



US 20130144393A1

(19) **United States**(12) **Patent Application Publication**
Mutchler et al.(10) **Pub. No.: US 2013/0144393 A1**(43) **Pub. Date: Jun. 6, 2013**(54) **SHOULDER PROSTHESIS GLENOID COMPONENT**(30) **Foreign Application Priority Data**

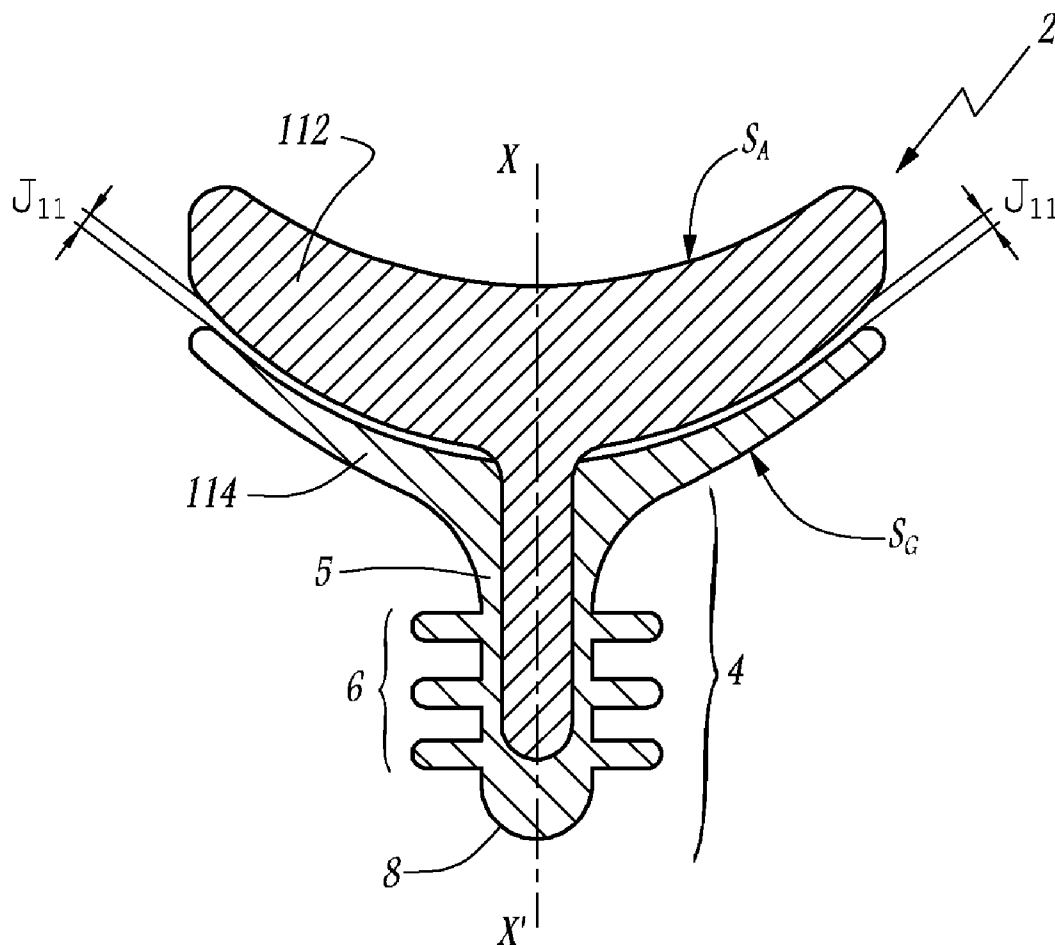
Jan. 21, 2010 (FR) 1050376

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Saint-Martin-Duriage (FR)**Publication Classification**(51) **Int. Cl.**
A61F 2/40 (2006.01)
(52) **U.S. Cl.**
CPC **A61F 2/4081** (2013.01)
USPC **623/19.11**(21) Appl. No.: **13/516,211**(22) PCT Filed: **Dec. 14, 2010**(86) PCT No.: **PCT/EP2010/069585**§ 371 (c)(1),
(2), (4) Date: **Jan. 25, 2013****Related U.S. Application Data**

(60) Provisional application No. 61/286,286, filed on Dec. 14, 2009.

(57) **ABSTRACT**

This shoulder prosthesis glenoid component (2) has on one of its faces an articulation surface (S_A) adapted to cooperate with a humeral head and having, on an opposite face (S_G) adapted to be immobilized on the glenoid cavity (G) of a shoulder, a keel (4) for anchoring it in the glenoid cavity (G). This keel (4) comprises a body (5) that extends from the opposite face (S_G). The keel (4) comprises at least one fin (6) projecting from the body (5) which runs over at least a part of the perimeter of the body (5).



