US 20110166661A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2011/0166661 A1**

(43) **Pub. Date: Jul. 7, 2011**

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(54) **APPARATUS FOR FITTING A SHOULDER PROSTHESIS**

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(21) Appl. No.: **13/007,355**

(22) Filed: **Jan. 14, 2011**

Related U.S. Application Data

(63) Continuation-in-part of application No. 12/020,913, filed on Jan. 28, 2008.

(60) Provisional application No. 60/888,437, filed on Feb. 6, 2007, provisional application No. 60/971,762, filed on Sep. 12, 2007, provisional application No. 61/015,042, filed on Dec. 19, 2007.

(30) **Foreign Application Priority Data**

Jan. 30, 2007 (FR) 0700622

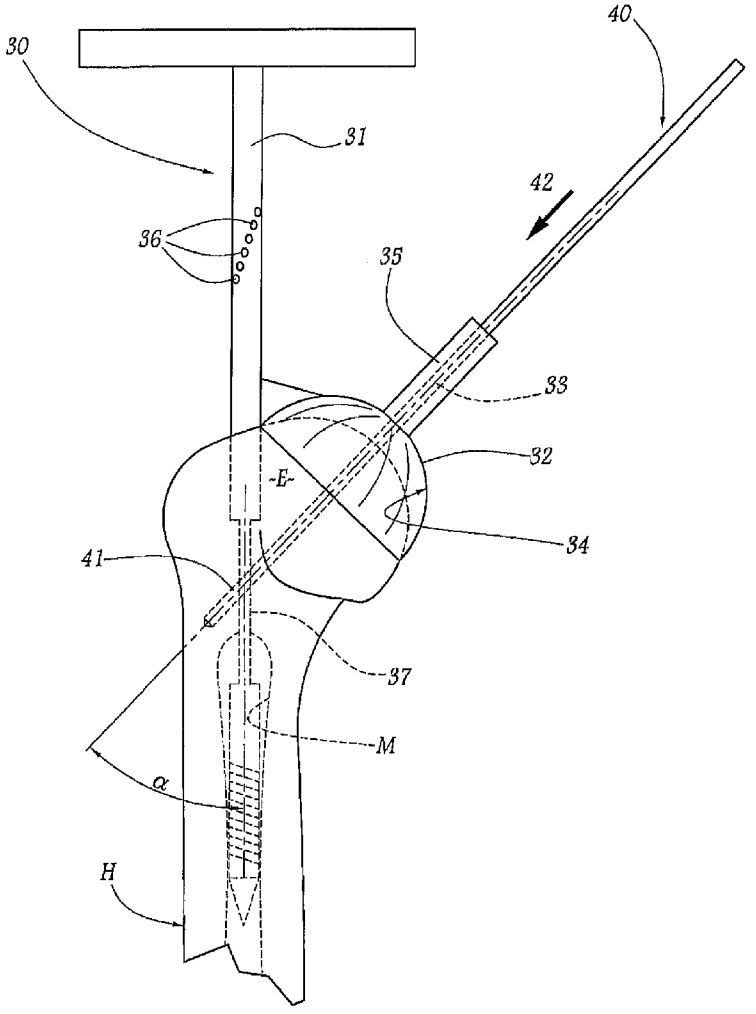
Publication Classification

(51) **Int. Cl.**
A61F 2/40 (2006.01)

(52) **U.S. Cl.** **623/19.13**; 623/19.14

(57) **ABSTRACT**

Method and set of surgical instruments for fitting a shoulder prosthesis, and the shoulder prosthesis. The proposed method seeks to interpose a bone graft between the previously prepared glenoid surface of a scapula of a patient's shoulder and the face of a glenoid prosthetic component opposite the articular surface. The set of instruments permit the bone graft to be taken from the upper epiphysis of the humerus, either in situ or ex vivo.



