a second end 94 configured to abut a surface within reamer 52. First end 92 may be patient-specific such that first end 92 is contoured to mate with the patient-specific contours of glenoid face 46. In other words, first end 92 that abuts glenoid face 46 may be a negative surface of a portion of the glenoid face 46 that the first end 92 contacts such that first end 92 will only mate with the glenoid face 46 in a single position. Regardless, depth guide 90 is preferably tubular or cylindrical in shape, but any shape may be used without departing from the scope of the present teachings so long as depth guide 90 may be received within reaming device 52. An outer surface 93 of depth guide 90 may be smooth, or may be formed to include apertures (not shown) that reduce the amount of material required to form depth guide 90.

[0034] Referring to FIGS. 8 and 8A, it can be seen that reaming device 52 includes an elongate recess 96 that extends from reaming tool 97 into an interior of a handle 99 of reaming device 52. Elongate recess 96 is configured to receive guiding wire 50 and depth guide 90 therein. In addition, it can be seen that recess 96 includes a reduced diameter section 98 that defines a shoulder 100. Second end 94 of depth guide 90 abuts shoulder 100 during reaming of glenoid 46, and prevents reaming device 52 from reaming too great a depth into glenoid 46. Accordingly, depth guide 90 of the present teachings acts to provide

a physical stop for glenoid reaming. More specifically, as reaming device 52 begins cutting into glenoid 46, second end 94 of depth guide 90 will be spaced apart from shoulder 100. Once reaming device 52 has cut to the patient-specific depth, however, second end 94 of depth guide 90 will abut shoulder 100 and
5 prevent reaming device 52 from cutting or reaming any further.

[0035] Depth guide 90 can be patient-specific such that a depth of reaming can be determined preoperatively. In this regard, the length L of depth guide 90 can be determined preoperatively to control reaming depth. Because reaming device 52 includes shoulder 100, reaming device 52 is made to
10 reference the patient-specific depth guide 90 such that the cutting depth of the reaming device 52 is limited to the patient-specific depth for both anatomic and reverse glenoid reaming. It should be understood, however, that after the reaming depth has been reached and reaming device 52 is removed from guiding wire 50, the surgeon may inspect hole 54 formed by reaming device 52.
15 If the surgeon determines that the patient-specific depth is not satisfactory for accommodating the size of the selected implant, depth guide 90 may be removed from guiding wire 50. Reaming device 52 may then be aligned with guiding wire 50 without depth guide 90, and reaming restarted to the depth desired by the surgeon intraoperatively.

[0036] In another embodiment, a plurality or kit of depth guides 90 having different lengths may be formed preoperatively. If during the course of reaming it is determined that a selected depth guide 90 prevents reaming to an adequate depth, the depth guide 90 may be removed and replaced by another depth guide having a shorter length. In this manner, the reaming depth can still
20 be controlled to prevent over-reaming the glenoid 46.

[0037] In addition to using depth guide 90 to patient-specifically control reaming depth, reaming device 52 may also be patient-specific. More specifically, as best shown in Figure 9, reaming device 52 may include a visual depth control window 102 that provides visual access to an interior of reaming
30 device 52 such that depth guide 90 may be visually inspected during reaming. Depth control window 102 is an elongated aperture 104 formed in an exterior surface 106 of reaming device 52. Although not required by the present

disclosure, depth control window 102 may include a first window 108 and a second window 110, with the first and second windows 108 and 110 being separated by a rib 112.

5 **[0038]** Rib 112 may separate first and second windows 108 and 110 at a patient-specific location that corresponds to the patient-specific reaming depth provided by depth guide 90. In this regard, the location of rib 112 may correspond to the location of shoulder 100 within reaming device 52. Alternatively, reaming device 52 may not include shoulder 100 and rib 112 will correspond to the above-noted patient-specific reaming depth provided by depth
10 guide 90 such that when end 94 of depth guide 90 reaches rib 112, the surgeon will visually determine that the patient-specific reaming depth has been reached. Accordingly, depth control window 102 may be configured pre-operatively according to a specific patient such that a position of rib 112 and, therefore, the depth control window 102 is patient-specific.

15 **[0039]** As can be seen in Figure 10, end 94 of depth guide 90 is visible in depth control window 102, but has not yet reached rib 112. Thus, the surgeon will be aware that the patient-specific reaming depth has not yet been reached. Now referring to Figure 11, it can be seen that end 94 of depth guide 90 has reached rib 112. Thus, the surgeon will be visually aware that the patient-
20 specific reaming depth has been reached. As noted above, the visual indication provided by rib 112 may be in lieu of or in addition to the physical indication provided by contact between depth guide 90 and shoulder 100.

[0040] In addition to depth control window 102, reaming device 52 may also include visual markings or notches 114 formed in exterior surface 106.
25 Notches 114 correspond to various reaming depths that are less than or greater than the patient-specific reaming depth indicated by rib 112 or depth guide 90. For example, notches 114 may include a first notch 114a that represents a reaming depth that is four millimeters less than that indicated by rib 112, a second notch 114b may represent a reaming depth that is two millimeters less
30 than that indicated by rib 112, a third notch 114c may represent a reaming depth that is two millimeters greater than that indicated by rib 112, and a fourth notch 114d may indicate a reaming depth that is four millimeters greater than that

indicated by rib 112. It should be understood, however, that notches 114 can indicate reaming depths different than the two millimeter increments noted above (e.g., any increment of one to ten millimeters is contemplated). Moreover, it should be understood that notches 114 may represent different lengths such as micrometers, nanometers, or any other length desired.

[0041] As set forth above, the present disclosure provides a patient-specific reaming system for preparing a shoulder for either an anatomic or reverse arthroplasty. The system includes a depth guide 90 having a patient-specific length that corresponds to a reaming depth that is determined pre-operatively. In addition, depth guide 90 may have an end 92 that abuts the glenoid face 46 that is patient-specific such that the depth guide 90 mates with the glenoid face 46 in only a single position. Further, the patient-specific depth guide 90 may be used in conjunction with a patient-specific reaming device 52. In this regard, the patient-specific reaming device 52 includes a patient-specific depth control window 102 having a rib 112 that corresponds to the patient-specific depth provided by depth guide 90 such that when an end 94 of the depth guide 90 reaches the rib 112, the surgeon will be visually aware that the patient-specific reaming depth has been reached. In addition, rib 112 may correspond to a shoulder 100 within reaming device 52 such that when end 94 abuts shoulder 100, a physical indication will be provided to the surgeon in addition to the visual indication provided by rib 112 that the patient-specific reaming depth has been reached.