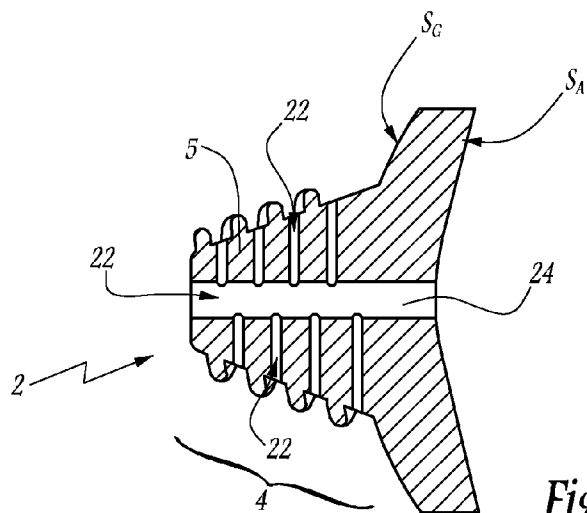
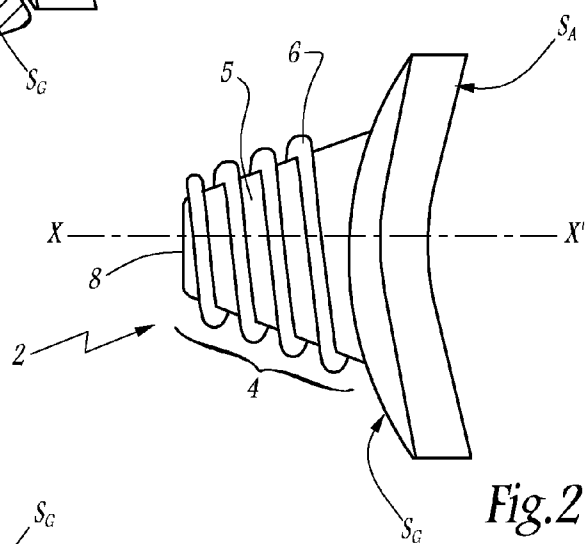
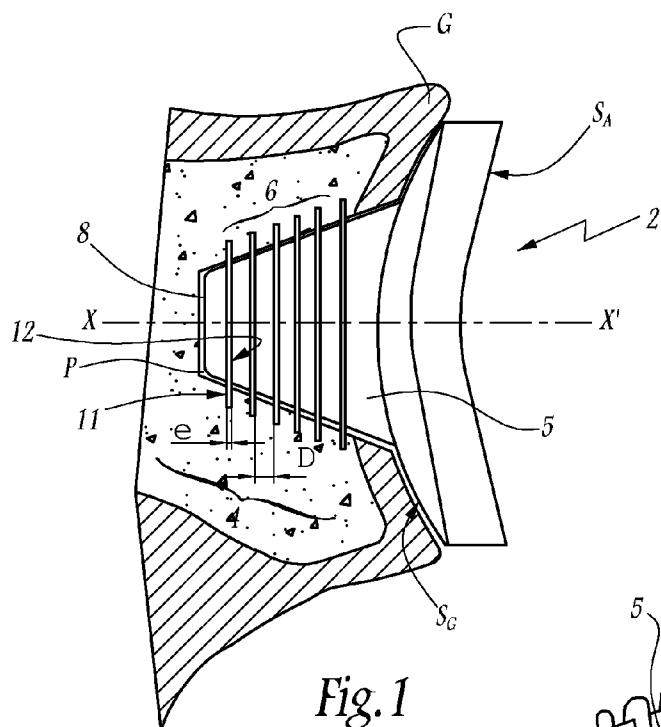
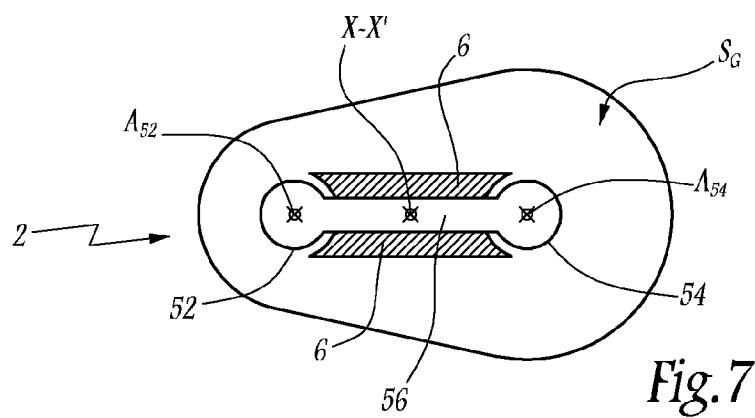
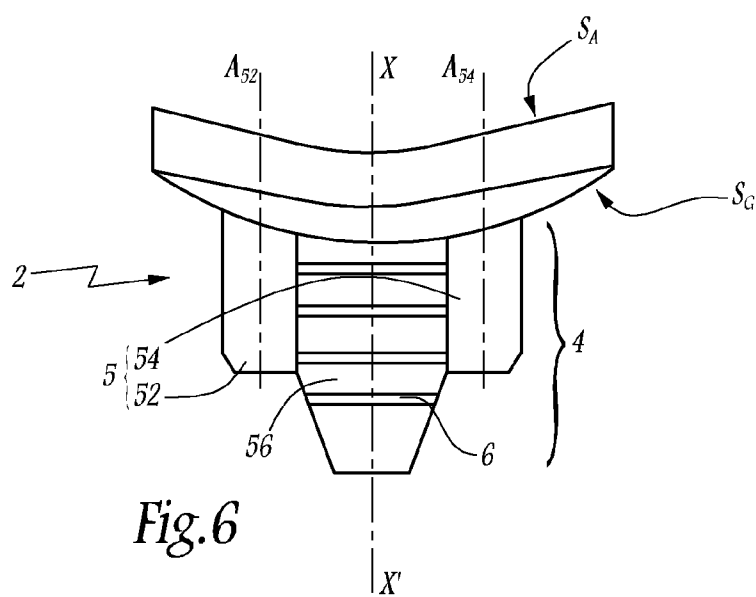