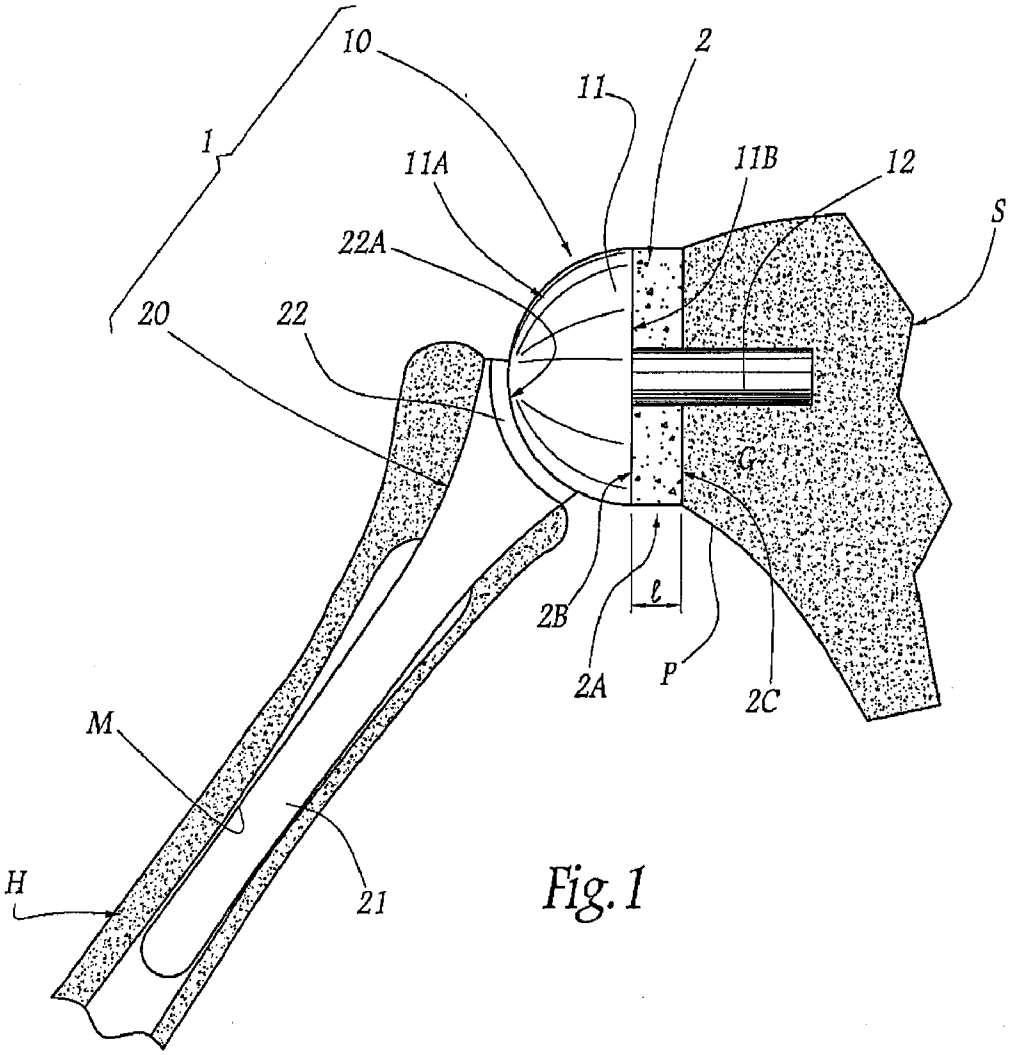


Fig. 1

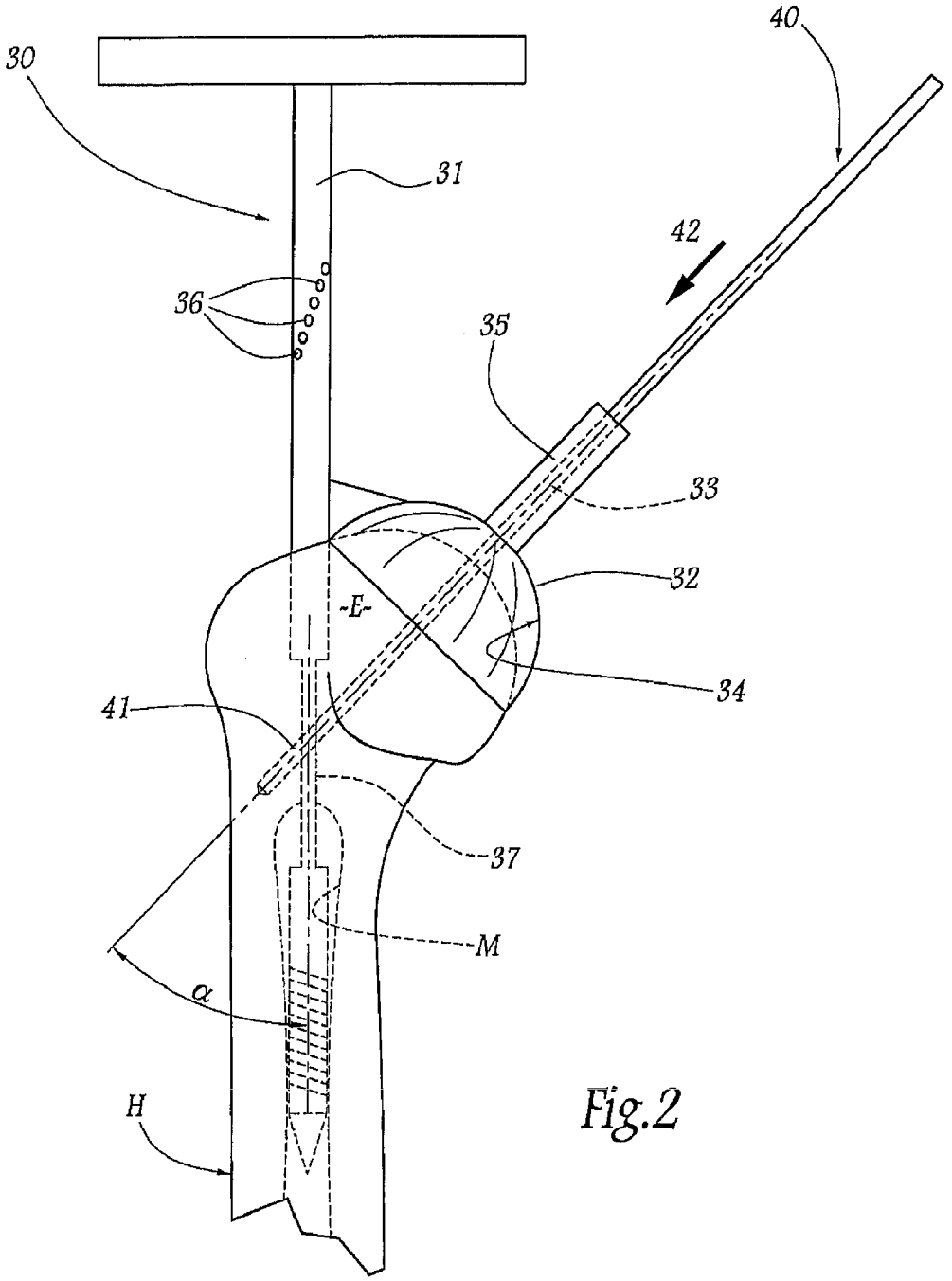


Fig.2

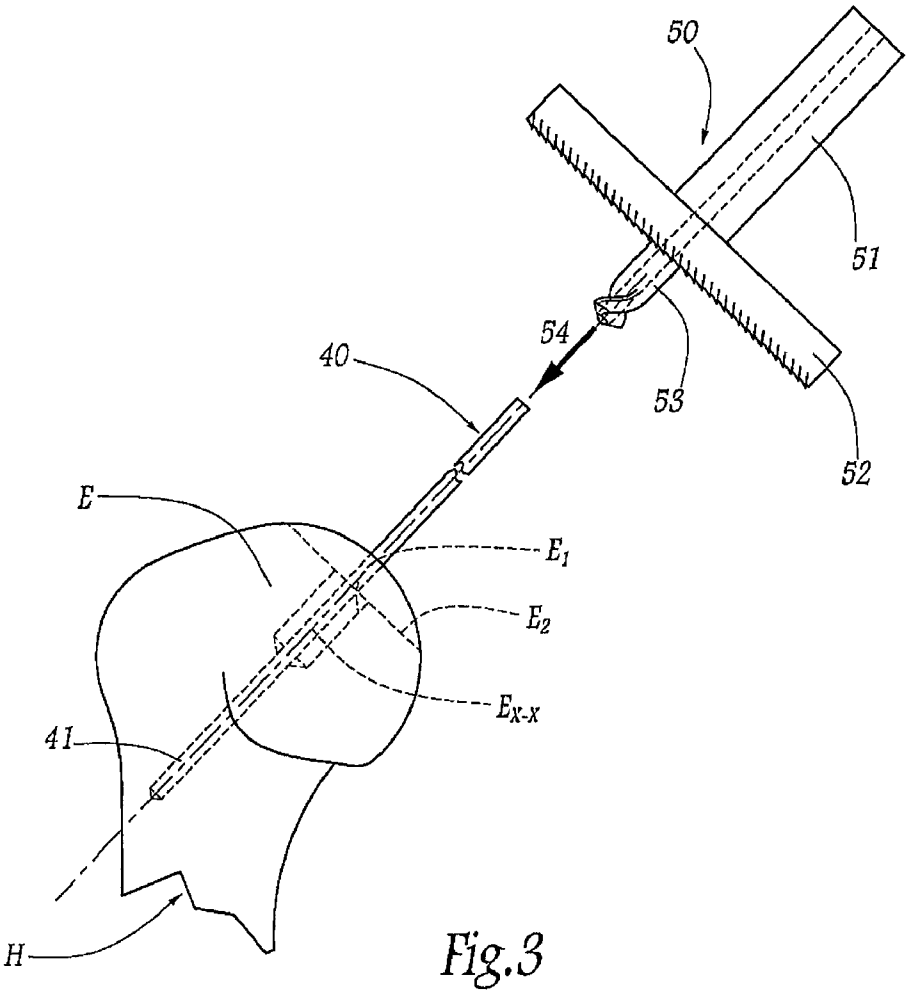


Fig.3

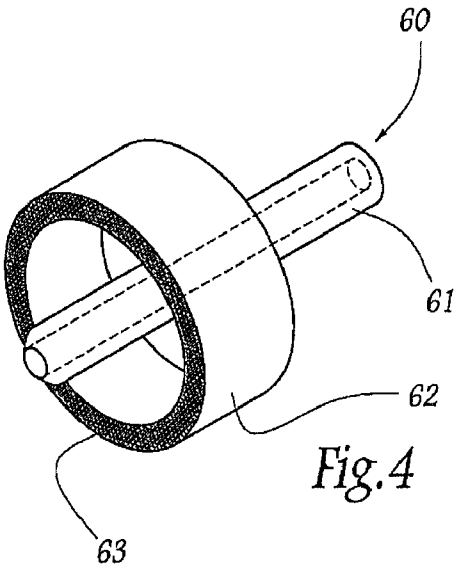


Fig.4

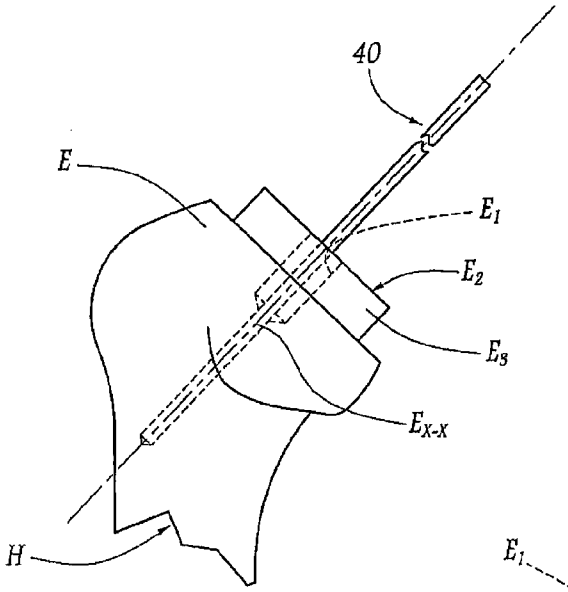


Fig.5

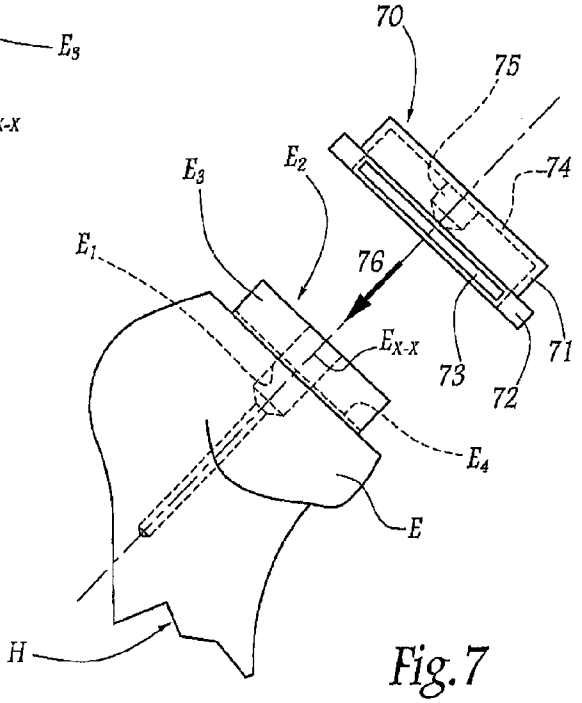


Fig.7

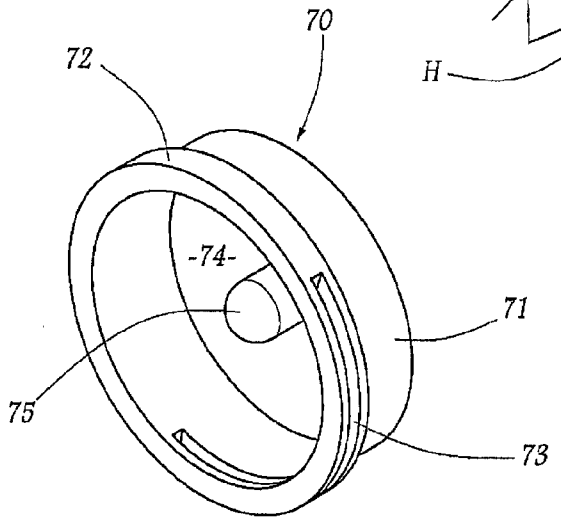


Fig.6

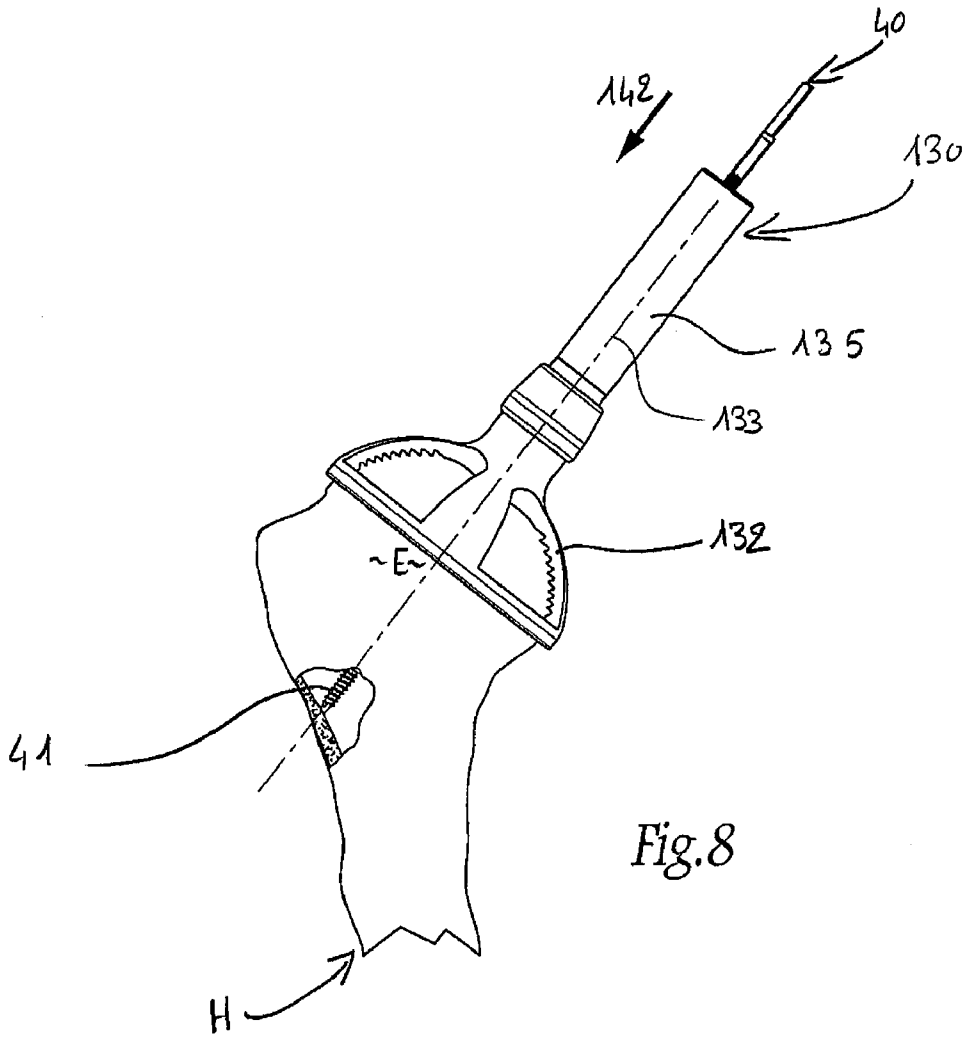


Fig.8

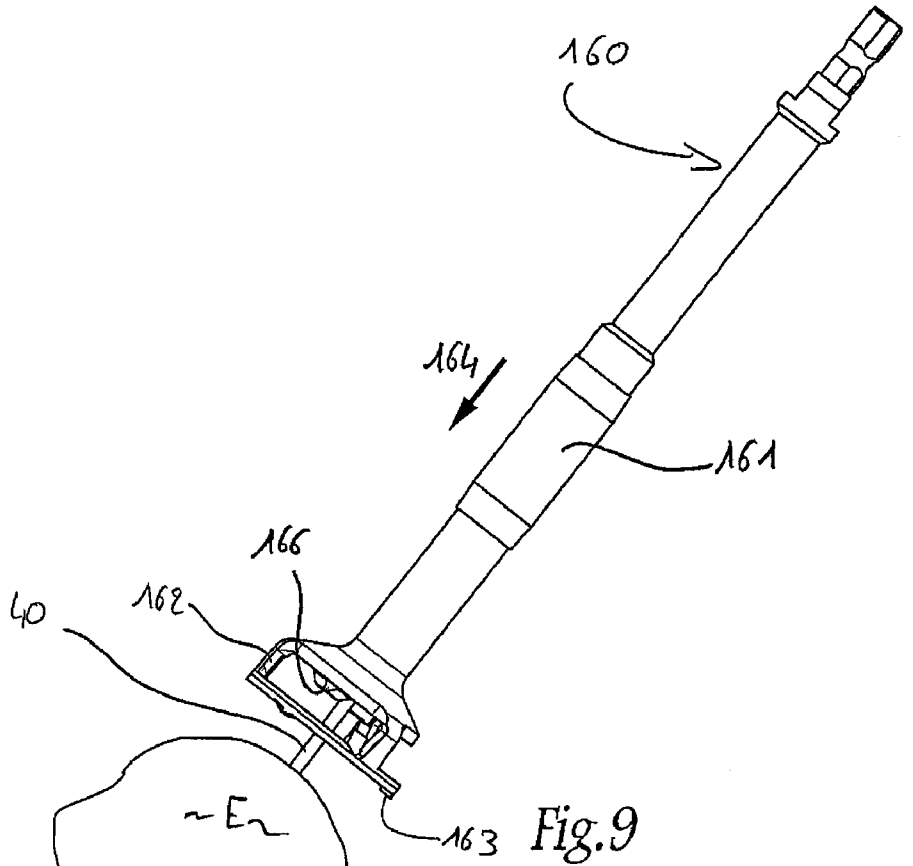


Fig.9

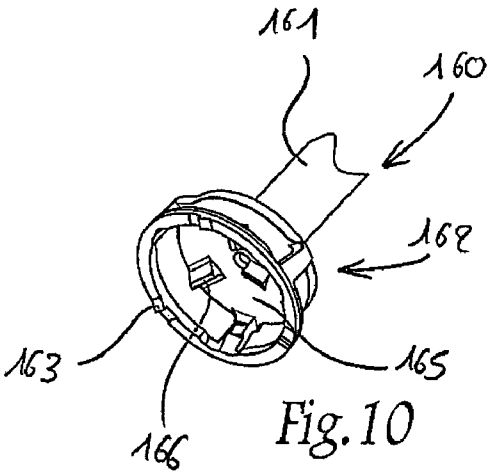


Fig.10

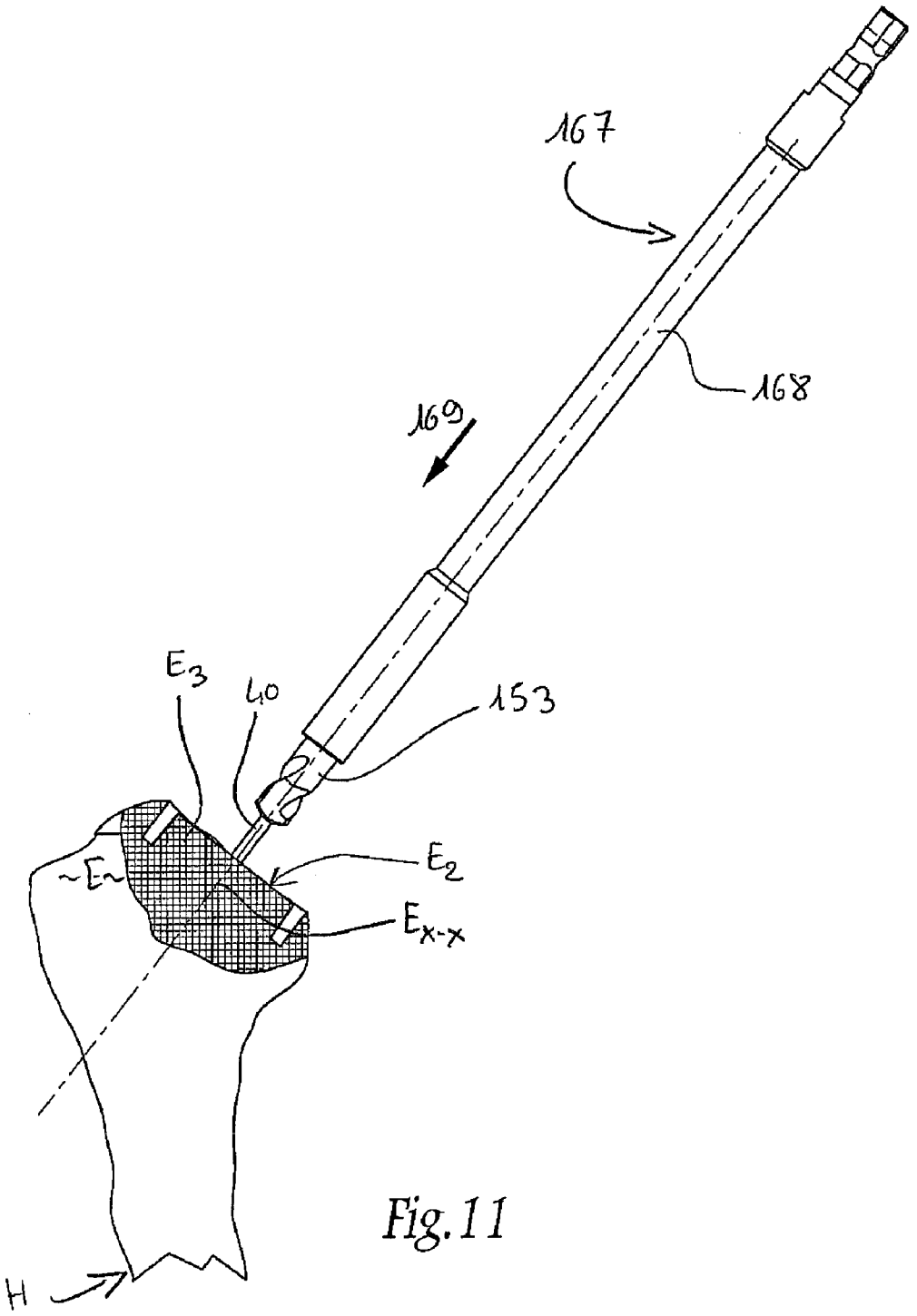


Fig. 11

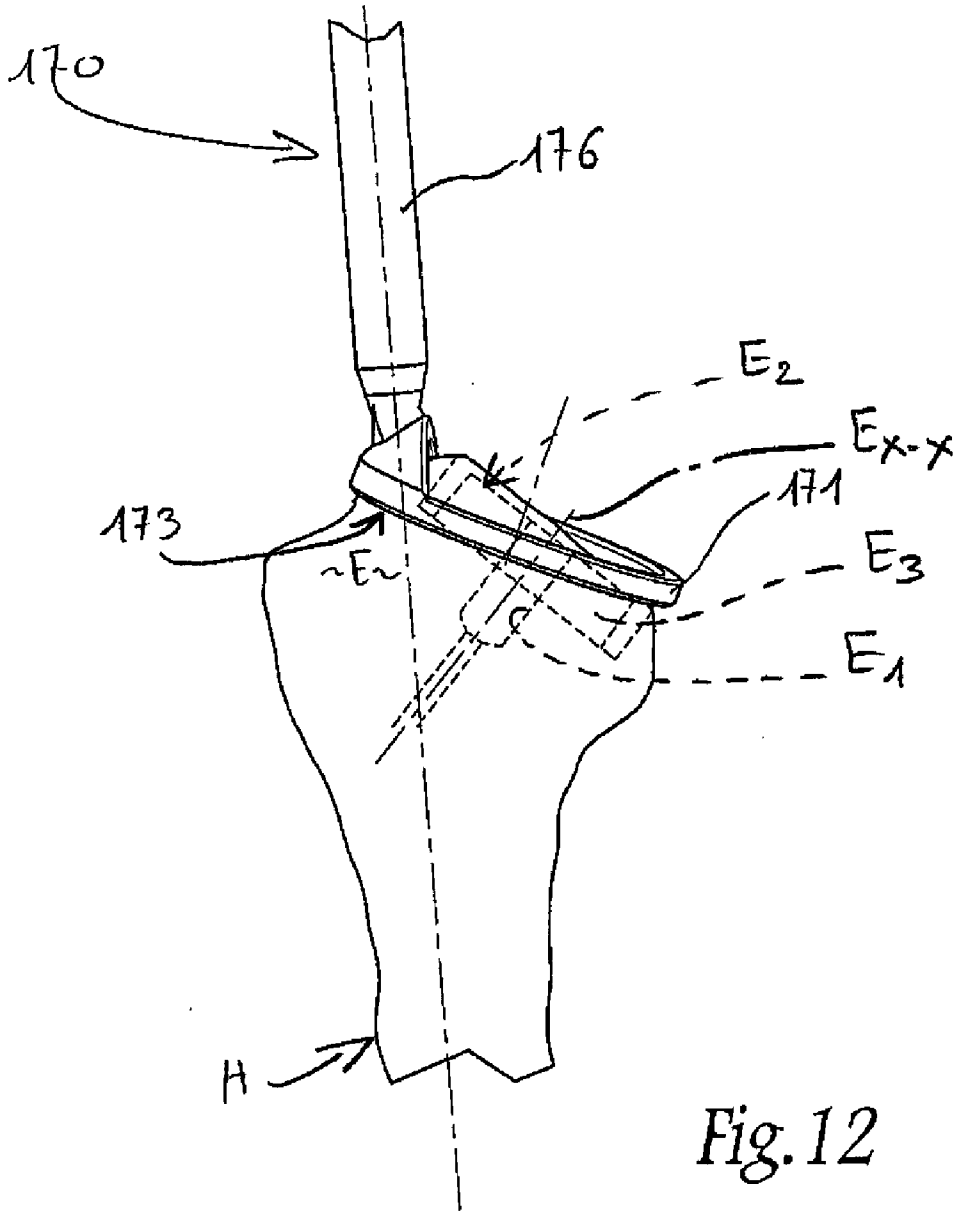


Fig. 12

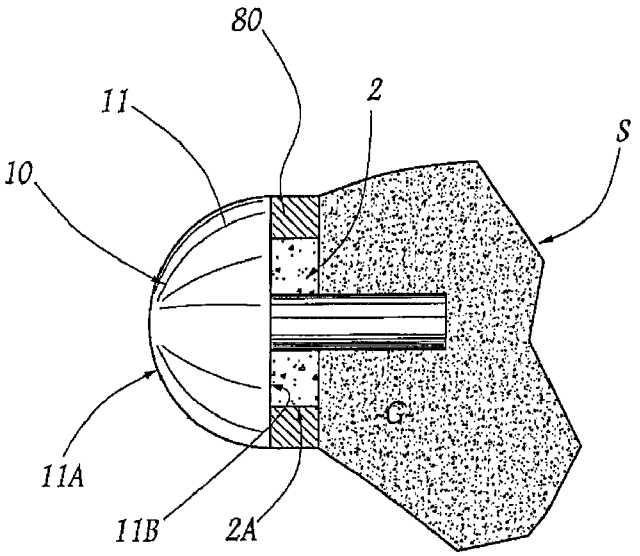


Fig. 13

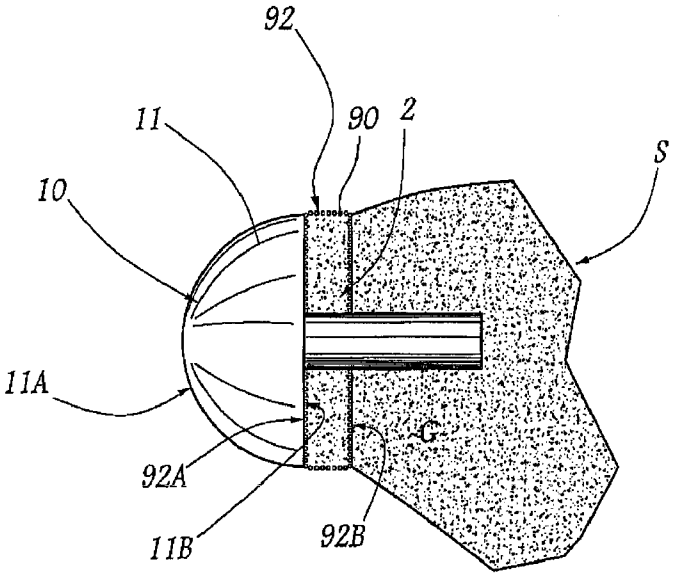


Fig. 14

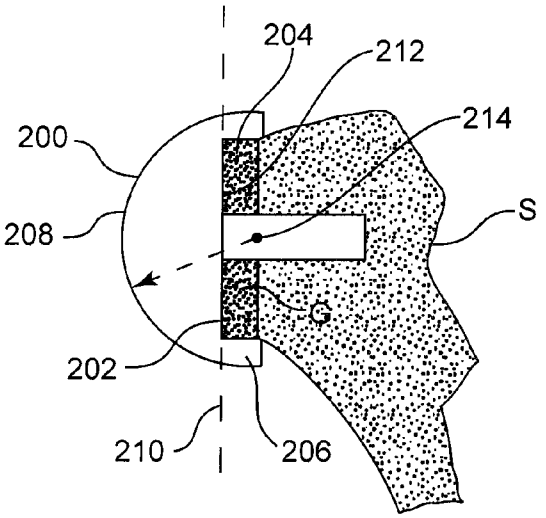


Fig. 15

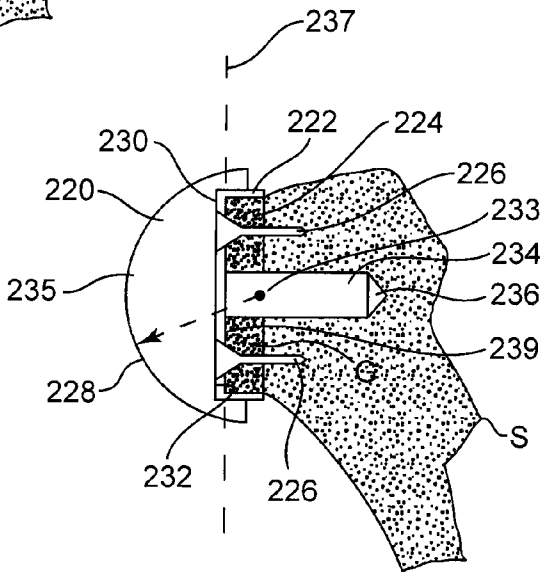


Fig. 16

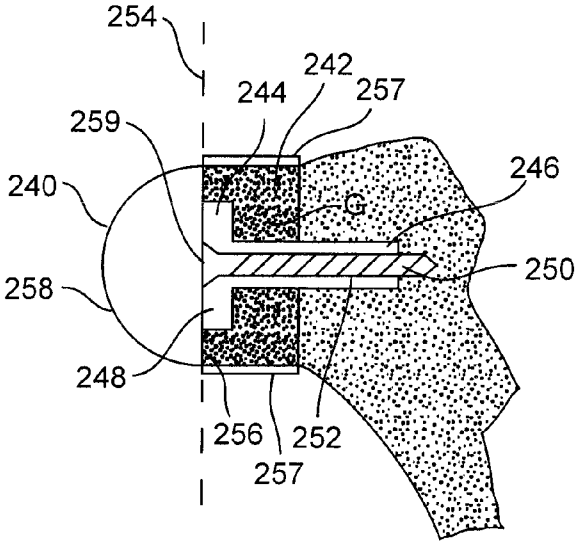


Fig. 17

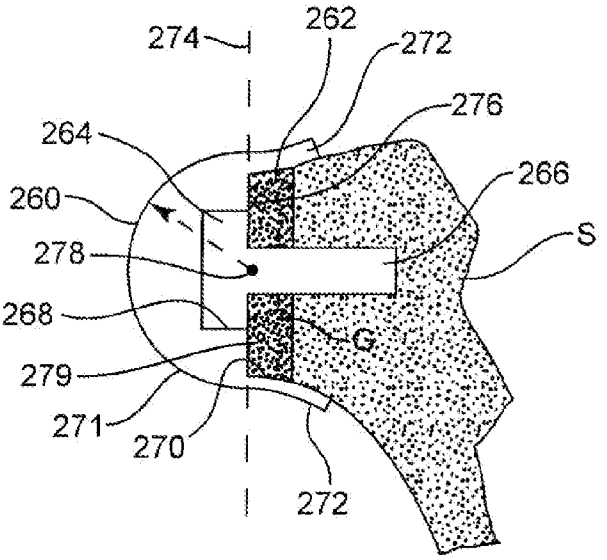


Fig. 18

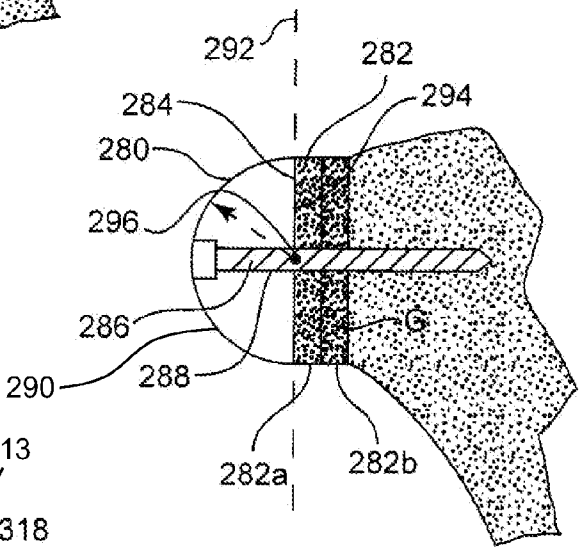


Fig. 19

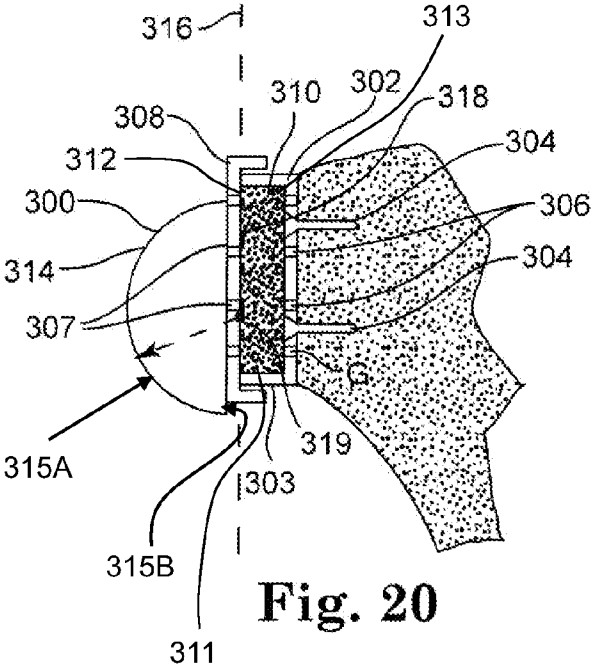


Fig. 20

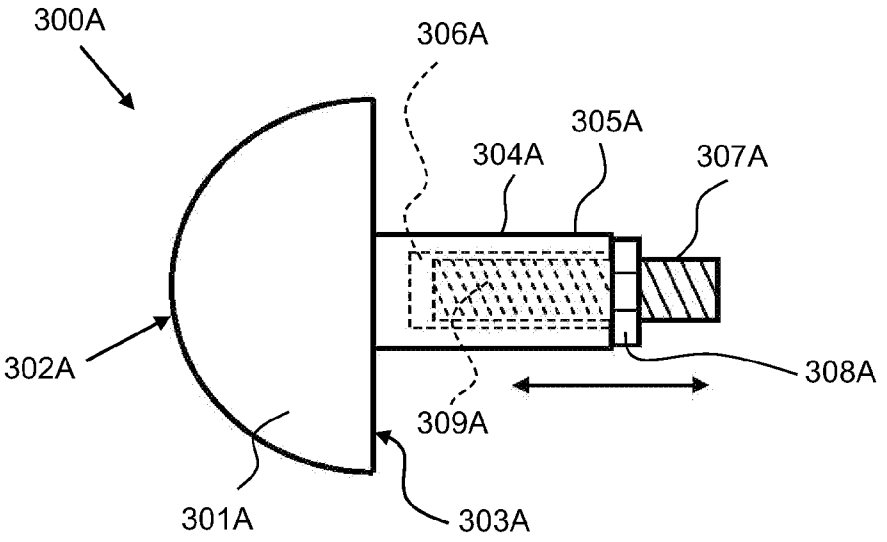


Fig. 20A

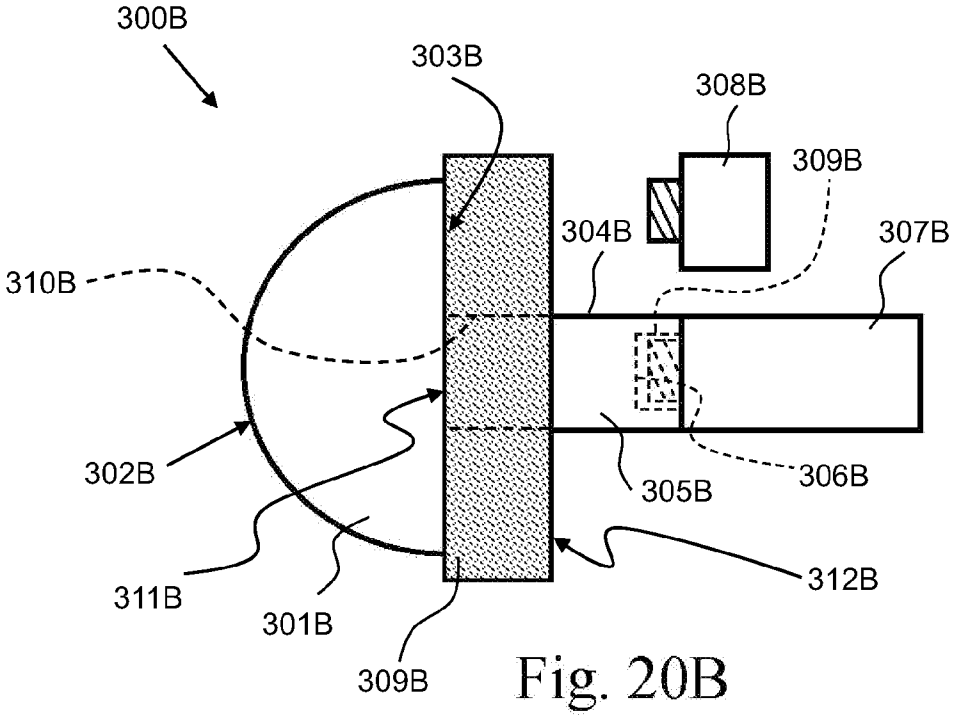


Fig. 20B

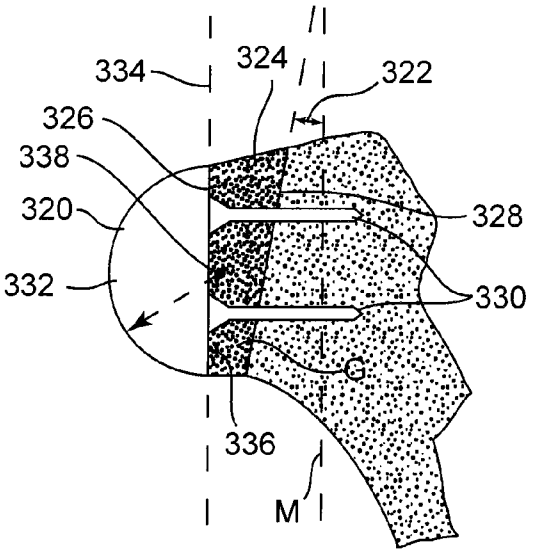


Fig. 21

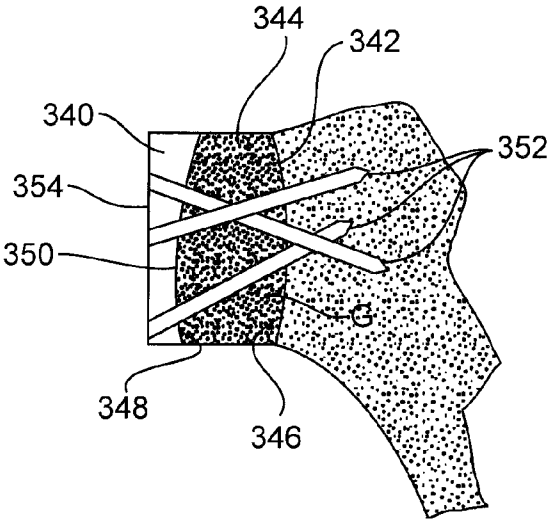


Fig. 22

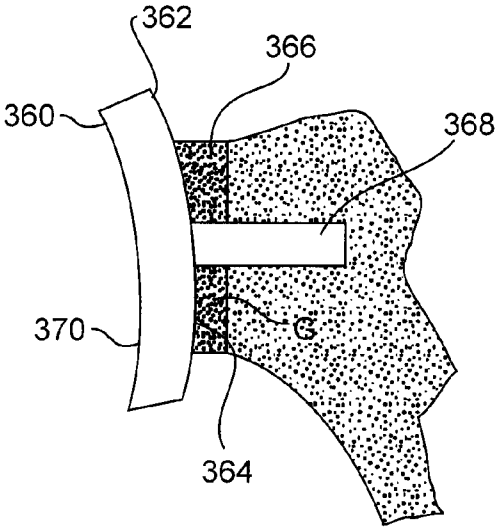


Fig. 23

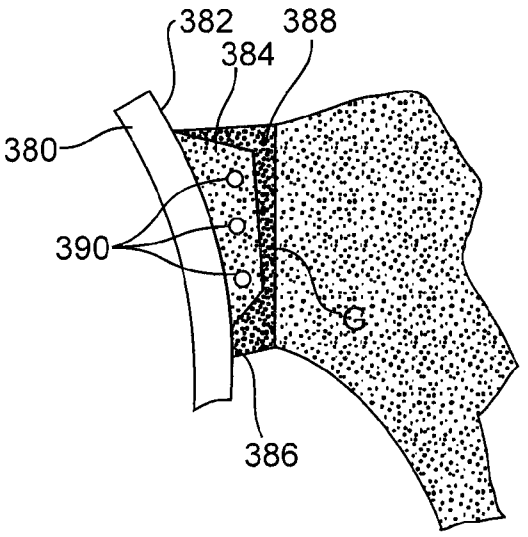


Fig. 24

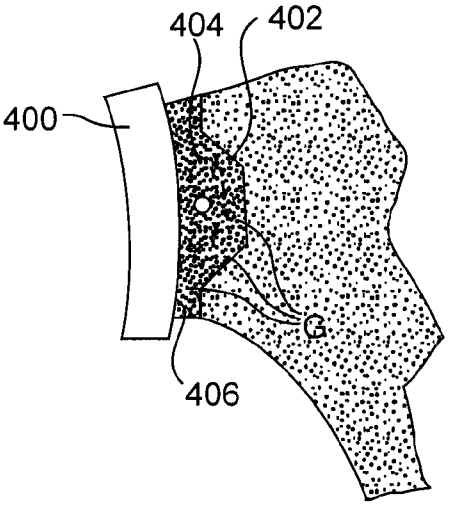


Fig. 25

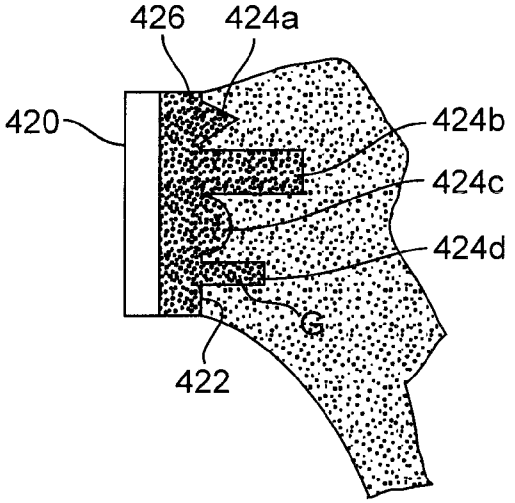


Fig. 26

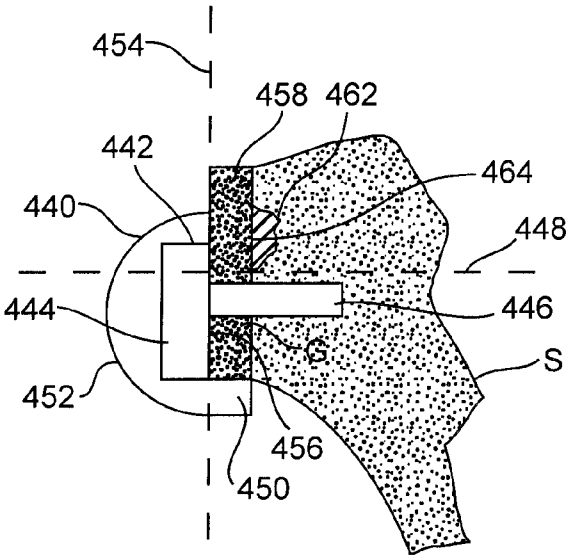


Fig. 27

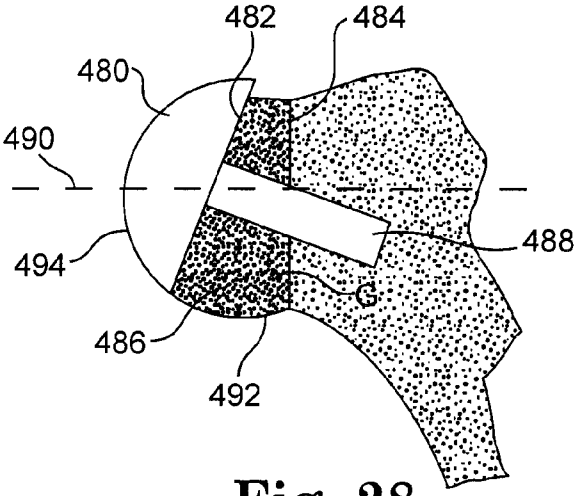


Fig. 28

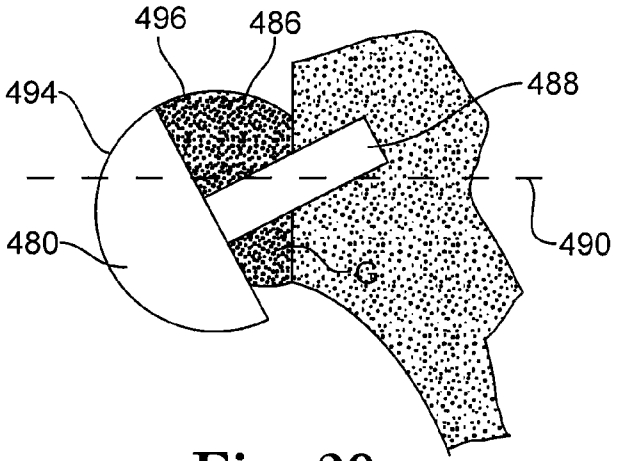


Fig. 29

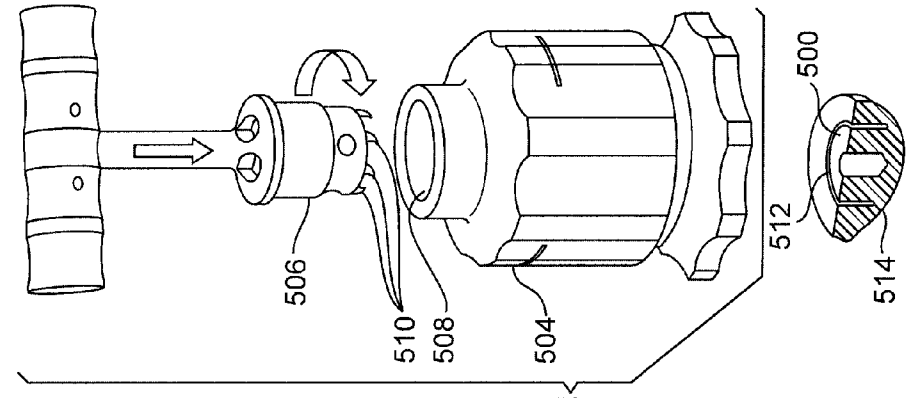


Fig. 30C

Fig. 30D

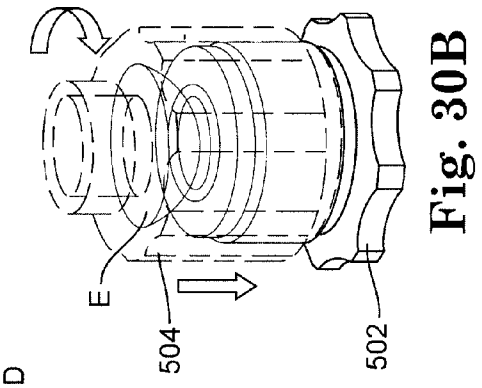


Fig. 30B

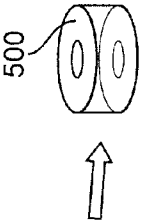


Fig. 30F

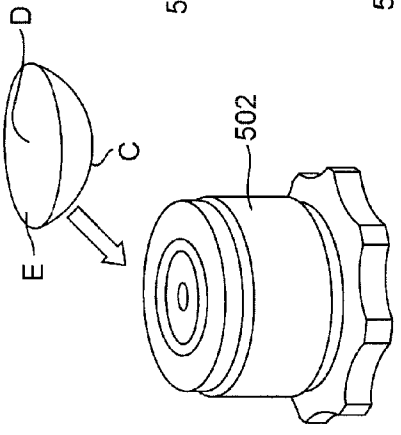


Fig. 30A

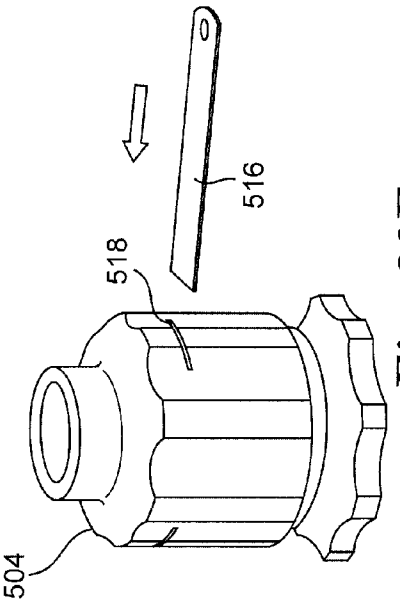


Fig. 30E

APPARATUS FOR FITTING A SHOULDER PROSTHESIS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present application is a continuation-in-part application of U.S. patent application Ser. No. 12/020,913 filed Jan. 28, 2008, entitled "Method and Apparatus for Fitting a Shoulder Prosthesis," which claims priority to French Application No. 0700622, entitled "Méthode et ensemble d'instrumentation chirurgicale pour poser une prothèse totale d'épaule inversée, et prothèse correspondante," filed Jan. 30, 2007 and also claims the benefit of U.S. Provisional Application Ser. Nos. 60/888,437 filed Feb. 6, 2007, 60/971,762 filed Sep. 12, 2007 (both entitled "Method and Apparatus for Fitting an Inverted Shoulder Prosthesis") and U.S. Provisional Application Ser. No. 61/015,042, entitled "Intra-Articular Joint Replacement," filed Dec. 19, 2007, the complete disclosures of each of which are hereby incorporated by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to an inverted or an anatomical shoulder prosthesis including a graft to lateralize a glenoid component of the shoulder prosthesis.

BACKGROUND OF THE INVENTION

[0003] Total shoulder prostheses, are commonly said to be inverted when they comprise, on the one hand, a glenoid part integral with the glenoid surface of a scapula of a patient's shoulder and delimiting a convex articular surface and, on the other hand, a humeral part integral with the humerus of the shoulder and delimiting a concave articular surface, the cooperation of these articular surfaces allowing an articulated connection to be reproduced at the shoulder. With this type of prosthesis, it is common, during adduction movement of the shoulder, for the lower portion of the humeral prosthetic part to strike the pillar of the scapula, i.e. the lower portion of the bone glenoid surface located, when the patient stands upright, just below the glenoid prosthetic part. This interference between the humeral prosthetic part and the scapula limits the range of the adduction movement and may cause pain to the patient or even lead to the prosthesis becoming dislodged, in particular by osteolysis of the scapula.

BRIEF SUMMARY OF THE INVENTION