[0042] The foregoing description of the embodiments has been provided for purposes of illustration and description. It is not intended to be exhaustive or to limit the disclosure. Individual elements or features of a particular embodiment are generally not limited to that particular embodiment, but, where applicable, are interchangeable and can be used in a selected embodiment, even if not specifically shown or described. The same may also be varied in many ways. Such variations are not to be regarded as a departure from the disclosure, and all such modifications are intended to be included within the scope of the disclosure.

[0043] Example embodiments are provided so that this disclosure will be thorough, and will fully convey the scope to those who are skilled in the art. Numerous specific details are set forth such as examples of specific components, devices, and methods, to provide a thorough understanding of
5 embodiments of the present disclosure. It will be apparent to those skilled in the art that specific details need not be employed, that example embodiments may be embodied in many different forms and that neither should be construed to limit the scope of the disclosure. In some example embodiments, well-known processes, well-known device structures, and well-known technologies are not
10 described in detail.

CLAIMS

What is claimed is:

1. A system for reaming a bone, comprising:
 - 5 a guiding wire configured to be attached to the bone;
 - a tubular depth guide configured to cover at least a portion of the guiding wire, the tubular depth guide including a first end configured to abut the bone, a second end opposite the first end, and having a patient-specific length;
 - a reaming device including an elongate recess therein that extends
 - 10 between a reaming tool of the reaming device and an interior of the reaming device; and
 - a depth control window formed in an exterior surface of the reaming device,
 - wherein the elongate recess is configured to receive each of the guiding
 - 15 wire and depth guide therein, and
 - during reaming of the bone, the depth control window is configured to provide visual access to the second end of the tubular depth guide to determine whether a patient-specific reaming depth has been reached.
- 20 2. The system for reaming a bone according to Claim 1, wherein the elongate recess includes a reduced diameter section that defines a shoulder, and
- the shoulder is designed to abut the second end of the tubular depth guide to control the reaming depth.
- 25 3. The system of Claim 1, wherein the length of the tubular depth guide corresponds to the patient-specific reaming depth.
4. The system of Claim 2, wherein the depth control window includes
- 30 a first window and a second window separated by a rib.

5. The system of Claim 4, wherein a location of the rib between the first and second windows corresponds to the shoulder.

6. The system of Claim 1, further comprising a plurality of notches
5 formed in the exterior surface about a periphery of the depth control window.

7. The system of Claim 6, wherein each of the notches are configured to provide a visual indication of a reaming depth different from the patient-specific reaming depth.

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8. A method for providing a system for use in reaming a bone, comprising:

providing a guiding wire to be attached to the bone;

providing a tubular depth guide having a patient-specific length extending
15 between a first end configured to abut the bone and a second end opposite the first end, where the tubular depth guide is configured to cover at least a portion of the guiding wire;

providing a reaming device having an elongate recess therein that is configured to receive each of the guiding wire and depth guide therein and
20 extends between a reaming tool of the reaming device and an interior of the reaming device for use in reaming the bone, and the reaming device including a depth control window formed in an exterior surface of the reaming device; and

wherein the second end of the tubular depth guide can be viewed through the depth control window to determine whether a patient-specific reaming depth
25 has been reached.

9. The method of Claim 8, wherein the length of the tubular depth guide corresponds to a specific reaming depth.

10. The method of Claim 8, wherein the elongate recess includes a reduced diameter section that defines a shoulder, and
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the shoulder is configured to abut the second end of the tubular depth guide to control the reaming depth.

11. The method of Claim 15, wherein the depth control window
5 includes a first window and a second window separated by a rib, and a location of the rib corresponding to the patient-specific reaming depth; and

wherein reaming of the bone is completed when the second end of the tubular depth guide reaches the rib.

12. The method of Claim 10, wherein the depth control window
10 includes a first window and a second window separated by a rib, and a location of the rib between the first and second windows corresponding to a location of the shoulder; and

wherein reaming of the bone is completed when the second end of the
15 tubular depth guide reaches the shoulder.

13. The method of Claim 8, wherein the reaming device includes a plurality of notches formed in the exterior surface about a periphery of the depth control window.
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14. The method of Claim 13, wherein each of the notches are configured to provide a visual indication of a reaming depth different from the patient-specific reaming depth.

25 15. A method for reaming a glenoid for an arthroplasty, comprising:
positioning a patient-specific glenoid guide proximate the glenoid, the glenoid guide including a first primary drill guide extending along a first axis and a second primary drill guide extending along a second axis;

selecting one of the first and second axes for orienting a guiding wire, and
30 positioning a guiding wire in the glenoid that extends along the selected axis;

positioning a tubular depth guide over the guiding wire such that a first end of the depth guide abuts the bone and the guiding wire extends outward from a second of the depth guide;

- 5 positioning a reaming device over the guiding wire, and reaming the glenoid along the selected axis, the reaming device including an elongate recess therein that is configured to receive each of the guiding wire and depth guide therein and extends between a reaming tool of the reaming device and an interior of the reaming device, and the reaming device including a depth control window formed in an exterior surface of the reaming device; and
- 10 viewing the second end of the tubular depth guide through the depth control window to determine whether a patient-specific reaming depth has been reached

16. The method of Claim 15, wherein a length of the tubular depth
15 guide is patient-specific and corresponds to the patient-specific reaming depth.

17. The method of Claim 15, wherein the elongate recess includes a reduced diameter section that defines a shoulder, and
the shoulder is configured to abut the second end of the tubular depth
20 guide to control the reaming depth.

18. The method of Claim 17, wherein the depth control window includes a first window and a second window separated by a rib, and a location of the rib between the first and second windows corresponding to a location of
25 the shoulder; and
the method further comprising completing reaming of the bone when the second end of the tubular depth guide reaches the shoulder.