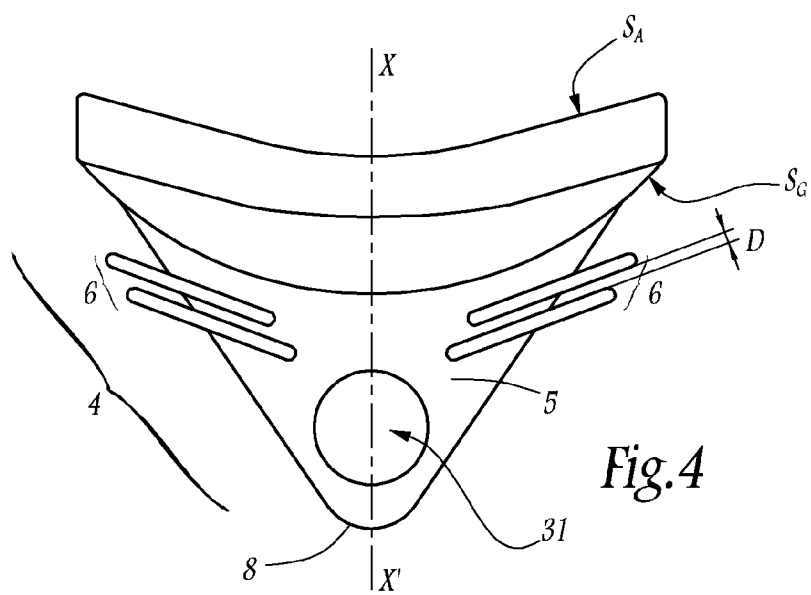
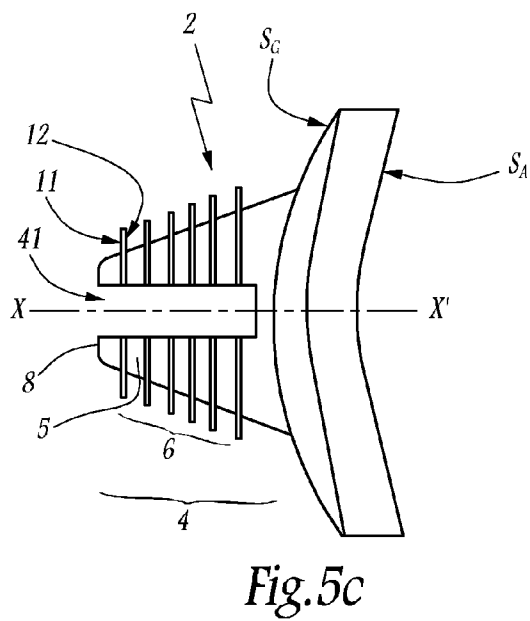
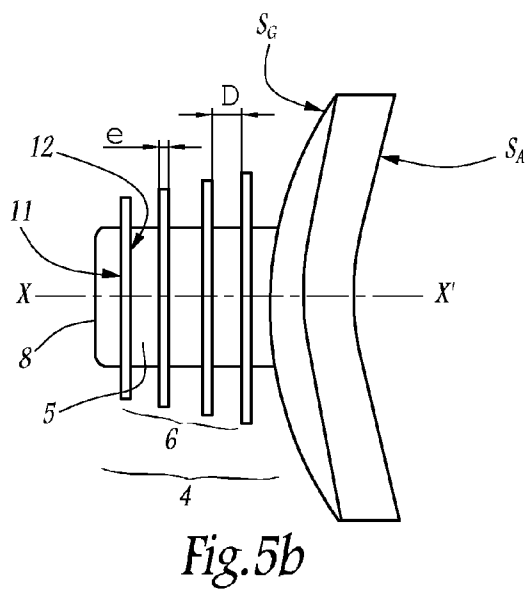
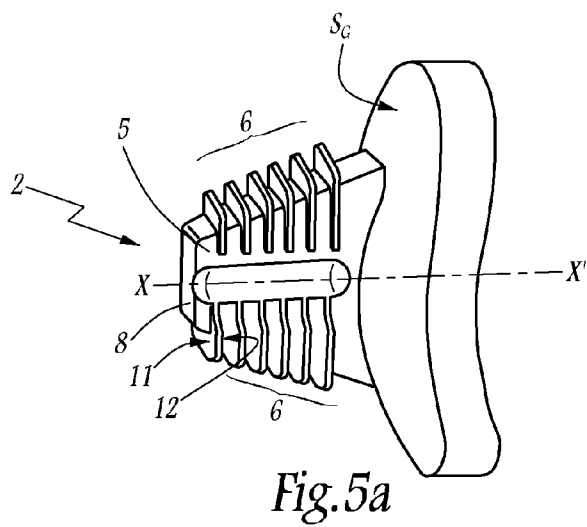