[0004] Various aspects of the invention relate to surgical methods and corresponding surgical instruments for reducing risk of interference between the scapula and the humeral part of an inverted or an anatomical shoulder prosthesis. All references to a "shoulder prosthesis" should be interpreted to include a total shoulder prosthesis with a humeral component and a glenoid component (including anatomical, inverted, or interpositional configurations), or a partial shoulder prosthesis with a glenoid component with an anatomical or resurface humeral head.

[0005] Some embodiments relate to a surgical method for fitting an inverted shoulder prosthesis, the prosthesis including a glenoid component having a convex articular surface and an opposing face, this fitting method including successive preoperative steps in which a graft is provided, the graft is placed on the previously prepared glenoid surface of a scapula of a patient's shoulder, and the glenoid component is implanted so as to cover the graft positioned on the glenoid surface with the opposing face of the glenoid component and to anchor the glenoid component in the glenoid surface through the graft. In some embodiments, a geometric center of articulation of the glenoid component is situated at the bone face in the glenoid surface, where a radius of curvature of a convex articular surface of the glenoid component is selected so a center of rotation of the glenoid component is in or behind a plane comprising a distal surface of the graft.

[0006] In some embodiments, the method includes "lateralizing" the glenoid component relative to the patient's scapula, withdrawing the glenoid component from the patient's scapula in a plane frontal to the patient, by interposing the graft between this glenoid component and the glenoid surface. In other words, the graft forms an outer lateral extension of the glenoid surface, extending the scapula, whereas the combination of the graft and the prosthetic glenoid component forms a composite prosthetic unit. The glenoid component is optionally implanted so as to cover a side of the graft opposing the glenoid surface, where the component includes a bone anchoring structure or anchor portion, such as a central tail, sufficiently elongate to pass through the graft and in the bone of the scapula delimiting the glenoid surface. According to some embodiments, once the graft has fused with the glenoid surface, a distal surface of the graft becomes the effective glenoid surface. References to glenoid surface should be interpreted to include a prepared or an unprepared exposed surface of a glenoid cavity.

[0007] In some embodiments, an articular face of the glenoid component occupies, relative to the scapula, a position laterally more remote than a position the articular face would occupy were the graft omitted. Removing the glenoid component laterally helps reduce risk of interference between the pillar of the scapula and the lower portion of the humeral prosthetic part cooperating with the glenoid articular face. The lateralization of the prosthetic glenoid component also helps increase tension in the rotator muscles of the shoulder and the co-adaptation vector of the deltoid muscle, which helps stabilize the prosthetic glenoid and humeral components and promote better mobility in relative rotation with a lower risk of shoulder dislocation. Furthermore, compared to typical inverted shoulder prostheses, which can be described as a medialized prostheses, lateralized prostheses according to various embodiments help restore some of the curved surface of the patient's shoulder, giving the shoulder a more pleasing appearance than the "coat hanger" appearance conferred by medialized prostheses.

[0008] Some embodiments relate to glenoid components that include adjustable length tails, or anchoring structures for use with grafts having a variety of thicknesses, according to embodiments of the present invention. For example, in some embodiments, a surgeon or other user selects a desired bone graft thickness and adjusts the overall length of an anchoring portion of the glenoid component for use with that graft thickness. By adjusting the overall length of the anchoring structures, the glenoid components are better able to facilitate lateralization of the center of rotation of the glenoid component with a secure affixation into the boney structure forming the glenoid, for example, as well as additional or alternative advantages.