19. The method of Claim 15, wherein the depth control window
30 includes a first window and a second window separated by a rib, and a location of the rib corresponds to the patient-specific reaming depth; and

the method further comprises completing reaming of the bone when the second end of the tubular depth guide reaches the rib.

20. The method of Claim 15, wherein the reaming device includes a plurality of notches formed in the exterior surface about a periphery of the depth control window.

21. The method of Claim 20, wherein each of the notches are configured to provide a visual indication of a reaming depth different from the patient-specific reaming depth.

22. A system for reaming a bone, comprising:
a patient-specific guiding wire configured to be attached to the bone;
a tubular depth guide configured to cover at least a portion of the patient-specific guiding wire, the tubular depth guide including a first end configured to abut the bone, and a second end opposite the first end;
a reaming device including an elongate recess therein that extends between a reaming tool of the reaming device and an interior of a handle of the reaming device,
wherein the elongate recess is configured to receive each of the guiding wire and depth guide therein,
the elongate recess includes a reduced diameter section that defines a shoulder, and
the shoulder is designed to abut the second end of the tubular depth guide to control a depth to which the bone is reamed.

23. The system of Claim 22, wherein a length of the tubular depth guide is patient-specific or corresponds to a specific reaming depth.

24. The system of Claim 22, wherein the tubular depth guide is formed from titanium, CoCr, or steel.

25. The system of Claim 22, wherein the tubular depth guide is formed from at least one of polyethylene, polypropylene, polystyrene, nylon, and polyether ether ketone (PEEK).

5 26. The system of Claim 22, further comprising a guide member for aligning the guiding wire relative to the bone.

27. The system of Claim 26, wherein the guide member includes a patient-specific bone engagement surface.

10

28. The system of Claim 27, wherein the bone engagement surface is complementary to a surface of the bone to be reamed.

29. The system of Claim 26, wherein the guide member includes first
15 guide and a second guide that are configured to align the guiding wire relative to the bone in a first orientation and a second orientation.

30. A method for providing a system for use in reaming a bone, comprising:

20

providing a guiding wire to be attached to the bone;

providing a tubular depth guide having a first end configured to abut the bone, and a second end opposite the first end, where the tubular depth guide is configured to cover at least a portion of the guiding wire;

25 providing a reaming device having an elongate recess therein that extends between a reaming tool of the reaming device and an interior of a handle of the reaming device for use in reaming the bone,

wherein the elongate recess is configured to receive each of the guiding wire and depth guide therein,

30 the elongate recess includes a reduced diameter section that defines a shoulder, and

the shoulder is designed to abut the second end of the tubular depth guide to control a depth to which the bone is reamed.

31. The method of Claim 30, wherein a length of the tubular depth guide is patient-specific or corresponds to a specific reaming depth.

5 32. The method of Claim 30, wherein the tubular depth guide is formed from titanium, CoCr, or steel.

33. The method of Claim 30, wherein the tubular depth guide is formed from at least one of polyethylene, polypropylene, polystyrene, nylon, and
10 polyether ether ketone (PEEK)..

34. The method of Claim 30, wherein the guide member is configured to align the guiding wire relative to the bone.

15 35. The method of Claim 34, wherein the guide member includes a patient-specific bone engagement surface.

36. The method of Claim 35, wherein the bone engagement surface is complementary to a surface of the bone to be reamed.
20

37. The method of Claim 34, wherein the guide member includes a first guide and a second guide that are configured to align the guiding wire relative to the bone in a first orientation and a second orientation.

25 38. A method for reaming a glenoid for an arthroplasty, comprising:
positioning a patient-specific glenoid guide proximate the glenoid, the glenoid guide including a first primary drill guide extending along a first axis and a second primary drill guide extending along a second axis;
selecting one of the first and second axes for orienting a guiding wire, and
30 positioning a guiding wire in the glenoid that extends along the selected axis;

positioning a tubular depth guide over the guiding wire such that a first end of the depth guide abuts the bone and the guiding wire extends outward from a second of the depth guide;

5 positioning a reaming device over the guiding wire, and reaming the glenoid along the selected axis,

wherein the reaming device includes an elongate recess therein that extends between a reaming tool of the reaming device and an interior of a handle of the reaming device,

10 the elongate recess is configured to receive each of the guiding wire and depth guide therein,

the elongate recess includes a reduced diameter section that defines a shoulder, and

the shoulder is designed to abut the second end of the tubular depth guide to control a depth to which the bone is reamed.