Fig. 3





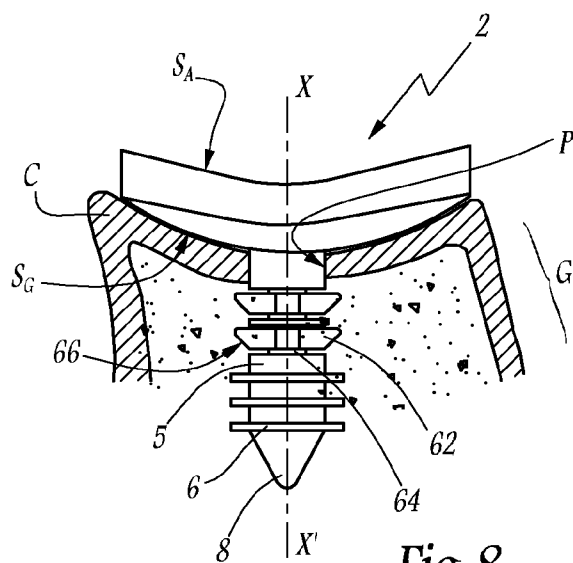


Fig. 8

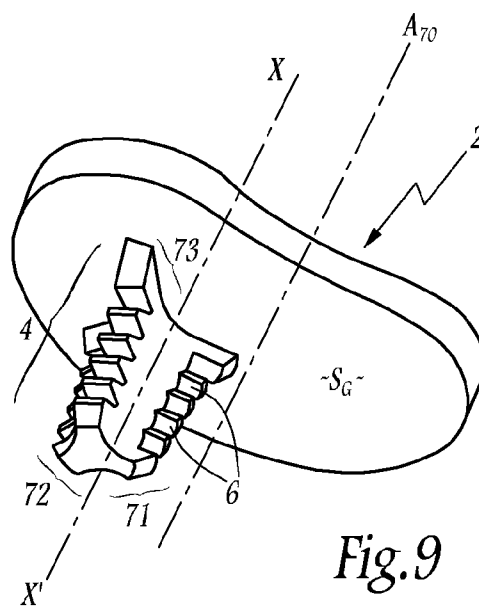


Fig. 9

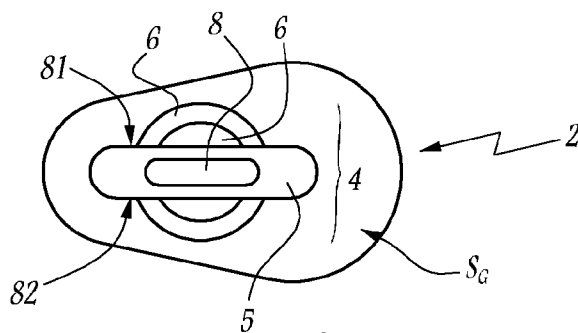
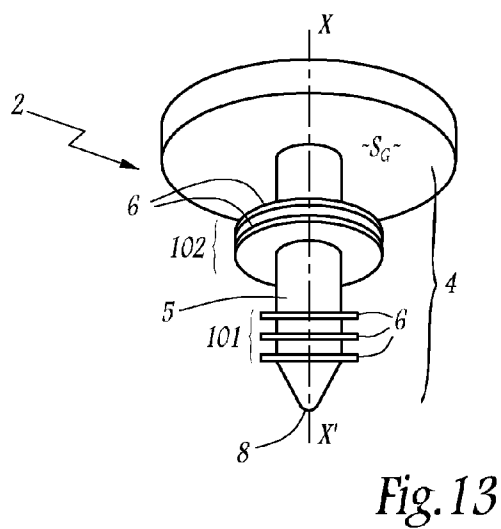