[0009] According to various embodiments, complete exposure of the glenoid surface is not required and is optionally limited to positioning of the graft, promoting efficiency and reproducibility. The graft is optionally taken from the patient,

although allografts, xenografts, metals, natural or synthetic materials are employed as desired. In some embodiments, the graft is taken from the upper epiphysis of the humerus of the patient's shoulder, such that the graft originates from the patient, thereby helping to limit risk of rejection, poor biological compatibility, and transmission of disease or infection, for example. Moreover, efficiencies are realized in that often times in order to implant a corresponding humeral component, the epiphysis of the patient's humerus is to be prepared by withdrawing a substantial amount of cancellous bone matter from this epiphysis which can then be used to provide the graft rather than, for example, simply discarding such bone matter. Accordingly, in some embodiments, the method includes a shaping step in which the bone matter forming the upper humeral epiphysis is shaped into a one-piece volume extending in length about an axis inclined relative to the longitudinal direction of the humerus, and a cutting step in which the volume of bone matter is removed from the humerus by cutting the humeral epiphysis transversely to the axis of this volume, the volume of bone matter thus removed forming the graft.

[0010] According to some methods, a surgical joint repair includes adjusting a length of the graft along an axis of a volume of bone matter and shaping respective longitudinal end faces of the graft to be substantially complementary to an opposing face of the glenoid component and the glenoid surface previously prepared. During the shaping step, the shaped volume of bone matter is chosen from a cylinder and a frustum of a cone, for example, centered on the axis of the shaped volume of bone matter. Before or during the shaping step, the end of the upper humeral epiphysis is resected as desired, for example, over a first plane. During the cutting step, the humeral epiphysis is optionally cut over a second plane, the first and second planes being transverse to the axis of the shaped volume of bone matter. A relative inclination of the first and second planes is adjusted as desired. During or after the shaping step, a recess is optionally formed that is centered on the axis of the volume of bone matter in the humeral epiphysis. In some embodiments, the glenoid component is anchored in the glenoid surface through the recess and, before carrying out the shaping step, a marker pin is inserted into the humeral epiphysis, thereby allowing, during the shaping step, positioning of the axis of the volume of bone matter relative to the humerus.

[0011] According to some other embodiments, rather than taking the graft from the patient's humeral epiphysis, the graft is taken from a bone region in the patient other than the upper humeral epiphysis, such as the patient's ilium, or the graft is formed as an allograft, a graft of synthetic origin, a graft of metallic origin, combinations thereof, or other material. For example, in some embodiments a protection layer is attached to at least a part of the graft that is not in contact with the glenoid surface and at least a part of the opposing face of the glenoid component is supported on the protection layer. In some embodiments, some or all of the surfaces on the glenoid component that engage with the graft are covered with hydroxyapatite or materials having a functionally similar surface state, such as a honeycomb surface state, allowing bone adhesion and rehabilitation to be improved. Selected surfaces of the glenoid component may be constructed of materials that facilitate fusion with bone, such as those disclosed in U.S. Pat. No. 7,250,550.

[0012] According to still other embodiments, the graft includes a purée of bone substance (e.g, originating from the patient, in such as from the upper epiphysis of the humerus, or from another, source, such as a synthetic or metallic source). In some embodiments, the purée of bone substance is advantageously used with a protective structure, such as a lattice shaped into a cage that is filled with the purée. The lattice cage optionally facilitates good exchange of biological flows between the purée forming the graft and the surrounding tissues of the shoulder.