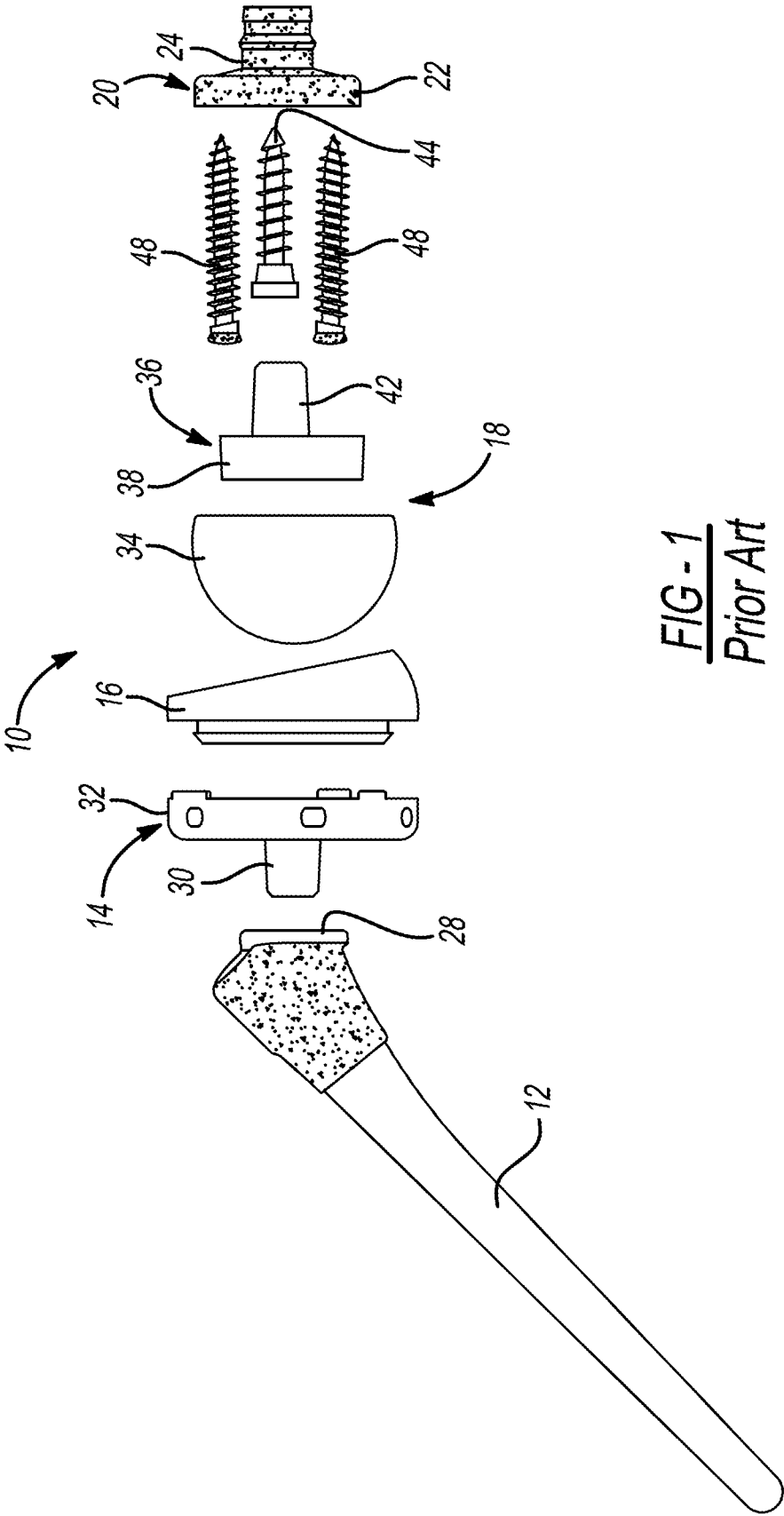
15

39. The method of Claim 38, wherein a length of the tubular depth guide is patient-specific or corresponds to the depth to which the bone is reamed.