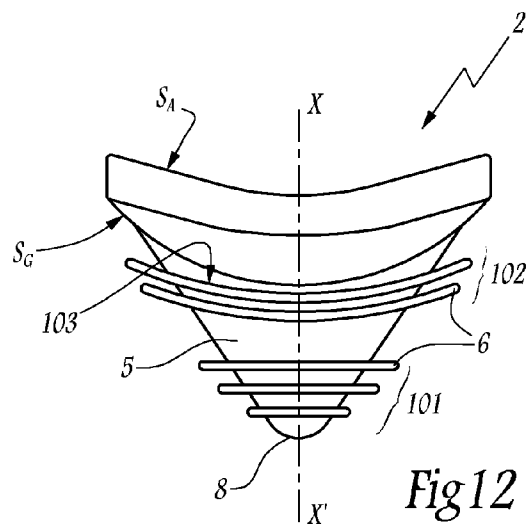
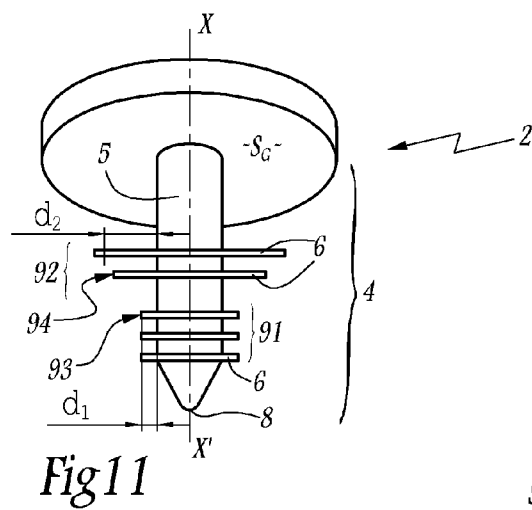
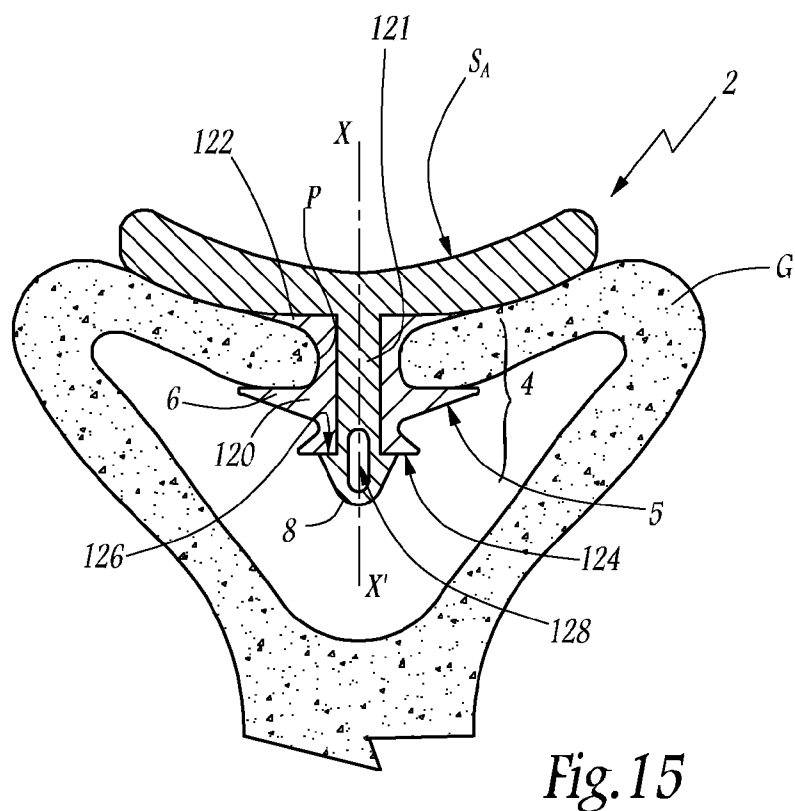
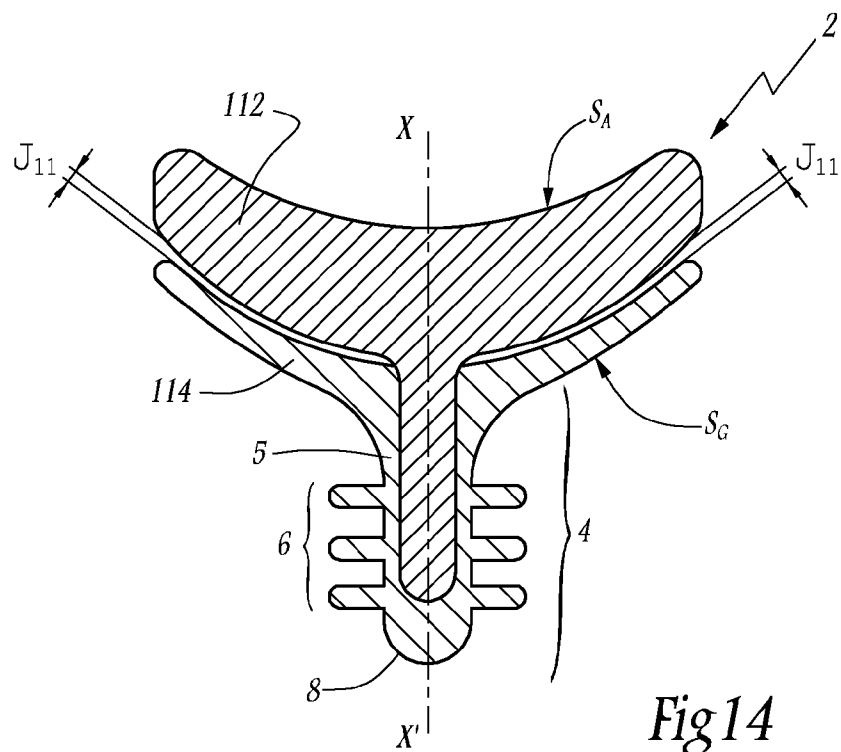