[0013] The invention also relates to a set of surgical instruments for fitting a shoulder prosthesis. The set includes a shaping ancillary instrument that shapes the bone matter forming the upper humeral epiphysis of a humerus into a one-piece volume extending in length about an axis inclined relative to the longitudinal direction of the humerus, and a cutting ancillary instrument that cuts the humeral epiphysis shaped by the shaping ancillary instrument, for cutting the volume of bone matter transversely to the axis of this volume. The cutting ancillary instrument is optionally used to remove the volume of bone matter from the humerus that is formed into a graft.

[0014] The set of instruments according to the invention allows implementation of the fitting method defined hereinbefore, the shaping and cutting steps of which are respectively carried out by the shaping and cutting ancillary instrument. The volume of bone matter removed from the humerus using the cutting ancillary instrument can thus be used as the bone graft for carrying out the general fitting method defined hereinbefore in order laterally to offset the convex articular surface of a glenoid component of the prosthesis relative to the scapula of the patient's shoulder, during implantation of this glenoid component.

[0015] According to advantageous features of this set of instruments, taken in isolation or in any technically feasible combination:

[0016] the set comprises a resecting instrument for resecting the end of the humeral epiphysis, which resecting instrument is either carried by a specific resection ancillary instrument, distinct from the other ancillary instrument of the set or integrated in the shaping ancillary instrument;

[0017] the resecting instrument comprises a planar reamer so as to resect the humeral epiphysis over a first plane transverse to the axis of the volume of bone matter;

[0018] the set comprises a humeral epiphysis drilling instrument which is adapted to form a recess, centered on the axis of the volume of bone matter, in the humeral epiphysis and which is either integrated in the shaping ancillary instrument, or the resection ancillary instrument, or is carried by a specific drilling ancillary instrument distinct from the other ancillary instrument of the set;

[0019] the set comprises a marker pin or a similar marker instrument capable of being inserted into the humeral epiphysis and suitable for guiding the shaping ancillary instrument and optionally at least one of the other ancillary instrument of the set;

[0020] the set comprises an inserting ancillary instrument for inserting the marker pin into the humeral epiphysis, which inserting instrument is suitable for adjusting the direction of insertion of this pin relative to the humerus;

[0021] the inserting ancillary instrument comprises, on the one hand, a rounded bell-shaped body configured internally to cover the upper humeral epiphysis in the manner of a cap and, on the other hand, a guide for applying the marker pin, which guide opens into the body;

[0022] the shaping ancillary instrument comprises a bell-shaped saw which is suitable for cutting the bone matter forming the humeral epiphysis by shaping it into the volume of bone matter;

[0023] the saw has an optionally perforated cylindrical or frustoconical inner face so as to provide the volume of bone matter with the overall shape of a cylinder or frustum of a cone, centered on the axis of this volume;

[0024] the cutting ancillary instrument comprises a tubular block suitable for being slipped about the volume of bone mass shaped by the shaping ancillary instrument, this block delimiting, at its longitudinal end turned during operation toward the humerus, an incision zone in the humeral epiphysis, in order to cut the volume of bone matter transversely to the axis thereof;

[0025] the incision zone forms a transverse slot for the passage of a saw blade or the like, in order to cut the volume of bone matter over a second plane transverse to the axis of this volume; and

[0026] the cutting ancillary instrument comprises an annular body adapted to be mounted around the humeral epiphysis while surrounding at least the volume of bone matter shaped by the shaping ancillary instrument, this body delimiting a guide surface for a cutting instrument to cut at least the volume of bone matter transversely to its axis.

[0027] The invention also relates to an inverted shoulder prosthesis comprising a glenoid component having a convex articular surface and an opposing face, wherein the prosthesis comprises a protection layer for protecting a graft interposed, when the prosthesis is fitted, between said opposing face and the glenoid surface of a scapula of a patient's shoulder, this protection layer being suitable for both covering at least a part of the graft that is not in contact with the glenoid surface and forming a support for at least a part of said opposing face.

[0028] The graft protected by the protection layer of the prosthesis according to the invention can be taken from the upper humeral epiphysis using the set of instruments defined hereinbefore, or else be chosen from a graft taken from a bone region in the patient other than the upper humeral epiphysis, in particular from the patient's ilium, an allograft and a graft of synthetic or metallic origin. In practice, this prosthesis is fitted in accordance with the general method defined hereinbefore.

[0029] According to advantageous features of this prosthesis, the prosthesis optionally includes a protection layer, such as for example, a layer of hydroxyapatite or other material that has a functionally similar surface state, such as a honeycomb surface state, allowing bone adhesion and rehabilitation to be improved. In another embodiment, the protection layer includes a shape of a ring suitable for surrounding, in a close-fitting manner, the portion of the bone graft not in contact with the glenoid surface, it being appreciated that, in practice, this ring is used for a one-piece graft obtained, in particular, by the set of instruments as defined hereinbefore. The protection layer may also be a lattice shaped as a cage adapted to be filled with a purée of bone matter forming the graft.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

[0030] A better understanding of the invention will be facilitated on reading the following description given merely by way of example and with reference to the drawings, in which:

[0031] FIG. **1** is a basic schematic illustration of an inverted shoulder prosthesis, implanted at a patient's shoulder;

[0032] FIG. **2** is a schematic elevation of an ancillary instrument of a set of instruments according to the invention, used in order to fit the prosthesis of FIG. **1**;

[0033] FIG. **3** is a view similar to FIG. **2**, illustrating another ancillary instrument pertaining to the set of instruments, to be applied to the patient's humerus after use of the ancillary instrument of FIG. **2**;

[0034] FIG. **4** is a schematic perspective view of a further ancillary instrument pertaining to the set of instruments;

[0035] FIG. **5** is a view similar to FIG. **2**, illustrating the humerus after use of the ancillary instrument of FIGS. **3** and **4**;

[0036] FIG. **6** is a schematic perspective view of another ancillary instrument pertaining to the set of instruments;

[0037] FIG. **7** is a view similar to FIG. **2**, illustrating the application of the ancillary instrument of FIG. **6** to the humerus after use of the ancillary instrument of FIG. **4**;

[0038] FIGS. **8-12** show a second embodiment of a set of instruments according to the invention,

[0039] FIGS. **8**, **9**, **11** and **12** being similar respective schematic elevations of four ancillary instruments pertaining to this set and used in succession, to fit the prosthesis from FIG. **1**, whereas

[0040] FIG. **10** is a partial perspective view of the ancillary instruments from FIG. **9**, shown alone;

[0041] FIG. **13** is a basic schematic illustration of the glenoid part of an inverted shoulder prosthesis according to the invention;

[0042] FIG. **14** is a view similar to FIG. **13** of a variation of the prosthesis according to the invention;

[0043] FIGS. **15-21** illustrate various uses of a graft to lateralize the glenoid component of an inverted shoulder prosthesis according to an embodiment of the present invention;

[0044] FIGS. **22-26** illustrate various uses of a graft to lateralize the glenoid component of an anatomical shoulder prosthesis according to an embodiment of the present invention;

[0045] FIGS. **27-29** illustrate various uses of a graft to lateralize the glenoid component of an inverted shoulder prosthesis according to an embodiment of the present invention; and

[0046] FIGS. **30A-30F** illustrate a method and tool set for preparing a graft in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0047] FIG. **1** shows a shoulder prosthesis **1** comprising a glenoid component **10** and a humeral component **20**, respectively implanted in the scapula S and the humerus H of a patient's shoulder. The glenoid components shown herein are illustrated schematically. The method and apparatus of the various embodiments disclosed herein may be used with a variety of other glenoid components, such as for example those disclosed in U.S. Pat. Nos. 7,033,396; 6,953,478; 6,761,740; 6,626,946; 5,702,447 and U.S. Publication Nos. 2004/0220673; 2005/0278030; 2005/0278031; 2005/0278032; 2006/0020344, which are hereby incorporated by reference.

[0048] The glenoid component **10** comprises a head **11**, also described as a head structure, which has, on the side opposing the glenoid surface G of the scapula S, a convex

articular surface **11**A, also described as a face, of generally hemispherical shape and, on the side turned toward the glenoid surface, an opposing face **11**B. In the example considered in the figures, this face **11**B is generally planar but, in non-illustrated variations, this face **11**B can have a more elaborate geometry, being, for example, substantially concave or convex.

[0049] The glenoid component **10** also comprises an anchoring tail **12**, also described as an anchor portion, which extends transversely so as to protrude from the face **11**B, in the direction opposing the face **11**A, and the free end part of which is securely anchored in the glenoid surface G, thus joining the glenoid component to the scapula S. In practice, in a manner not shown, the anchoring tail **12** can be provided, at its end turned toward the head **11**, with a base accommodated inside the head **11**, being securely joined thereto. In other words, more generally, the connection between the tail **12** and the head **11** can assume a broad range of forms, such as material continuity, respective wedging surfaces, attached mechanical assembly structures, etc. Also by way of non-illustrated variation, the tail **12** can be externally threaded or, generally, have a surface state promoting the anchoring thereof.

[0050] Between the face **11**B of the glenoid head **11** and the glenoid surface G of the scapula S there is interposed a graft **2** having a substantially cylindrical outer shape with a circular base, the external diameter of which is substantially equal to that of the head **11**. The outer lateral face **2**A of the graft **2** thus extends substantially in the extension of the hemispherical face **11**A. The graft **2** has, on its side opposing the glenoid surface G, a longitudinal end face or distal surface **2**B covered by the face **11**B of the head **11** and, on its side directed toward the glenoid surface, a longitudinal end face or medial surface **2**C resting against the glenoid surface G. Once the graft **2** fuses with the glenoid surface G, the effective glenoid surface G is displaced laterally outward to the distal surface **2**B of the graft **2**.

[0051] In the example considered in the figures, the longitudinal end faces **2**B and **2**C are planar; this has proven to be an embodiment that is simple to handle and easy to obtain, as will be referred to hereinafter. However, in practice, these faces **2**B and **2**C can have more elaborate geometries: on one side, the face **2**B is provided to be covered in a substantially complementary manner with the face **11**B of the head **11**, including in this face **11**B the zones or the structure for connecting to the tail **12**, it being understood that, as indicated hereinbefore, this face **11**B can be generally concave, convex or planar; on the opposing side, the face **2**C is provided to embrace the surface of the glenoid surface G, which has been previously prepared for this purpose, so that the face **2**C and the glenoid surface G are substantially complementary and can equally well be planar or curved.

[0052] The graft **2** can be a one-piece bone graft, a plurality of random or pre-formed bone pieces, one or more layers of bone material, a purée of bone substance, or combinations thereof. In addition to the patient's bone, the graft **2** can also be formed from an allograft, a xenograft, a synthetic material, a porous metal or a combination thereof. The graft **2** can optionally be resorbable. The graft **2** may be used alone or in combination with bone replacements, bone fillers, bone cements and/or bone adhesives. Various bone replacements, bone fillers, bone cements and bone adhesives are disclosed in U.S. Pat. No. 6,692,563 (Zimmerman), which is hereby incorporated by reference. Various additives can be included in the graft **2**, such as for example, bone growth agents or pain inhibitors. In one embodiment, reinforcing fibers are added to the purée of bone substance.

[0053] In some embodiments, the graft is formed of materials into which native bone will grow to create a structure with properties comparable to native bone, such as for example, a three-dimensional porous matrix or scaffold. Examples of a porous matrix or scaffold include a reticulated bioceramic framework, structured porous tantalum, synthetic fiber mesh, and the like. Various porous matrices and scaffoldings are disclosed in U.S. Pat. Nos. 4,479,271; 6,511,511; 6,605,117; 6,797,006; 6,902,584; and 7,250,550, which are hereby incorporated by reference.

[0054] The graft **2** can be made from a variety of synthetic compounds, such as for example, polyglycolide, polylactides, polycaprolactones, polytrimethylenecarbonates, polyhydroxybutyrates, polyhydroxyvalerates, polydioxanones, polyorthoesters, polycarbonates, polytyrosinecarbonates, polyorthocarbonates, polyalkylene oxalates, polyalkylene succinates, poly(malic acid), poly(maleic anhydride), polypeptides, polydepsipeptides, polyvinylalcohol, polyesteramides, polyamides, polyanhydrides, polyurethanes, polyphosphazenes, polycyanoacrylates, polyfumarates, poly (amino acids), modified polysaccharides (e.g., cellulose, starch, dextran, chitin, chitosan, etc.), modified proteins (e.g., collagen, casein, fibrin, etc.) and their copolymers, or combinations thereof. Other polymers include polyglycolide, poly(L-lactide-co-glycolide), poly(D,L-lactide-co-glycolide), poly(L-lactide), poly(D,L-lactide), poly(L-lactide-co-D,L-lactide), polycaprolactone, poly(L-lactide-co-caprolactone), poly(D,L-lactide-co-caprolactone) polytrimethylenecarbonate, poly(L-lactide-co-trimethylenecarbonate), poly(D,L-lactide-co-trimethylen-ecarbonate), polydioxanone and copolymers, and polymer blends thereof. Various methods of manufacturing the bone graft from a synthetic compound can be found in U.S. Pat. Nos. 6,767,928; 6,730,252; 6,541,022; 6,454,811, which are hereby incorporated by reference. Optionally, before or during the surgical procedure the graft **2** can be secured to the glenoid component **10** using additional methods known in the art, such as for example biocompatible adhesives, mechanical fasteners, or combinations thereof.

[0055] The graft **2** can be made from a variety of metallic solutions, such as for example, a highly porous metal having interconnecting pores. In one embodiment, the porous metal is about 80% porous. The metal has a porosity giving it a mechanical and physical structure similar to that of bone such that bone ingrowth is promoted. The highly porous metal used to form the graft **2** has a high strength-to-weight ratio and low stiffness and is capable of withstanding physiologic loading and minimizing stress. The porous metal may have, for example, a trabecular configuration. In one embodiment, the porous metal may include growth factors to further stimulate bone ingrowth. An example of a suitable graft is one formed from tantalum and vapour deposition techniquies. An example of a suitable commercially available porous metal includes but is not limited to, "TRABECULAR METAL," available from Zimmer Technology, Warsaw, Ind.

[0056] In some embodiments, the tail **12** passes straight through the graft **2**, in the longitudinal direction thereof. In other words, the length of the tail **12** is much greater than that of the graft **2**, so that at least a substantial part of the tail **12** is anchored securely in the native layer of the glenoid surface G. As described in greater detail, in some embodiments the

overall length of the tail **12** is adjustable to accommodate a variety of thicknesses of the graft **2** and/or geometry of the glenoid surface G.

[0057] In optional embodiments (not shown), the securing of the graft **2** to the glenoid surface G can be reinforced by fasteners additional to the tail **12**, such as screws distributed around the tail **12** and passing through the graft **2** over at least part of the length thereof.

[0058] The humeral component **20** comprises a tail **21** for anchoring in the medullary cavity M of the humerus H. At its upper end, the tail **21** is provided with a head **22**, also described as a humeral head, having, on its side opposing the tail **21**, a concave articular face **22**A in the form of a portion of a sphere, the radius of which is substantially equal to that of the face **11**A. References to a humeral head should be interpreted to include a prepared or an unprepared natural humeral head as well as synthetic, or prosthetic humeral heads. When the prosthesis **1** is implanted, as shown in FIG. **1**, the faces **11**A and **22**A are in mutual surface contact, thus allowing the various desired shoulder articular movements.

[0059] Given the presence of the graft **2**, the face **11**A is remote from the resected surface of the glenoid surface G in the sense that, if the graft **2** were omitted, the face **11**A would be directly juxtaposed with the resected surface of the glenoid surface. Thus, on account of the graft **2**, the glenoid articular face **11**A and, accordingly, the humeral articular face **22**A are laterally remote from the glenoid surface G, limiting the risk of the lower portion of the head **22** interfering with the bottom of the glenoid surface G, (e.g., with the pillar P of the scapula S). Thus, lateralization of the prosthesis **1** can be adjusted and modified based on the thickness of the graft **2**. As the thickness of the graft **2** increases, the amount of lateralization also increases. In addition, it will be understood that, as a consequence resulting from this lateralization desired within the scope of the invention, the graft **2** acts as bone matter to make good any bone deficit in the glenoid surface.