20

40. The method of Claim 34, wherein the glenoid guide includes a patient-specific bone engagement surface.

41. The method of Claim 40, wherein the bone engagement surface is complementary to the glenoid.



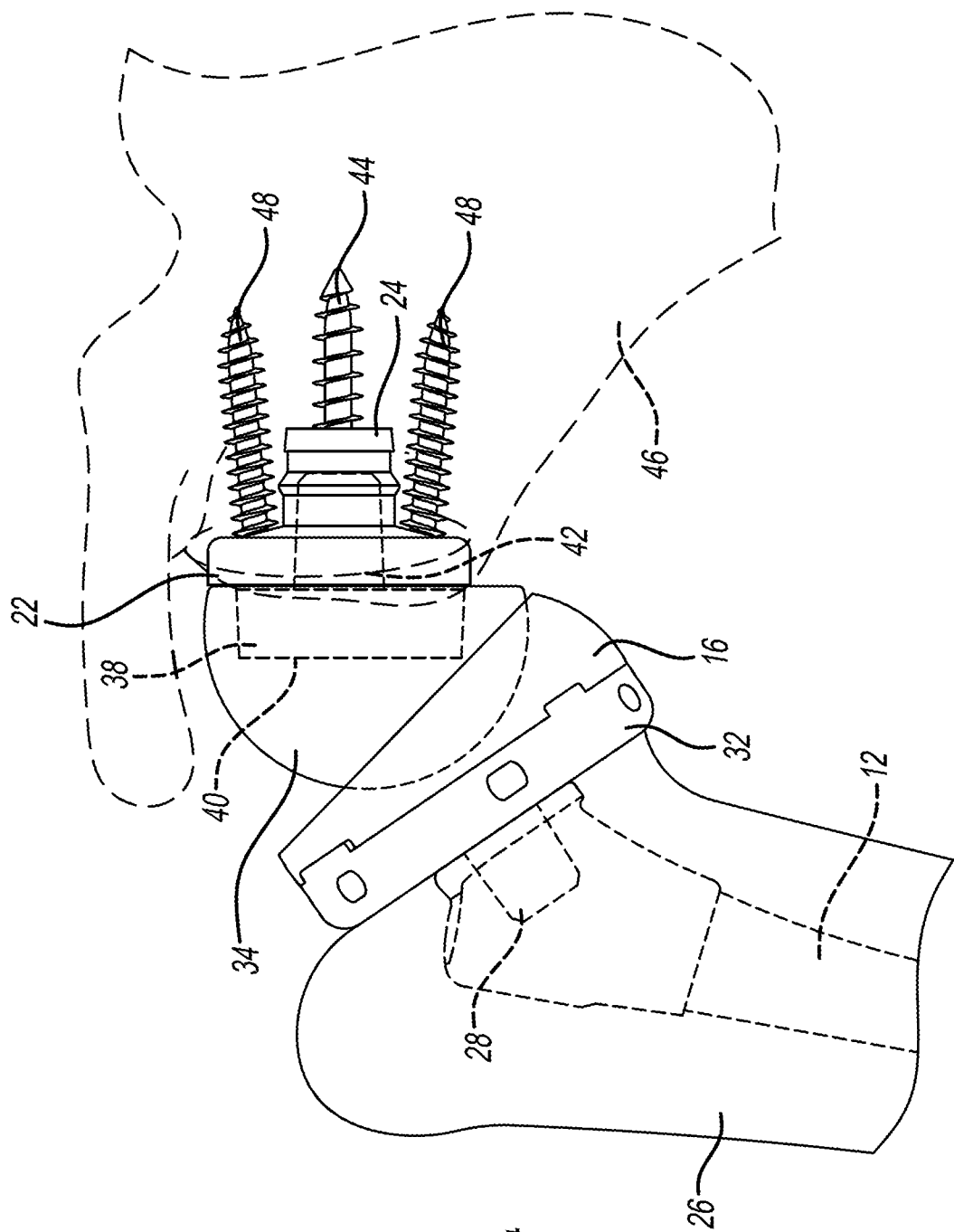
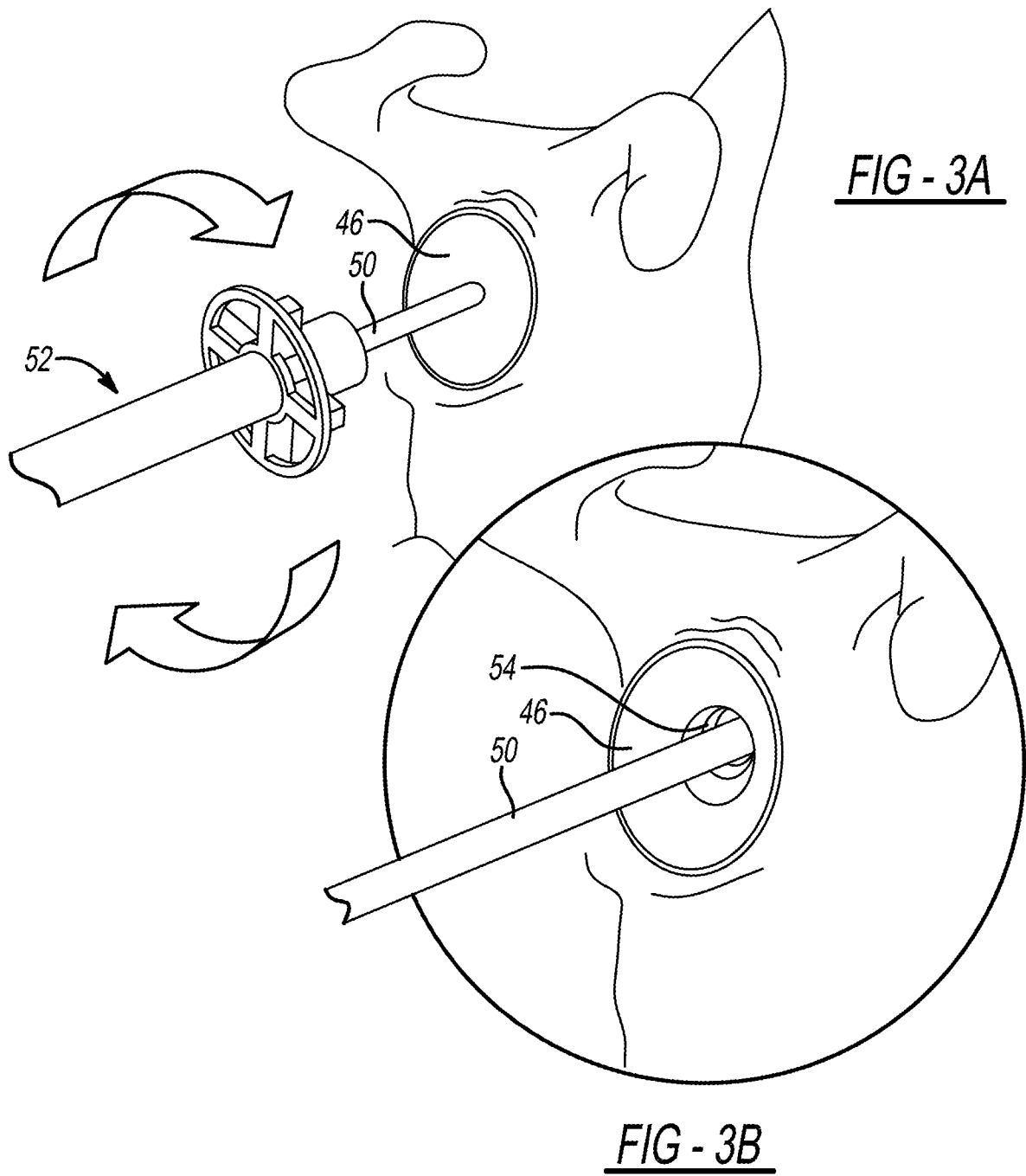