Fig. 10





SHOULDER PROSTHESIS GLENOID COMPONENT

[0001] The present invention concerns a shoulder prosthesis glenoid component.

[0002] In the field of shoulder prostheses, it is routine to use a glenoid component comprising an articulation surface, a bearing surface on a shoulder glenoid cavity and means for fixing the component in the glenoid cavity. These means may constitute screws, pegs, rods or keels or combinations of these means. It is known in particular from US-A-2001/0037153 to produce components provided with cylindrical studs of circular section.

[0003] These solutions have drawbacks linked to the mode of implanting the glenoid component in the glenoid cavity of the shoulder. The conjugate effects of movement of the arm and aging of the component tend to loosen the fixing of the component and cause deterioration of its fixing means. In particular, the eccentric forces exerted by the head of the humerus on the articulation surface are liable to reduce the firmness of a keel-type fixing of the glenoid component, in that part of the keel is anchored in the spongy part of the bone. Moreover, studs such as are known from the aforementioned document are not able to block rotation of the components in the glenoid cavity.

[0004] It is these drawbacks that the invention aims more particularly to remedy by proposing a new keel-type glenoid component the fixing of which is made reliable and durable.

[0005] To this end, the invention provides a shoulder prosthesis glenoid component having on one of its faces an articulation surface adapted to cooperate with a humeral head and an opposite face. This component further includes a keel for anchoring it in the glenoid cavity of a shoulder, comprising a body that extends from an opposite face adapted to be immobilized in the glenoid cavity. This component is characterized in that the keel comprises at least one fin projecting from the body which runs over at least a part of the perimeter of the body.

[0006] Thanks to the invention, the fixing of the component in the glenoid cavity is improved compared to fixing using a keel with no fins, the free spaces created by the fins encouraging locking of the component in the glenoid cavity by bone growth in these spaces. Adding fins to the keel of the glenoid component therefore makes it possible to improve the stability and the service life of the prosthesis.

[0007] According to advantageous but non-mandatory aspects of the invention, such a component may incorporate one or more of the following features, in all technically permissible combinations:

[0008] The body of the keel has in cross section a non-circular peripheral contour.

[0009] The fin or at least one of the fins has a helicoidal shape and winds around the body.

[0010] The body comprises at least one internal passage opening onto the external surface of the body and connected to an orifice for injecting a fluid such as a bone substitute or a solution containing growth factors.

[0011] The fin or at least one of the fins extends in a plane substantially perpendicular to a longitudinal main axis of the body.

[0012] The body comprises at least two separate cylindrical parts the respective axes of which are substantially parallel to each other and between which the fin or fins extend(s).

[0013] The body includes at least one external peripheral groove for receiving an elastic ring adapted to expand in the glenoid cavity.

[0014] The body has a star-shaped cross section including at least three branches and the keel has an eccentric position relative to a central axis of the component.

[0015] The fin or at least one of the fins has a substantially semicircular peripheral contour.

[0016] The keel comprises a first series of substantially parallel fins.

[0017] The keel further comprises at least one second series of parallel fins, of width greater than that of the first fins and placed at a distance from the opposite face along a longitudinal main axis of the body less than that of the first series of fins.

[0018] The fins of the or each second series of fins have a shape that is geometrically similar to the shape of the opposite face.

[0019] The articulation surface is carried by an element adapted to be mounted in a preferably metal shell of the component carrying the opposite face and in one piece with the body of the keel.

[0020] The body of the keel comprises a flexible sheath provided with the fin or fins into which a part in one piece with the opposite face is adapted to fit.

[0021] The fins are made of a deformable material chosen from materials such as polyethylene or other polymer materials.

[0022] The body of the keel includes a hole passing through the body.