[0060] In practice, the glenoid component **10** can be of a broad range of sizes, to which the graft **2** is adapted. Typically, the head **11** is available in at least two different sizes, namely with an external diameter of about 36 mm or about 42 mm, it being understood that other sizes are conceivable. Similarly, the length l of the graft **2** can have a broad range of values, distributed in practice in a uniform sequence, in a manner adapted to the morphology and/or to the pathology of the patient. The graft **2** can thus have lengths of about 3, 6, 8 or 10 mm, whereas the tail **12** has a length of between about 15 and about 25 mm, possibly greater.

[0061] A surgical method seeking to implant the shoulder prosthesis **1** of FIG. **1** will be described hereinafter, it being understood that the prosthesis in question is merely a non-limiting illustrative example of the method and the surgical instruments used to implant this prosthesis. In other words, the method and the instruments specified hereinafter can be used to implant shoulder prostheses of a broad range of structures, of which, for example, the glenoid and/or humeral components consist of a plurality of metallic, plastic and/or ceramic-type parts joined together. Thus it is possible, for example, to use a humeral component without an anchoring tail.

[0062] FIGS. **2-12** illustrate various methods and instruments for forming the graft **2** in situ. In a first stage of the operation, once the soft parts of the shoulder have been removed using a deltopectoral or supero-external approach, the shaft **31** of an ancillary instrument **30** is introduced into the medullary cavity M of the humerus H, passing straight through the upper epiphysis E of the humerus H, as illustrated in FIG. **2**. In order to do this, the point of entry in the humeral epiphysis is determined beforehand by radiograph analysis of the face and profile of the humerus H.

[0063] In its common part, the shaft **31** is secured, in particular detachably, to a body **32** in the shape of an upwardly rounded bell. The body **32** is generally arranged transversely to the shaft **31**, extending in length about a central geometrical axis **33**. Projected in a plane mediolateral to the patient and containing the longitudinal axis of the shaft **31**, as shown in FIG. **2**, the central geometrical axis **33** is inclined relative to the longitudinal axis of the shaft at an angle α of between about 10 and about 70°, it being noted that, spatially, the two aforementioned axes do not necessarily intersect but cross in a somewhat mutually remote manner in an anteroposterior direction.

[0064] The body **32** has on its inside a concave surface **34**, of which the main center of curvature and the peak pertain substantially to the central geometrical axis **33**. The concave surface **34** is provided to reproduce approximately the surface features of the upper epiphysis of a normal anatomical humerus, it being understood that, in practice, the surgeon has a range of a plurality of homothetic ancillary instruments **30**, the bodies **32** of which have respective dimensions associated with the size and the state of the patient's bones. On its outer face, the body **32** is provided with a protruding tube **35** centered on the central geometrical axis **33** and opening into the interior of the body **32**, on its inner surface **34**.

[0065] The shaft **31** is inserted into the medullary cavity M of the humerus H until contact is established between the inner surface **34** and the humeral epiphysis E, the body **32** then covering the epiphysis E in the manner of a cap. Then, advantageously, the shaft **31** is driven in rotation about itself, over a short course, in order to allow for the retroversion of the humerus H. In a manner known to those of skill in the art, the shaft **31** is provided, in its proximal end part, with diametral through-orifices **36** angularly offset from one another about the longitudinal axis of the shaft **31** and, as a function of the retroversion of the patient determined by the surgeon, an elongate rod (not shown) is introduced into one of these orifices in order effectively to display the retained direction of retroversion, so that the shaft **31** is rotated on itself until this retroversion rod is aligned with the patient's forearm.

[0066] A guide pin **40**, at the pointed distal end **41**, is then introduced into the tube **35**, from the free end thereof, and is inserted into the humeral epiphysis E over a substantial depth, as indicated by arrow **42** in FIG. **2**, until its point pierces and passes at least partially through the outer cortex of the humerus H. It will be understood that the ancillary instrument **30** allows the guide pin **40** to be inserted in a suitable direction relative to the humerus H, the tube **35** acting as a guide for introducing and feeding through the pin. In order to prevent interference between the guide pin **40** and the shaft **31**, when the guide pin **40** passes through the central zone of the humerus H, the corresponding common part **37** of the shaft **31** advantageously tapers: the part **37** of the shaft **31** thus has a smaller cross-section than the proximal and distal end parts forming the remainder of the shaft **31**.

[0067] Once the guide pin **40** has reached an insertion depth in, or even through, the humerus H sufficient securely to anchor it, the ancillary instrument **30** is withdrawn, without removing the guide pin **40**. The humerus H is then in the state illustrated by solid lines in FIG. **3**.

[0068] In a variation, when carrying out the first stage of the operation, the guide pin **40** is inserted in the humerus H without being guided, i.e. without using the ancillary instrument **30**.

[0069] In a second stage, the surgeon will resect the end of the humeral epiphysis E using an ancillary instrument **50** illustrated in FIG. **3**. This ancillary instrument **50** comprises a tubular body **51**, the internal central bore in which has a diameter equal to the external diameter of the guide pin **40**. At the distal end of the body **51**, the ancillary instrument **50** comprises a planar cutter **52**, extending in a plane substantially perpendicular to the longitudinal axis of the body **51**. In the distal projection of the cutter **52** and in a manner centered on the longitudinal axis of the body **51**, the ancillary instrument **50** further comprises a terminal drill **53** internally delimiting a central bore communicating with the bore in the body **51**. The external diameter of the drill **53** is provided so as to be equal to the external diameter of the anchoring tail **12** of the glenoid component **10** to be implanted, for reasons which will become apparent hereinafter.

[0070] The surgeon threads the ancillary instrument **50** around the guide pin **40** by introducing it by the terminal drill **53** thereof, as indicated by arrow **54** in FIG. **3**. When this drill reaches the end of the epiphysis E, it drills the bone matter so as to form a cylindrical recess E_1 centered about the guide pin **40** and indicated by broken lines in FIG. **3**. Similarly, as the ancillary instrument **50** moves downward along the guide pin **40**, the cutter **52** gradually resects the end of the humeral epiphysis E, over a depth of a few millimeters, until there is obtained a cutting plane E_2 perpendicular to the guide pin **40**, also indicated by broken lines in FIG. **3**.

[0071] In a third stage, once the ancillary instrument **50** has been removed from the guide pin **40**, the surgeon will cut the humeral epiphysis E in a manner centered on the guide pin **40**, i.e. he will shape the bone matter forming this epiphysis E into a cylinder E_3 having a center axis E_{X-X} corresponding to the axis **33**, as illustrated in FIG. **5**. For this purpose, the surgeon uses an ancillary instrument **60** illustrated in FIG. **4**. The ancillary instrument **60** comprises a central rod **61**, bored internally in a manner complementary to the guide pin **40** and having an external diameter equal to that of the drill **53**. The rod **61** carries, in its common part, a crown saw **62** which is of annular shape centered on the rod **61** and the distal end edge of which has teeth **63**.

[0072] The rod **61** of the ancillary instrument **60** is slipped around the guide pin **40**, which is left in place in the humeral epiphysis E, until its distal end is received in a complementary manner in the recess E_1. In doing this, the saw **62** gradually cuts out the bone matter from the epiphysis E so as to obtain the bone cylinder E_3, it being noted that a corresponding part of the recess E_1 passes through the entire length of said bone cylinder. The length of the cylinder E_3 thus obtained, i.e. its dimension along its axis E_{X-X}, is determined by the depth of action of the saw **62**, wherein this depth can easily be marked along the rod **61**, in particular by markings.

[0073] Once the ancillary instrument **60** has been removed, the humerus H is in the state illustrated in FIG. **5**.

[0074] In a fourth stage, the surgeon will remove the cylinder of bone matter E_3 from the humerus H using a cutting ancillary instrument **70** illustrated in FIGS. **6** and **7**. This ancillary instrument **70** comprises a tubular block **71**, the internal diameter of which is equal to that of the saw **62**. At its distal end, the block **71** forms a protruding outer edge **72** in which there is delimited a transverse slot **73** opening into the internal volume of the block. At its proximal end, the block **71** is closed by a base wall **74**, from the central zone of which there protrudes, inside the block, a centering stud **75**, the external diameter of which is equal to that of the drill **53**.

[0075] After having removed the guide pin **40**, the ancillary instrument **70** is slipped around the humeral cylinder E_3, as indicated by arrow **76** in FIG. **7**. The cylinder E_3 is received in a complementary manner in the block **71** until the edge **72** rests against the bone surface surrounding the base of the cylinder E_3. A planar saw blade (not shown) is then introduced from outside into the slot **73** in order to cut the base of the cylinder E_3 over a cutting plane E_4 substantially perpendicular to the axis E_{X-X} and indicated by broken lines in FIG. **7**. During sawing, most of the cylinder E_3 is protected by the block **71** and the base wall **74**, it being noted that the stud **75** is accommodated in a complementary manner in the upper end part of the central recess E_1.

[0076] Once the ancillary instrument **70** has been removed, the surgeon recovers the cylinder of bone matter E_3 thus separated from the humerus H.

[0077] In a non-illustrated variation, the slot **73** can be provided so as to be inclined relative to the longitudinal direction of the block **71** so that, in contrast to the cylinder E_3 described hereinbefore, the bone cylinder thus obtained has longitudinal end faces inclined relative to one another. The graft **2** is thus able to make good the wear to a peripheral portion of the glenoid surface G, it being noted that the inclination of the slot **73** is advantageously adjustable as a function of the wear noted by the surgeon during the operation.

[0078] Before describing the following stage of the operation, namely the fifth stage, FIGS. **8** to **12**, which illustrate a set of instruments forming a variation of the unit comprising the ancillary instrument **30**, **50**, **60** and **70** described hitherto, will now be considered.

[0079] Thus, FIG. **8** shows an ancillary instrument **130** as a variation of the ancillary instrument **30** from FIG. **2**. The ancillary instrument **130** comprises a distal body **132** which is functionally similar to the body **32** of the ancillary instrument **30**. In particular, the body **132** is designed to cover the upper humeral epiphysis E in the manner of a cap. Unlike the body **32** of the ancillary instrument **30**, the body **132** is perforated, in particular to give the surgeon a better view of the humeral epiphysis when positioning the body **132**. Like the body **32** of the ancillary instrument **30**, the body **132** is provided with a proximal tube **135** projecting from its external face and centered on the axis **133** around which the body **132** extends.

[0080] The ancillary instrument **130** allows the guide pin **40** to be inserted in the humeral epiphysis E so as to be close-fitted relative to the humerus H, as indicated by the arrow **142** in FIG. **8**.

[0081] As a variation of both the ancillary instrument **50** and the ancillary instrument **60** shown in FIGS. **3** and **4**, an ancillary instrument **160** is shown in FIGS. **9** and **10**. The ancillary instrument **160** comprises an elongate shaft **161** provided, at its distal end, with a crown saw **162** of annular shape centered on the shaft **161** and of which the distal end edge has teeth **163**. The shaft **161** has an internal bore throughout its length so that it can be slipped, in a close-fitting and coaxial manner, around the guide pin **40** which is left in position in the humeral epiphysis E, as indicated by the arrow **164** in FIG. **9**. Unlike the saw **62** of the ancillary instrument **60**, the saw **162** has perforations in its lateral wall and comprises a base wall **165** which extends perpendicularly to the

longitudinal direction of the shaft **161** and of which the distal face forms a planar reamer **166**.

[0082] Hence, when the ancillary instrument **160** is slipped round the guide pin **40**, the teeth **163** of the saw **162** gradually cut out the bone matter of the humeral epiphysis E so as to obtain the bone cylinder E_3. Once the entire height of the saw **162** has thus been introduced into the epiphysis, the reamer **166** begins to cut the upper end of this epiphysis and thus progressively resects this end until the cutting plane E_2 is obtained.

[0083] Once the ancillary instrument **160** has been released, the humerus H is in the state shown in FIG. **11**.

[0084] The surgeon then uses a drilling ancillary instrument **167** comprising a bored shaft **168** of which the distal end is provided with a drill **153**. By slipping the shaft **168** around the guide pin **40**, as indicated by the arrow **169** in FIG. **11**, the surgeon, by the action of the drill **153**, digs the central part of the cylinder of bone matter E_3 round the guide pin **40** so as to form the recess E_1, centered on the axis E_{x-x} of the cylinder E_3, as indicated in broken lines in FIG. **12**, in which the ancillary instrument **168** has been released.

[0085] In practice, the drilling ancillary instrument **167** can also be used after a variation of the ancillary instrument **50**, depleted of the drill **53**, has been used and/or after a variation of the ancillary instrument **60**, of which the rod **61** does not project on the distal side of the base wall of the saw **62** has been used.

[0086] As a variation of the ancillary instrument **70** shown in FIGS. **6** and **7**, FIG. **12** shows an ancillary instrument **170**. The ancillary instrument **170** comprises an annular body **171** equipped at a point of its periphery with a proximal handling shaft **176**. The annular body **171** is designed to be mounted on the humeral epiphysis E while surrounding the entire portion of the epiphysis in which the cylinder of bone matter E_3, previously cut out by the ancillary instrument **160**, is delimited. On its distal side, the body **171** delimits a surface **173** for application and guidance of a bone cutting instrument, not shown, such as a saw blade or the like.

[0087] Hence, by manipulating the shaft **176**, the surgeon positions the annular body **171** around the humeral epiphysis E so as to position the guide surface **173** in a suitable manner relative to the cylinder of bone matter E_3. The surgeon then applies the cutting instrument against this surface **173** in a guided manner in order to cut the base of the cylinder E_3 over the cutting plane E_4 and release this cylinder from the humerus H.

[0088] Advantageously, the guide surface **173** forms an angle of approximately 155 degrees with the longitudinal direction of the shaft **176**, and this allows the ancillary instrument **170** also to be used to prepare the implantation of the humeral component **20** at a later stage, by positioning the shaft **176** in such a way that its longitudinal direction is substantially aligned with the longitudinal direction of the humerus H, as illustrated in FIG. **12**.

[0089] In a fifth stage, the cylinder of bone matter E_3 is used to form the graft **2** described hereinbefore. In order to do this, this cylinder is fitted on the glenoid surface G. The glenoid surface G is previously prepared for this purpose, being opened up and, if necessary, resected. The glenoid component **10** is then implanted in the configuration described hereinbefore with reference to FIG. **1**. It will be understood that the anchoring tail **12** is introduced coaxially, in a substantially close-fitting manner, into the central recess E_1 in the cylinder E_3.

[0090] If the longitudinal end faces of the bone cylinder have been formed so as to be inclined relative to each other, it will be understood that the interposing of this cylinder, as the graft, between the glenoid component **10** and the glenoid surface G allows inclination, in particular downward inclination, of the glenoid articular face **11**A.

[0091] More generally, it will be understood that the dimensions desired by the surgeon for the graft **2**, in particular as a function of the size of the glenoid component **10**, determine the dimensions of the ancillary instruments **50**, **60** and **70** or the ancillary instruments **160**, **168** and **170** used to take the bone cylinder E_3 from the humeral epiphysis E. In particular, the internal diameter of the saw **62** or **162** determines the external diameter of the graft **2**. Similarly, the depth of action of this saw determines the length/of the graft while at the same time allowing for any adjustment in length resulting from the positioning of the sawing slot **73** or the guide surface **173**.

[0092] Furthermore, the geometry desired for the longitudinal end faces **2**B and **2**C of the graft **2** directly conditions the embodiment of the resection ancillary instrument **50** and cutting ancillary instrument **70** or the ancillary instrument **160** and **170**, in the sense that the parts of these ancillary instruments that determine the incision profile of the bone are shaped to form an appropriate incision in the humeral epiphysis. Optionally, these ancillary instruments **50** and **70** can be associated with one or more ancillary instrument for resurfacing the longitudinal end faces of the removed cylinder E_3.

[0093] In practice, the surgeon also takes account of the state of the cancellous bone matter forming the epiphysis E in order, if necessary, to remove the graft with as healthy a constitution as possible. For this purpose ancillary instrument for gripping and storing the graft **2** after it has been released from the humerus H can optionally be provided, in order to limit the risks of damaging the graft.

[0094] Furthermore, in non-illustrated variations, the graft **2** can have volume forms other than a cylinder as in the figures, provided that the volume of bone matter forming the graft **2** has a shape generally centered about a longitudinal axis of the type of the axis E_{X-X}, while at the same time defining a lateral face and longitudinal end faces of the type of the faces **2**A, **2**B and **2**C. For example, the graft **2** can thus be truncated in shape, having a longitudinal axis E_{X-X}; in this case, the inner surface of the crown saw **62** or **162** is, for example, provided so as to be truncated.