FIG - 2
Prior Art



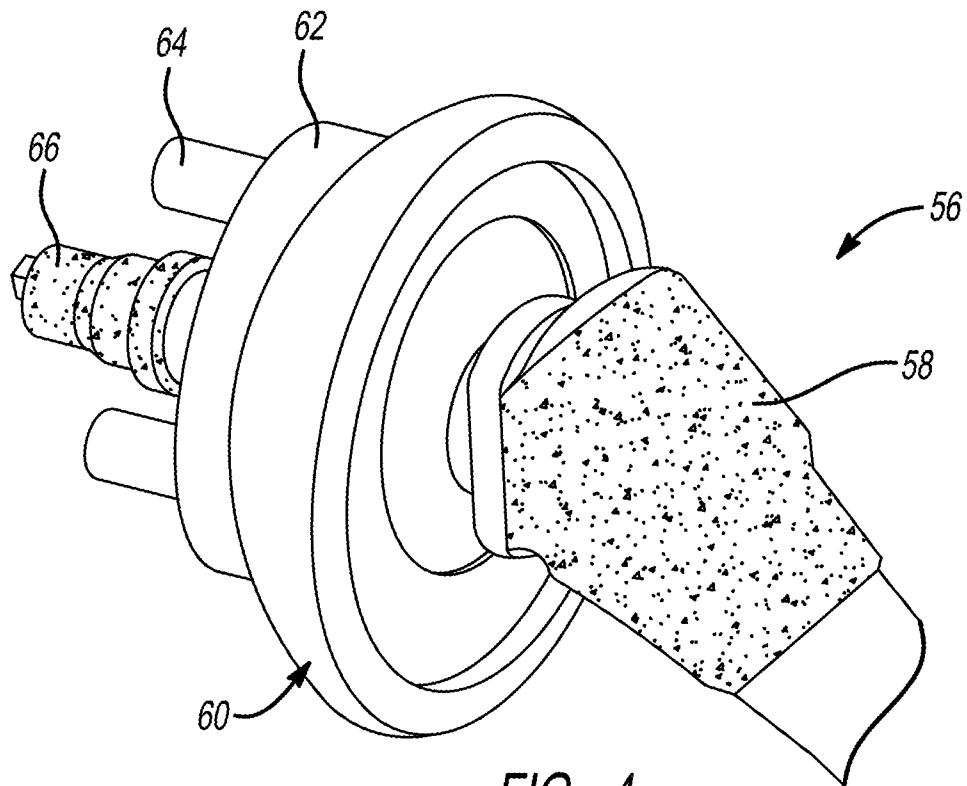


FIG - 4
Prior Art

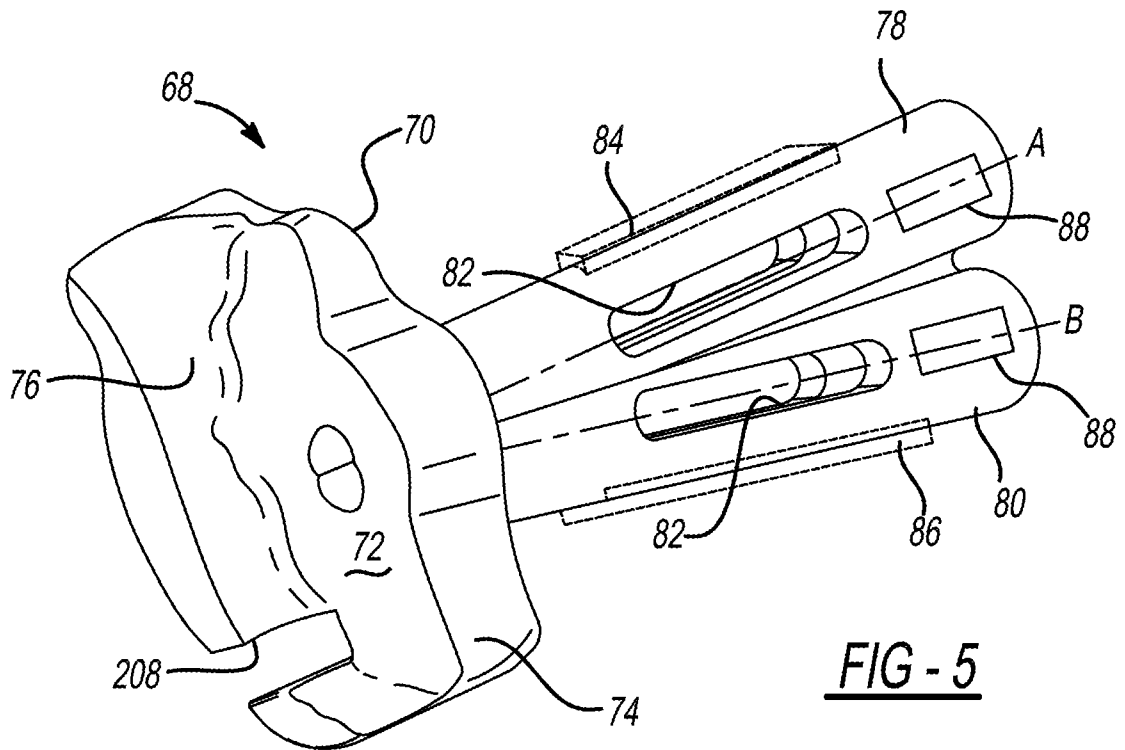
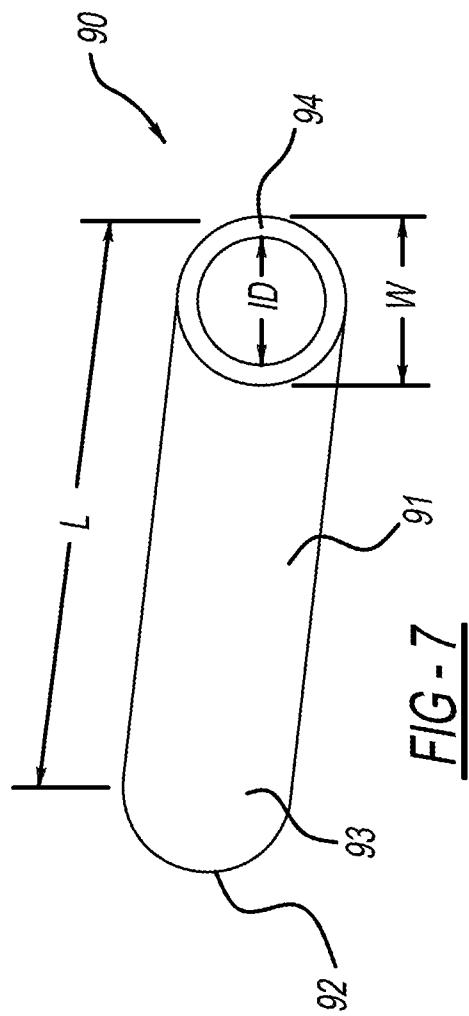