[0023] The invention will be better understood and other advantages thereof will become more clearly apparent in the light of the following description of a glenoid component of various embodiments of the invention given by way of example only and with reference to the drawings, in which:

[0024] FIG. 1 is a front view of a glenoid component of the invention, corresponding to a generic embodiment and shown implanted in the glenoid cavity of a shoulder.

[0025] FIG. 2 is a front view of a glenoid component according to a specific first embodiment of the invention.

[0026] FIG. 3 is a front view of a glenoid component according to a second embodiment of the invention.

[0027] FIG. 4 is a front view of a glenoid component according to a third embodiment of the invention.

[0028] FIG. 5a is a front view of a glenoid component according to a fourth embodiment of the invention.

[0029] FIG. 5b is a front view of a glenoid component according to a variant of the fourth embodiment of the invention.

[0030] FIG. 5c is a front view of a glenoid component according to a second variant of the fourth embodiment of the invention.

[0031] FIG. 6 is a front view of a glenoid component according to a fifth embodiment of the invention.

[0032] FIG. 7 is a bottom view of the glenoid component from FIG. 6.

[0033] FIG. 8 is a front view of a glenoid component according to a sixth embodiment of the invention implanted in the glenoid cavity of a shoulder.

[0034] FIG. 9 is a perspective view of a glenoid component according to a seventh embodiment of the invention.

[0035] FIG. 10 is a perspective view of a glenoid component according to an eighth embodiment of the invention.

[0036] FIG. 11 is a perspective view of a glenoid component according to a ninth embodiment of the invention.

[0037] FIG. 12 is a perspective view of a glenoid component according to a tenth embodiment of the invention.

[0038] FIG. 13 is a side view of the glenoid component from FIG. 12.

[0039] FIG. 14 is a section on a median plane of a glenoid component according to an eleventh embodiment of the invention.

[0040] FIG. 15 is a section in a median plane of a glenoid component according to a twelfth embodiment of the invention implanted in the glenoid cavity of a shoulder socket.

[0041] The glenoid component 2 represented in FIGS. 1 to 15 is adapted to be fixed on the glenoid cavity G of a shoulder of a human being. The glenoid component 2 has an articulation surface S_A , here generally concave, intended to cooperate with a humeral component, not shown, that may be prosthetic or natural. The surface S_A may equally be convex in order to cooperate with a concave spherical surface of the humeral component, notably in the case of a reversed prosthesis.

[0042] The component 2 has on the side opposite its articulation surface S_A a face S_G that bears on the glenoid cavity G. This face S_G can be superposed on that of the glenoid cavity and is generally of convex shape. However, as a function of the shape of the socket G, the face S_G may have other shapes, notably plane in order to fit a flat-bottomed glenoid cavity G.

[0043] For fixing it into the glenoid cavity G, the glenoid component 2 includes an anchor keel 4. This keel 4 consists mainly of a body 5 extending from the central region of the bearing face S_G . This keel is intended to be immobilized in a drilled hole P or the like of corresponding size and shape produced in the socket G. In practice, the keel 4 may have an external envelope of varied dimensions and shapes so as to have in cross section a non-circular peripheral contour in order to block rotation of the component in the glenoid cavity G. In particular, the keel 4 may preferably have an envelope of truncated pyramid shape, the base of which may be substantially square or rectangular. Alternatively, this envelope may be of frustoconical shape with a substantially elliptical base. In all cases, the geometry of the body 5 defines a longitudinal main axis X-X' transverse to the articulation surface S_A and to the bearing face S_G .

[0044] As shown generically in FIG. 1, the keel 4 of the component 2 is provided with at least one fin 6. Each fin is constituted of a wall projecting from the body 5 and has two substantially parallel opposite surfaces 11 and 12 separated by a distance e that defines the thickness of the fin. The fin or fins may run along part or the whole of the perimeter of the keel 4, this perimeter being defined by the peripheral surface enveloping the body 5 around the longitudinal axis X-X' from the face S_G at the axially opposite end 8 of this body. For fixing the implant, the distance between the bearing surface S_G and the first fin 6 advantageously corresponds to the average thickness of cortical bone tissue constituting the surface of the glenoid cavity. Thus during insertion of the prosthesis all of the fins 6 are inserted into the spongy bone tissue of the glenoid cavity, trapping the cortical structure between the fins 6 and the bearing surface S_G in order to render extraction of the prosthesis more difficult.

[0045] References common to the specific embodiments described hereinafter remain unchanged. The references that differentiate these embodiments include a numerical prefix corresponding to the numbering of the embodiment described.

[0046] In the first embodiment represented in FIG. 2 the keel 4 is provided with a single fin 6. This fin 6 is of helicoidal shape and winds around the body 5 of the keel 4 along the longitudinal main axis X-X' and with a pitch that either is constant or varies. The helicoid described by the fin 6 advantageously winds continuously around the body 5 of the keel 4.