[0095] Optionally, the graft **2** can be protected laterally by a reinforcing structure, such as for example ring **80** shown in FIG. **13**. In practice, the ring **80** is configured to surround in an appropriate manner the lateral face **2**A of the graft **2**, over the entire length of this graft. The ring **80** is thus, in conjunction with the graft **2**, interposed between the glenoid component **10** and the glenoid surface G. It will be understood that the ring **80** can, for example, be used if the graft **2** has, at least over a part of its length, an external diameter less than that of the glenoid head **11**, the ring thus compensating for the difference in diameter.

[0096] If the ring **80** is implanted in conjunction with the graft **2**, it protects the lateral face **2**A of the graft **2** and forms a support for at least a part of the face **11**B of the glenoid component **10**, thus limiting the stresses applied to the graft **2**. Advantageously, the ring **80** is covered with hydroxyapatite or, more generally, has a porous or honeycomb surface state allowing improved bone adhesion and rehabilitation of the ring **80** to the graft **2** and to the resected surface part of the

glenoid surface G that is not covered by the graft **2**. In one embodiment, the ring **80** is attached to the glenoid component **10**.

[0097] In practice, it will be understood that the inner surface of the ring **80** is advantageously complementary with the face **2**A of the graft **2**, whereas its outer face can have advantageous optional configurations. The outer surface can thus be provided so as to be truncated and diverged toward the glenoid surface G, so holes passing through the ring **80** in respective directions substantially perpendicular to the outer surface thereof are able to receive screws or the like in order to reinforce the securing of the graft **2** to the glenoid surface G. Similarly, the bottom portion of the ring **80** can be provided so as to be less thick than the remainder of the ring so as not subsequently to disturb the humeral component **20** during adduction movements on the part of the patient.

[0098] In a variation of the fitting method, rather than delivering a one-piece bone volume such as the cylinder E_3, in the upper humeral epiphysis E, the graft **2** can consist of a purée of bone substance. This substance is taken from the spongy bone zones of the humeral epiphysis, in particular when preparing the humerus H for the fitting of the humeral implant. In practice, in order to contain this purée of bone substance during implantation of the glenoid component **10**, a reinforcing structure, such as for example a lattice **90** shaped as a cage **92** for receiving this purée will advantageously be used, as shown in FIG. **14**. The cage **92** is designed to be interposed between the glenoid component **10** and the previously prepared glenoid surface G, according to an arrangement similar to the one-piece graft illustrated in FIG. **1**. In particular, the cage **92** has, for example, a generally cylindrical shape of which the external diameter corresponds to that of the glenoid head **11** and of which the length corresponds to the aforementioned length l.

[0099] The lattice **90** forming the cage **92** allows exchanges of biological fluids between the purée of bone substance with which the cage is filled and the surrounding tissues of the patient. The cage **92** thus prevents necrosis of the purée of bone substance while mechanically protecting it. In particular the cage **92** absorbs a proportion, or even the majority, of the stresses applied to the graft **2** consisting of the purée of bone substances by forming, in the region of its lateral end walls **92**A and **92**B, supports for the face **11**B of the glenoid component **10** and the previously prepared surface of the glenoid surface G respectively. The bone substance preferably chemically bonds with the glenoid surface G through the lattice **90**. In effect, the glenoid surface G is extended laterally outward to engage with the face **11**B of the glenoid component **10**.

[0100] In another embodiment, the cage **92** is constructed from a porous matrix or scaffold, without the purée of bone substance. The cage **92** can be, for example, reticulated bioceramic framework, structured porous tantalum, synthetic fiber mesh, and the like. The native bone of the glenoid surface G grows into the porous matrix or scaffold to create a graft with structure properties comparable to native bone. The cage **92** is alternately made of a slow-absorbing, biologically benign material, such as Poly-4-hydroxybutyrate (a.k.a. Tephaflex™), poly(urethane urea) (Artelon™), surgical silk, or other materials, known to the art, having similar characteristics, such as disclosed in U.S. Patent Publication No. 2007/0198087, entitled Method and Device for Rotator Cuff Repair, filed Feb. 5, 2007 and U.S. Patent Publication No. 2007/0276509, entitled Tissue Scaffold, filed Aug. 9, 2007, the entire disclosures of which are incorporated by reference. Other less preferred embodiments employ non-absorbable materials such as PTFE, Polypropylene, Nylon, or other biocompatible, inert materials known to the art.

[0101] Before or after implanting of the glenoid component **10**, the humeral component **20** is implanted in the humerus H, advantageously using ancillary instrument (not shown), the handling of which is marked by the end part of the recess E_1 remaining in the humeral epiphysis E after removal of the bone volume such as the cylinder E_3. If the surgical actions applied to the humerus H for implanting the component **20** by way of the recess E_1 are dispensed with and these actions are therefore generally independent of those applied to the humerus for taking the graft **2**, the ancillary instrument **30** can be simplified, as it is in this case no longer necessary to take account of the retroversion of the patient's forearm in order to insert the guide pin **40**. The shaft **31** may in this case assume the form of an intramedullary humeral rod.

[0102] According to a variation of the fitting method, the graft **2**, whether in the form of a one-piece bone volume or of a purée of bone substance, is not taken from the humeral epiphysis E but rather is taken from another of the patient's bones, in particular from his ilium, or consists of an allograft, a graft of synthetic origin or a graft of metallic origin, it being understood that the dimensions of this synthetic graft are provided so as to be appropriate for the glenoid component **10** to be implanted, as stated hereinbefore for the removed cylinder E_3 or cone frustum. Obviously, the protection ring **80** and the cage **92** described hereinbefore can be used in conjunction with a graft of this type of alternative origin.

[0103] FIG. **15** is a schematic illustration of a glenoid component **200** of an inverted shoulder prosthesis attached to the glenoid surface G according to an embodiment of the present invention. The glenoid component **200** includes a recess **202** that substantially receives the graft **204**. The recess **202** acts as a reinforcing structure that protects the graft **204** laterally, similar to the ring **80** in the embodiment of FIG. **13**. Consequently, the graft **204** can be a one-piece bone volume, a purée of bone substance or formed from a synthetic or metallic material. In an embodiment where the graft **204** is a purée of bone substance, reinforcing fibers **279** are optionally added to the mixture. In the illustrated embodiment, lower portion **206** of the convex articular surface **208** extends beyond the pillar of the scapula S to minimize interference with the humeral prosthetic portion. The radius of curvature of convex articular surface **208** is preferably selected so the center of rotation **214** around the glenoid component **200** is preferably in plane **210** comprising a distal surface **212** of the graft **204** or between the plane **210** and the glenoid surface G. Once the graft **204** has fused with the glenoid surface G, the distal surface **212** of the graft **204** becomes the effective glenoid surface.

[0104] FIG. **16** is a schematic illustration of a glenoid component **220** of an inverted shoulder prosthesis attached to the glenoid surface G according to an embodiment of the present invention. A reinforcing structure **222** extends over at least a portion of the graft **224**. The reinforcing structure **222** can be rigid or flexible. In one embodiment, the reinforcing structure **222** is constructed from a mesh material made from metal, synthetics, ceramics, or a combination thereof. Consequently, the graft **224** can be a one-piece bone volume, a purée of bone substance or formed from a synthetic or metallic material. Screws **226** optionally secure the reinforcing structure **222** and/or graft **224** to the glenoid surface G.

[0105] The glenoid component **220** includes a recess **230** that engages with distal surface **232** of the reinforcing struc-

ture **222**. An anchor **234** optionally extends through the reinforcing structure **222** and graft **224** to further secure the glenoid component **220** to the scapula S. In the illustrated embodiment, the anchor **234** includes a pointed tip **236** to facilitate insertion into the glenoid surface G. The radius of curvature **228** of convex articular surface **235** is preferably selected such that the center of rotation **233** of the glenoid component **220** is preferably either in or behind plane **237** comprising a distal surface **239** of the graft **224**. Once the graft **224** has fused with the glenoid surface G, the distal surface **239** of the graft **224** becomes the effective glenoid surface.

[0106] FIG. **17** is a schematic illustration of a glenoid component **240** of an inverted shoulder prosthesis attached to the glenoid surface G according to an embodiment of the present invention. A graft **242** is formed with a distal recess **244**. An anchor **246** extends through the graft **242** into the glenoid surface G so that base plate **248** is positioned in the distal recess **244**. A tension member **250** is optionally positioned in a center bore **252** of the anchor **246** to retain the base plate **248** against the glenoid surface G. A variety of glenoid components **240** can then be attached to the base plate **248** using a variety of attachment mechanisms. In one embodiment, the graft **242** is surrounded by reinforcing structure **257**, such as for example a metal or synthetic mesh material. The radius of curvature of convex articular surface **258** is preferably selected so the center of rotation **259** around the glenoid component **240** is preferably in or behind a plane **254** comprising a distal surface **256** of the graft **242**. Once the graft **242** has fused with the glenoid surface G, the distal surface **256** of the graft **242** becomes the effective glenoid surface.

[0107] FIG. **18** is a schematic illustration of a glenoid component **260** of an inverted shoulder prosthesis attached to the glenoid surface G according to an embodiment of the present invention. A graft **262** is secured to the glenoid surface G using base plate **264** and anchor **266**. The glenoid component **260** includes a first recess **268** sized to engage with the base plate **264** and a second recess **270** so that extensions **272** of the convex articular surface **271** extend onto a portion of the scapula S. The extensions **272** can optionally be flexible or semi-flexible to facilitate implantation. In one embodiment, the extensions **272** are attached to the scapula S using adhesives, fasteners, and the like. The graft **262** can be a one-piece bone volume, a purée of bone substance or formed from a synthetic or metallic material. The radius of curvature of convex articular surface **271** is preferably selected such that the center of rotation **278** around the glenoid component **260** is preferably in or behind a plane **274** comprising a distal surface **276** of the bone graft **262**.

[0108] FIG. **19** is a schematic illustration of a glenoid component **280** of an inverted shoulder prosthesis attached to the glenoid surface G according to an embodiment of the present invention. A bone graft **282** is located between the glenoid surface G and the opposing surface **284** of the glenoid component **280**. In the illustrated embodiment, the bone graft **282** is two or more layers **282***a*, **282***b* of bone graft material. A tension member **286** is positioned in center bore **288** to retain the glenoid component **280** against the glenoid surface G. The radius of curvature of convex articular surface **290** is preferably selected so the center of rotation **296** is in or behind plane **292** comprising distal surface **294** of the bone graft **282**.

[0109] FIG. **20** is a schematic illustration of a glenoid component **300** of an inverted shoulder prosthesis attached to the glenoid surface G according to an embodiment of the present invention. An adjustable anchor portion, also described as an anchor structure or tail portion, of the glenoid component **300** includes reinforcing structure **302**, which is attached to the boney structure forming the glenoid surface G using fasteners **304**. Side walls **303** of the reinforcing structure **302** support a bone graft **310** by engaging an outer lateral face **311** of the bone graft **310**. The reinforcing structure **302** preferably has a plurality of holes or perforations **306** to facility bone in-growth.

[0110] The adjustable anchor portion also includes an opposite reinforcing structure **308** that extends over the reinforcing structure **302** and bone graft **310** and restricts lateral movement of the bone graft **310**. Thus, the adjustable anchor portion is formed of two, opposing portions—the first and second reinforcing structures **304**, **308**. In the illustrated embodiment, the opposite reinforcing structure **308** telescopically engages with the reinforcing structure **302** to adjust an overall length of the reinforcing structure **308**. The bone graft **310** has a distal face **312** and a medial face **313** and defines a thickness between the distal and medial faces **312**, **313**. The bone graft **310** can be a one-piece bone volume, a purée of bone substance, or any of the other materials previously described. The opposite reinforcing structure **308** optionally includes a plurality of holes **307** to facilitate bone in-growth.

[0111] In some embodiments, the glenoid component **300** includes an articulation surface **315**A and an engagement surface **315**B that is attached to distal surface **312** of the opposing reinforcing structure **308**. In the illustrated embodiment, the glenoid component **300** is mounted to the opposing reinforcing structure **308** off-center. The opposing reinforcing structure **308** preferably has a plurality of mounting features that permit the surgeon to locate the glenoid component **300** in a variety of locations. The radius of curvature of convex articular surface **314** is preferably selected so the center of rotation **319** is in or behind plane **316** comprising distal surface **318** of the bone graft **310**. In another embodiment, the center of rotation is close to the plane **316**.

[0112] FIGS. **20**A and **20**B show additional glenoid components that include adjustable length tails, or anchoring structures for use with grafts having a variety of thicknesses, according to embodiments of the present invention. For example, in some embodiments, a surgeon or other user selects a desired bone graft thickness and adjusts the overall length of an anchoring portion of the glenoid component for use with that graft thickness. By adjusting the overall length of the anchoring structures, the glenoid components are better able to facilitate lateralization of the center of rotation of the glenoid component with a secure affixation into the boney structure forming the glenoid, for example, as well as additional or alternative advantages. In some embodiments, the bone graft is at least 7 mm thick, at least 10 mm thick, or from about 7 mm thick to about 10 mm thick, and the anchor portion is adjustable to at least 20 mm in length, at least 25 mm in length, or from about 20 mm in length to about 25 mm in length, although other dimensions are contemplated.

[0113] FIG. **20**A shows a glenoid component **300**A of an inverted shoulder prosthesis, according to an embodiment of the present invention. The glenoid component **300**A includes a head **301**A, also described as a head structure, which has a convex articular surface **302**A of generally hemispherical shape and an opposing, engagement face **303**A. The convex articular surface is adapted for engagement with a humeral head (e.g., a prosthetic humeral head or a natural humeral

head that has been formed to define a complementary, concave humeral articular surface). In some embodiments, the opposing face **303**A is generally planar although different configurations (e.g., concave or convex configurations) are contemplated. Although an inverted shoulder prosthesis configuration is shown, in other embodiments the glenoid component **300**A is configured as a standard shoulder prosthesis with the articular surface **301**A being substantially concave, for example.

[0114] As shown, the glenoid component **300**A also includes an anchoring tail **304**A, also described as an anchoring portion or anchoring structure, that extends transversely from the engagement face **303**A and is adapted to be anchored in the glenoid surface G (FIG. **1**) to secure the glenoid component to the scapula S (FIG. **1**). In some embodiments, the anchoring tail **304**A is provided with a base (not shown) adapted to be received inside the head **301**A and secured thereto (e.g., via a press fit, complementary threads, adhesives, or other fastening means). In different terms, the connection between the tail **304**A and the head **301**A optionally includes material continuity (i.e., formation of a single piece of material, also described as a monolithic structure), respective wedging surfaces (e.g., a press fit), mechanical assembly structures (e.g., threading), and others.

[0115] As shown, the anchoring tail **304**A defines an overall length and includes a first portion **305**A having an inner lumen **306**A, a second portion **307**A, and a lock member **308**A. The first portion **305**A optionally has a substantially circular cross-section, although non-circular cross-sections (e.g., hexagonal or square), are contemplated. As described, the tail **304**A is configured such that a user is able to telescope the second portion **307**A in and out of the first portion **305**A in order to adjust the overall length of the anchoring tail **304**A. In some embodiments, the second portion **307**A includes a conical threadform or a buttress threadform.

[0116] The inner lumen **306**A of the first portion **305**A optionally includes female threading (not shown). The second portion **307**A is adapted to telescopically fit within the inner lumen **306**A of the first portion **305**A, the second portion **306**A having male threading **309**A according to some embodiments. The second portion **307**A is optionally substantially cylindrical with a circular transverse cross-section, although other cross sections (e.g., hexagonal or square) are contemplated. The lock member **308**A is optionally formed similar to a nut, with flats or other surface features. The overall length of the tail **304**A is adjusted by rotating the second member within the first member to the desired overall length. The overall length is optionally locked by tightening the lock member **308** to help ensure the anchoring tail **304**A remains at the desired length and does not back or forward rotate to a different overall length.

[0117] In some embodiments, a bone graft (not shown) such as those previously described, is received by the tail **304**A, the bone graft optionally including a central aperture or other feature that fits over the tail that restricts lateral movement of the bone graft and secures the bone graft to the tail **304**A, where the tail **304**A receives the bone graft with a medial surface of the bone graft engaged with the engagement face **303**A. In some embodiments, the bone graft is first received against the engagement face **303**A and then the tail **304**A is secured to the head **301**A thereby securing the bone graft to the head **301**A. In some embodiments, the bone graft is received over the first portion **305**A of the tail **304**A and then the second portion **306**A is secured to the first portion **305**A of the tail **304**A.