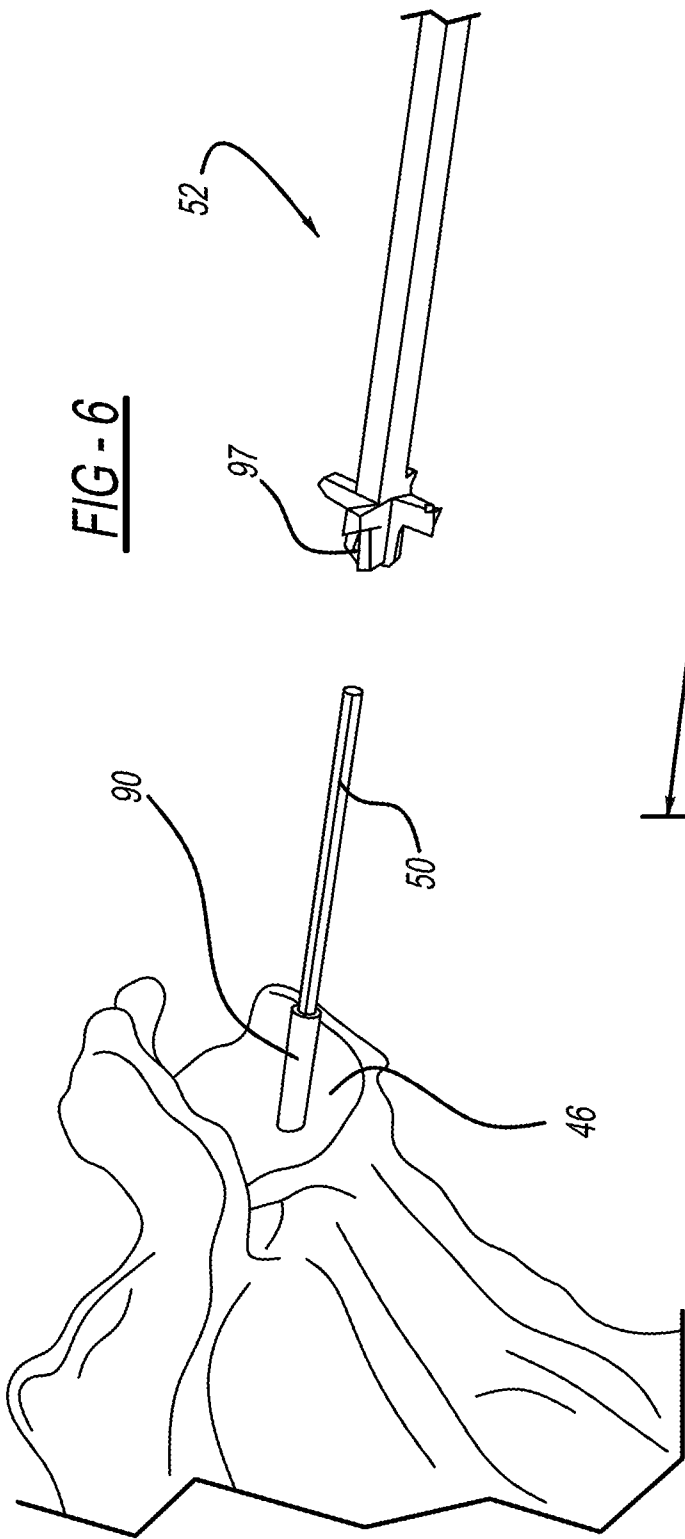
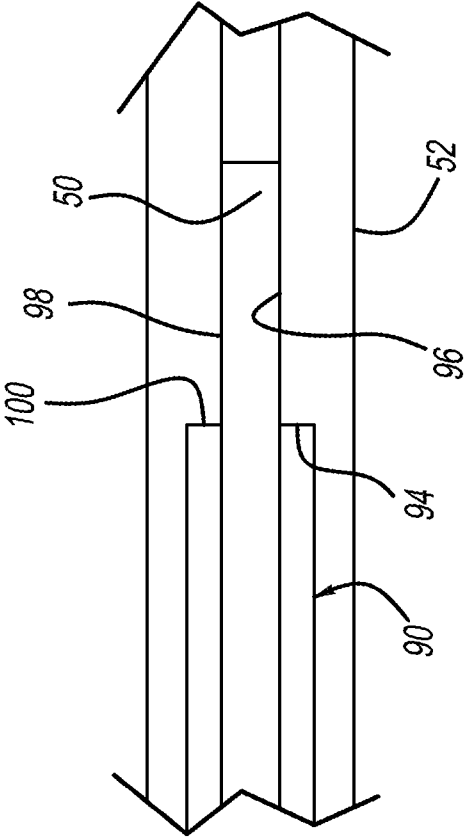
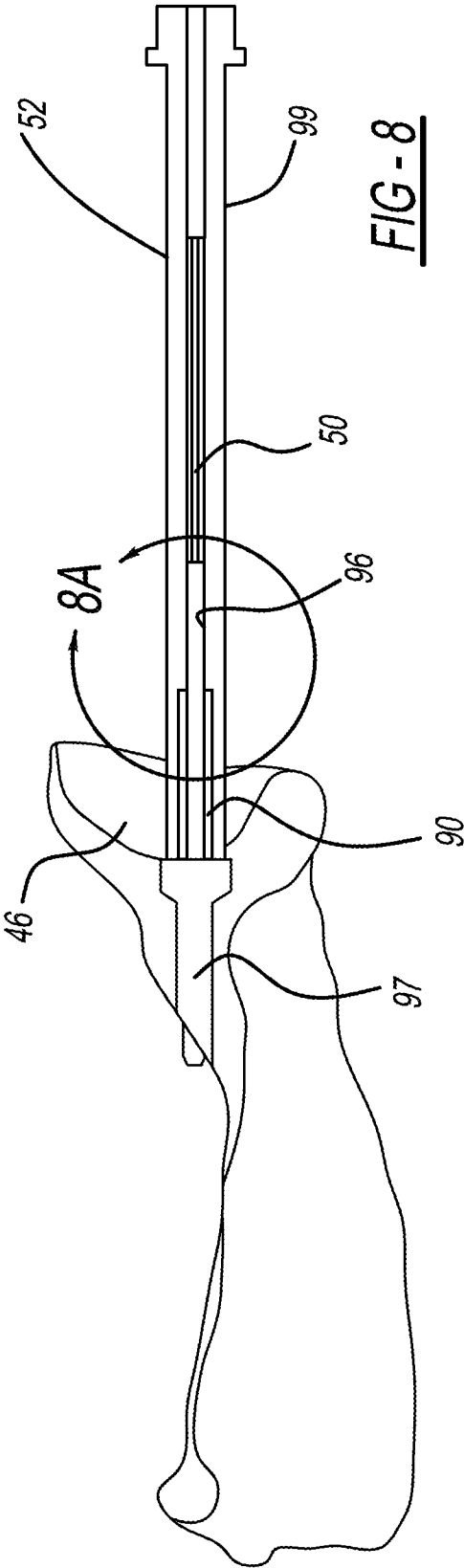