[0118] FIG. **20**B shows a glenoid component **300**B of an inverted shoulder prosthesis, according to some other embodiments. The glenoid component **300**B includes a head **301**B which has a convex articular surface **302**B of generally hemispherical shape and an opposing face **303**B. In some embodiments, the opposing face **303**B is generally planar although different configurations (e.g., concave or convex configurations) are contemplated. Although an inverted shoulder prosthesis configuration is shown, in other embodiments the glenoid component **300**B is configured as a standard shoulder prosthesis with the articular surface **302**B being substantially concave, for example.

[0119] As shown, the glenoid component **300**B also includes an anchoring tail **304**B that extends transversely from the face **302**B and is adapted to be anchored in the glenoid surface G (FIG. **1**) to secure the glenoid component to the scapula S (FIG. **1**). In some embodiments, the anchoring tail **304**B is provided with a base (not shown) adapted to be received inside the head **301**B and secured thereto (e.g., via a press fit, complementary threads, adhesives, or other fastening means). In different terms, the connection between the tail **304**B and the head **301**B optionally includes material continuity (i.e., formation of a single piece of material, also described as a monolithic structure), respective wedging surfaces (e.g., a press fit), mechanical assembly structures (e.g., threading), and others.

[0120] As shown, the anchoring tail **304**B defines an overall length and includes a first portion **305**B having an inner lumen **306**B and a second portion **307**B. The second portion **307**B is optionally interchanged with a similar component having a substantially different configuration, such as a different length. For example, a third portion **308**B is shown which may be substituted for the second portion **307**B. Additional components, of different lengths, widths, cross-sections, or other alternate configurations that are adapted to be secured to the first portion **305**B are also available according to some embodiments.

[0121] The first portion **305**B optionally has a substantially circular cross-section, although non-circular cross-sections (e.g., hexagonal or square), are contemplated. As alluded to in the foregoing description, the tail **304**B is configured such that a user is able to select between a plurality of extensions (e.g., between second and third portions **307**B, **308**B) in order to adjust the overall length of the anchoring tail **304**B. The inner lumen **306**B of the first portion **305**B optionally includes female threading (not shown). In some other embodiments, the first portion **305**B includes male threading for mating with female threading on the second portion **307**B and/or third portion **307**C.

[0122] In some embodiments, the second portion **307**B has a narrowed region **309**B with male threading adapted to form a complementary fit with the female threading of the first portion **305**B. The second portion **307**B is optionally substantially cylindrical with a circular transverse cross-section, although other cross sections (e.g., hexagonal or square) are contemplated. As shown, the second portion **307**B has a length that is substantially longer than that of the third portion **308**B. Thus, a user desiring to adjust the overall length of the anchoring tail **304**B is able to not attach any additional component to the first portion **305**B (i.e., utilize the non-extended length of the anchoring tail **304**B), or select between securing

one of a plurality of additional components of different lengths (e.g., the second and third portions **307**B, **308**B) to the first portion **305**B to extend the overall length of the anchoring tail **304**B.

[0123] In some embodiments, a bone graft **309**B such as those previously described, is received by the tail **304**B, the bone graft optionally including a central aperture or other feature that fits over the tail that restricts lateral movement of the bone graft and secures the bone graft to the tail **304**B. As shown in FIG. **20**B, the bone graft **309**B has a central aperture **310**B and defines a medial face **311**B, a distal face **312**B, and a thickness between the medial and distal faces **311**B, **312**B. As shown, the tail **304**B receives the bone graft **309**B with the medial surface **311**B engaged with the engagement face **303**B. As shown, the aperture **310**B and the tail **304**B have substantially complementary transverse cross-sections, although other configurations are contemplated.

[0124] In some embodiments, the bone graft **309**B is first received against the engagement face **303**B and then the tail **304**B is secured to the head **301**B thereby securing the bone graft to the head **301**B. In some embodiments, the bone graft **309**B is received over the first portion **305**B of the tail **304**B and then the second portion **306**B is secured to the first portion **305**B of the tail **304**B.

[0125] FIG. **21** is a schematic illustration of a glenoid component **320** of an inverted shoulder prosthesis attached to the glenoid surface G according to an embodiment of the present invention. The glenoid surface G is resected at an angle **322** with respect to the medial line M of the patient. In order to compensate, the bone graft **324** is formed with non-parallel faces **326**, **328**. In the illustrated embodiment, the bone graft **324** is secured to the glenoid surface G using fasteners **330**, although any of the structures disclosed herein could be used. The radius of curvature of convex articular surface **332** is preferably selected so the center of rotation **338** is in or behind plane **334** comprising distal surface **336** of the bone graft **324**.

[0126] FIG. **22** is a schematic illustration of a glenoid component **340** of an inverted shoulder prosthesis attached to the glenoid surface G according to an embodiment of the present invention. The exposed surface **342** of the glenoid surface G is non-planar. In order to compensate, the bone graft **344** is preferably formed with a complementary shaped surface **346**. In the illustrated embodiment, opposing face **348** of the glenoid component **340** also is non-planar. Consequently, distal surface **350** of the bone graft **344** is also preferably formed with a complementary shape. The non-planar surfaces **346**, **348** provide structural advantages for some applications.

[0127] In the illustrated embodiment, the glenoid component **340** is secured to glenoid surface G using a plurality of fasteners **352**. Although distal surface **354** of the glenoid component **340** is illustrated as planar it can be configured for with either a convex or concave articular surface, depending on the application.

[0128] FIG. **23** is a schematic illustration of a glenoid component **360** of an anatomical shoulder prosthesis attached to the glenoid surface G according to an embodiment of the present invention. An opposing face **362** of the glenoid component **360** is non-planar. In order to compensate, distal surface **364** of the bone graft **366** is preferably formed with a complementary shape. In the illustrated embodiment, the glenoid component **360** is secured to glenoid surface G using anchor **368**, although any of the securing structures disclosed herein may be used. A distal surface **370** of the glenoid component **360** is illustrated as concave, but could be convex depending on the application.

[0129] FIG. **24** is a schematic illustration of a glenoid component **380** of an anatomical shoulder prosthesis attached to the glenoid surface G according to an embodiment of the present invention. An opposing face **382** of the glenoid component **380** is non-planar and keel **384**. The keel **384** optionally includes holes **390** to facilitate bone in-growth. A distal surface **386** of the bone graft **388** is preferably formed with a shape complementary to opposing surface **382**. The bone graft **388** can be a one-piece bone volume or a purée of bone substance. In one embodiment, a cut-out is formed in the bone graft **388** to receive the keel **384**. In another embodiment, the bone graft **388** is an annular ring and the keel is located in the center opening and secured using a purée of bone substance, bone cement, or a variety of adhesives.

[0130] FIG. **25** is a schematic illustration of a glenoid component **400** of an anatomical shoulder prosthesis attached to the glenoid surface G according to an embodiment of the present invention. An exposed surface **402** of the glenoid surface G is non-planar. In the illustrated embodiment, the exposed surface **402** has a shape complementary to keel **404** on opposing face **406** of the glenoid component **400**.

[0131] FIG. **26** is a schematic illustration of a glenoid component **420** of an inverted shoulder prosthesis attached to the glenoid surface G according to an embodiment of the present invention. An exposed surface **422** of the glenoid surface G is non-planar. In one embodiment, the various shapes **424***a*, **424***b*, **424***c*, **424***d* (collectively "**424**") illustrated in FIG. **26** are formed in the glenoid surface G, such as for example to remove defects in the surface of the glenoid surface G and to increase the stability of the glenoid component **420**.

[0132] The bone graft **426** can be a one-piece volume, a plurality of pieces, purée of bone substance, or a combination thereof. In one embodiment, a plurality of pre-formed bone grafts of known shape are available to the surgeon during the procedure. The surgeon removes material from the exposed surface **422** of the glenoid surface G corresponding to the shape of one of the pre-formed bone grafts. The surgeon then places the pre-formed bone graft into the corresponding recess formed in the glenoid surface G.

[0133] FIG. **27** is a schematic illustration of a glenoid component **440** of an inverted shoulder prosthesis attached to the glenoid surface G according to an embodiment of the present invention. The glenoid component **440** includes a recess **442** that engaged with base plate **444**. The bone graft **458** can be a one-piece bone volume or a purée of bone substance.

[0134] In the illustrated embodiment, anchor **446** of the base plate **444** and/or the glenoid component **440** are located off-set from the center axis **448** of the glenoid surface G. Lower portion **450** of the convex articular surface **452** extends beyond the pillar of the scapula S to minimize interference with the humeral prosthetic portion. The radius of curvature of convex articular surface **452** is preferably selected so the center of rotation around the glenoid component **440** is preferably in a plane **454** comprising a distal surface **456** of the bone graft **458** or between the plane **454** and the glenoid surface G.

[0135] In the illustrated embodiment, the exposed surface **460** of the glenoid surface G includes one or more defects **462**. These defects **462** are preferably repaired with a one-piece bone graft, a plurality of pieces, purée of bone substance, or a combination thereof **464**. After the repair, the

exposed surface **460** of the glenoid surface G is preferably generally planar and well suited to receive the bone graft **458**.

[0136] FIG. **28** is a schematic illustration of a glenoid component **480** of an inverted shoulder prosthesis attached to the glenoid surface G according to an embodiment of the present invention. End faces **482**, **484** of the bone graft **486** are not parallel. In the illustrated embodiment, an anchor **488** of the glenoid component **480** is at an angle with respect to horizontal axis **490** of the glenoid surface G. As a result, a surface **492** of the bone graft **486** acts as an extension of a lower portion of the convex articular surface **494**.

[0137] FIG. **29** is a schematic illustration of the glenoid component **480** of FIG. **28** with the anchor **488** at a different angle with respect to the horizontal axis **490** of the glenoid surface G. Surface **496** of the bone graft **486** acts as an extension of an upper portion of the convex articular surface **494**.

[0138] FIGS. **30**A-**30**F illustrate an alternate method and apparatus for forming a bone graft **500** ex vivo in accordance with an embodiment of the present invention. The humeral epiphysis E is resected from the humerus H (see e.g., FIG. **7**). In the illustrated embodiment, the resected humeral epiphysis E includes a planar surface P created during the resection and a curvilinear surface C.

[0139] The curvilinear surface C of the humeral epiphysis E is located on base **502**, as illustrated in FIG. **30**A. A cover **504** illustrated in FIG. **30**B secures the humeral epiphysis E to the base **502**. As illustrated in FIG. **30**C, boring instrument **506** is inserted through opening **508** in the cover **504**. The boring instrument **506** may be operated by hand or a motorized driver. In an alternate embodiment, the instrument **506** is an impaction instrument that does not include teeth **510**.

[0140] In one embodiment, the resulting bone graft **500** is an annular ring with a planar surface **512** and a curvilinear surface **514** as illustrated in FIG. **30**D. In an alternate embodiment, cutting instrument **516** is inserted through slot **518** in cover **504** so that the bone graft **500** is an annular ring with opposing planar surfaces, as illustrated in FIG. **30**F.

[0141] Various modifications and additions can be made to the exemplary embodiments discussed without departing from the scope of the present invention. For example, the distal surfaces of the glenoid components disclosed herein can be used with an interpositional implant, such as disclosed in U.S. Pat. Nos. 6,436,146; 5,723,018; 4,846,840; 4,206,517; and U.S. Provisional Application Ser. No. 61/015,042, entitled INTRA-ARTICULAR JOINT REPLACEMENT, the complete disclosures of which are hereby incorporated by reference. While the embodiments described above refer to particular features, the scope of this invention also includes embodiments having different combinations of features and embodiments that do not include all of the described features. Accordingly, the scope of the present invention is intended to embrace all such alternatives, modifications, and variations as fall within the scope of the claims, together with all equivalents thereof.

What is claimed is:

1. A shoulder prosthesis adapted for implantation in a glenoid of a patient, the prosthesis comprising:

a head portion having an articulation surface adapted for articulation with a humeral head and an engagement surface opposite the articulation surface;

a bone graft having a medial surface and a distal surface and defining a thickness between the medial and distal surfaces, the medial surface having a shape complementary to the glenoid surface and the distal surface having a shape complementary to the engagement face of the head portion; and

an anchor structure connected to the engagement surface and adapted to extend through the bone graft and into the glenoid surface, the anchor structure being adjustable in overall length to accommodate the thickness of the bone graft such that the anchor structure extends through and projects beyond the bone graft upon engagement of the distal surface of the bone graft with the engagement surface of the head portion.

2. The prosthesis of claim **1**, wherein the bone graft is at least 7 mm thick.

3. The prosthesis of claim **1**, wherein the anchor structure is adjustable to at least 20 mm in length.

4. The prosthesis of claim **1**, wherein the anchor structure includes a first portion and a second portion telescopically received in the first portion, the second portion being extendable from the first portion to adjust the overall length of the anchor structure.

5. The prosthesis of claim **1**, wherein the anchor structure includes a first portion having a first length and a second portion releasably connected to the first portion to extend the overall length of the anchor structure.

6. The prosthesis of claim **1**, wherein the bone graft includes metal material having a trabecular structure.

7. The prosthesis of claim **1**, wherein the bone graft includes structured porous tantalum.

8. The prosthesis of claim **1**, wherein the bone graft is taken from a bone in the patient.

9. The prosthesis of claim **1**, wherein the bone graft comprises an upper epiphysis of a humerus.

10. The prosthesis of claim **1**, wherein the bone graft comprises at least one of an allograft, a xenograft, a natural material, and a synthetic material.

11. The prosthesis of claim **1**, wherein the bone graft defines an outer lateral face and the prosthesis further comprises a reinforcing structure that at least partially surrounds the outer lateral face of the bone graft.

12. The prosthesis of claim **1**, wherein the bone graft defines an outer lateral face and the glenoid component at least partially surrounds the outer lateral face of the bone graft.

13. The prosthesis of claim **1**, wherein the bone graft defines an outer lateral face and the prosthesis further comprises a reinforcing structure located between the medial surface of the bone graft and the glenoid surface, the first reinforcing structure comprising first side walls supporting the outer lateral face of the bone graft.

14. A shoulder prosthesis system adapted for replacement of a glenohumeral joint of a patient, the prosthesis comprising:

a humeral head having a humeral articulation surface; and

a glenoid component including:

a head portion having an articulation surface in articulating engagement with the humeral articulation surface of the humeral head;

a bone graft having a medial surface and a distal surface and defining a thickness between the medial and distal surfaces; and

an anchor structure connected to the engagement surface and secured into a glenoid surface of the glenohumeral joint, the anchor structure engaging the bone graft and restricting lateral movement of the bone

graft, the anchor structure being adapted to be adjusted in overall length to accommodate the thickness of the bone graft.

15. The system of claim **14**, wherein the anchor structure includes a first portion and a second portion, the second portion being telescopically received in the first portion and extendable from the first portion to adjust the overall length of the anchor structure.

16. The system of claim **14**, wherein the anchor structure includes a first portion and a second portion releasably secured to the first portion to extend the overall length of the anchor structure.

17. A method of repairing a glenohumeral joint, the method comprising:

receiving a bone graft with an anchor structure of a glenoid component, the bone graft having a thickness between a medial surface and a distal surface of the bone graft;

engaging the medial surface of the bone graft with an engagement surface of a head structure of the glenoid component, the head structure having an articulation surface that is adapted to articulate with a humeral head, the articulation surface being positioned opposite the engagement surface;

restricting lateral movement of the bone graft with the anchor structure of the glenoid component, the anchor structure of the glenoid component projecting from the engagement surface of the glenoid component;

adjusting an overall length of the anchor structure of the glenoid component to compensate for the thickness of the bone graft; and

securing the anchor structure of the glenoid component into a boney structure of the glenoid.

18. The method of claim **17**, further comprising engaging the articulation surface of the glenoid component with a natural humeral head.

19. The method of claim **17**, further comprising engaging the articulation surface of the glenoid component with a prosthetic humeral head.

20. The method of claim **17**, further comprising shaping a natural humeral head to define a humeral engagement surface and engaging the articulation surface of the glenoid component with the humeral engagement surface.

21. The method of claim **17**, wherein the anchor structure includes a first portion having a first length and a second portion releasably connected to the first portion to extend the overall length of the anchor structure, and further wherein the bone graft is received by the first portion and then the second portion is releasably connected to the first portion.

22. The method of claim **17**, wherein the bone graft is received by the engagement surface and then the first portion of the anchor structure is connected to the head structure.

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