FIG - 5





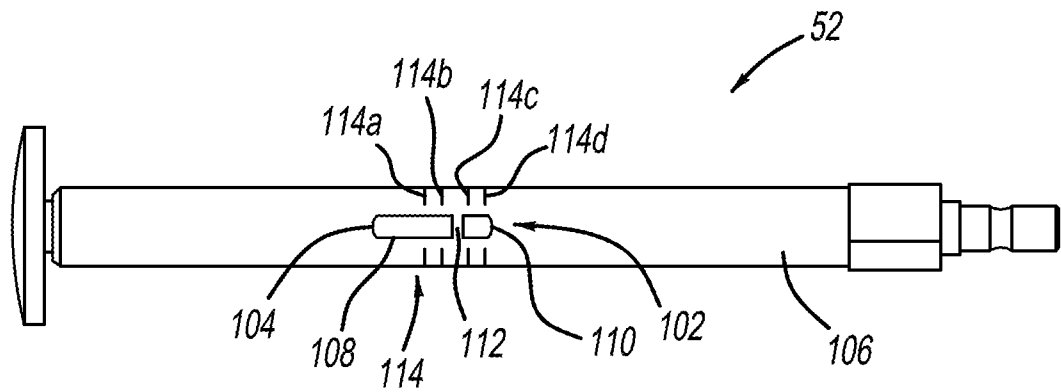


FIG - 9

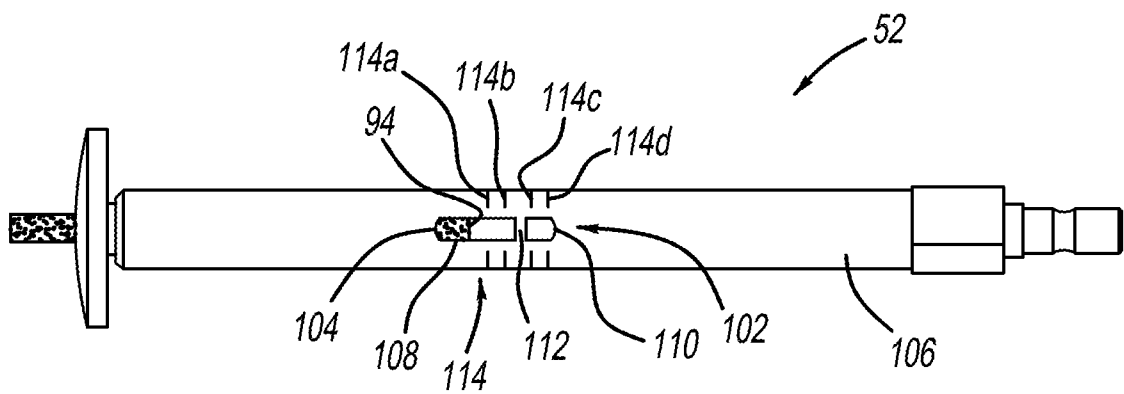


FIG - 10

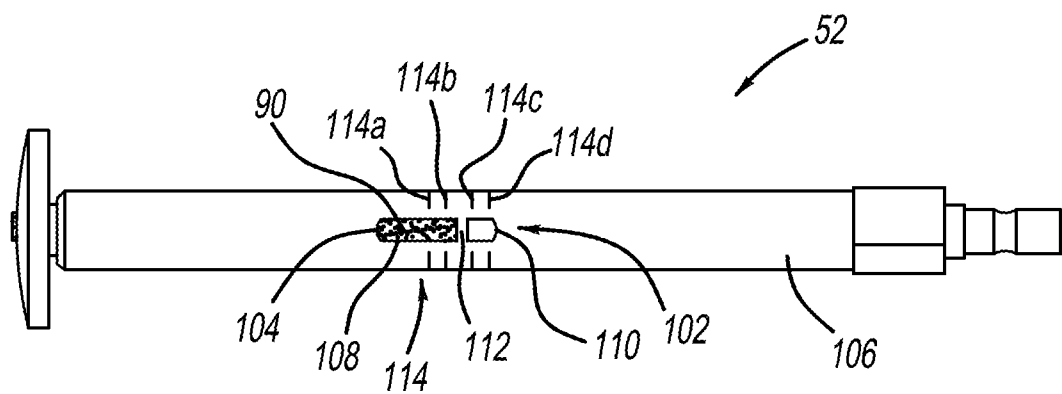


FIG - 11

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2015/033756

A. CLASSIFICATION OF SUBJECT MATTER

INV. A61B17/16

ADD. A61B17/17 A61B19/00 A61F2/46

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)

A61B A61F A61C A61M B23B B23C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2012/130505 A1 (LONG JACK F [US] ET AL) 24 May 2012 (2012-05-24) paragraphs [0160] - [0170]; figures 26-33 -----	1,3,8,9, 24,25, 31-37
A	US 2014/066933 A1 (EK STEVEN [US] ET AL) 6 March 2014 (2014-03-06) paragraphs [0010], [0031], [0035]; figure 3E -----	2,10,22, 23,26-30
A	US 2012/259423 A1 (CARR JONATHAN E [US] ET AL) 11 October 2012 (2012-10-11) paragraphs [0133], [0139], [0140], [0161], [0162]; figures 24,25,30-32 ----- -/-	1,6,7, 13,14



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

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"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

20 October 2015

Date of mailing of the international search report

29/10/2015

Name and mailing address of the ISA/

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Authorized officer

Hagberg, Åsa

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2015/033756

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2012/226315 A1 (ALTARAC MOTI [US] ET AL) 6 September 2012 (2012-09-06) paragraphs [0115] - [0117], [0193], [0199]; figures 4,4B -----	1,8,22,30
A	US 2006/074434 A1 (WENSTROM RICHARD F JR [US] ET AL) 6 April 2006 (2006-04-06) paragraphs [0022], [0023]; figure 1 -----	4,11,12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/033756

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.: 15-21, 38-41
because they relate to subject matter not required to be searched by this Authority, namely:
see FURTHER INFORMATION sheet PCT/ISA/210
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 additional 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 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.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.1

Claims Nos.: 15-21, 38-41

No search has been performed and no opinion has been established with regard to claims 15-21 and 38-41, because under Rules 39.1(iv) and 67.1(iv) PCT, no international search or international preliminary examination is required for subject-matter which is methods for treatment of the human or animal body by surgery or therapy.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2015/033756

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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