[0047] This embodiment has, among others, the particular benefit of encouraging bone growth producing a continuous volume of bone material representing a high fixing power and firmness. This volume of material may equally be produced by a bone substitute, which may be introduced into the drilled hole P.

[0048] In a second embodiment represented in FIG. 3 the body of the keel 4 comprises a network of internal passages 22. These internal passages 22 open onto the external surface of the body 5, preferably between two successive fins 6. They advantageously pass completely through the body of the keel, communicate with each other and are connected to an orifice 24 for injecting a fluid. This injection orifice 24 is preferably situated on the articulation surface S_A of the component 2 and must be used to inject into the internal passages 22 a bone substitute, preferably bioresorbable, or a solution containing growth factors. The injection of a solution containing growth factors has the object of accelerating and encouraging bone growth in the gap induced by the presence of the fins in order to make firm the fixing of the component 2 into the glenoid cavity G.

[0049] In a third embodiment of the invention represented in FIG. 4 the keel 4 includes a series of fins 6, the surfaces 11 and 12 of each fin being parallel to the surfaces of the other fins. The keel 4 can thus have a plurality of parallel fins 6 over a part of its perimeter, as in FIG. 4. As represented in this figure, the fins 6 may be inclined in the direction of the end 8. This inclination makes it possible to facilitate the insertion of the component into the glenoid cavity and to prevent its withdrawal, the fins 6 tending to spread apart in the spongy tissue.

[0050] The implantation of such a series of fins 6 makes it possible, among other things, to improve the immobilization of the component 2 in the glenoid cavity G. The distance D between two successive fins of the series, which is defined by the distance between the surface 11 of one of the fins and the surface 12 of the next fin in the series, is chosen in order to optimize the stability of fixing and the efficacy of bone growth. A small distance D between the fins 6 may induce a high stability of fixing and fast bone growth in the gaps, but the bony reinforcement created in this gap will be less firm than a bony reinforcement generated between fins with a greater spacing. The distance D between the two successive fins may be different from one pair of fins to another.

[0051] As shown in FIG. 4, the keel 4 may include at least one hole 31 passing completely through the body 5, preferably in a direction corresponding to the smallest dimension of the cross section of the body 5. Like the fins 6, this hole serves to improve the retention of the component by encouraging bone regrowth in the space created.

[0052] It will be noted that the presence of such a hole 31 may be considered independently of the presence of the fins 6.

[0053] In a fourth embodiment represented in FIGS. 5a, 5b and 5c the fins 6 of the keel 4 are disposed perpendicularly to the longitudinal main axis X-X' of the body 5 of the keel. The surfaces 11 and 12 of the walls constituting the fins are thus contained in planes perpendicular to the longitudinal axis X-X'. This disposition of the fins 6 provides a more effica-

cious fixing if the forces that are exerted on the component 2 are directed along the longitudinal axis X-X'.

[0054] In this regard, the body 5 of the keel 4 may be of parallelepiped shape with the overall external envelope of the keel resembling a truncated cone with an elliptical base or a truncated pyramid, as shown in FIG. 5b. To this end, the width of the fins, i.e. the dimension of their projection from the external surface of the body 5, decreases between the bearing face S_G and the end 8. This increases the stability of the component 2 near the bearing face S_G .

[0055] The body 5 of the keel 4 may equally have the external shape of a truncated cone with an elliptical base or a truncated pyramid, as shown in FIGS. 5a and 5c, the fins 6 being of identical width. The overall exterior envelope of the keel 4 is then conical. In a variant that is not shown, the body 5 may be frustoconical or pyramidal and the keel 4 have a cylindrical envelope with an elliptical base and vice-versa. The body 5 and/or the external envelope of the keel 4 may equally have an inverted cone or inverted pyramid shape the area of the section of which increases toward the end 8.

[0056] As shown in FIG. 5c the body 5 of the keel 4 may include an opening 41 extending along the axis X-X' over a middle part of the body 5. This opening 41 may extend along the axis X-X' over all or part of the body 5. Such an opening enables movement toward each other of the two lateral parts created in this way when inserting the component. The tendency of these two parts to move apart makes it possible to improve the retention of the component.

[0057] In a fifth embodiment of the invention shown in FIGS. 6 and 7, the body 5 of the keel 4 comprises two separate and parallel cylindrical parts 52 and 54. These cylindrical parts, the number of which is not limited, may be of circular section. These cylindrical parts extend from the bearing face S_G along longitudinal parallel axes A_{52} and A_{54} . The two cylindrical parts 52 and 54 advantageously extend parallel to the longitudinal main axis X-X' of the body of the keel. Alternatively, the cylindrical parts 52 and 54 may extend along longitudinal axes A_{52} and A_{54} inclined one relative to the other and also relative to the axis X-X'.

[0058] Between these two cylindrical parts 52 and 54 extends a central connecting wall 56 on which the fins 6 are implanted. The fins thus extend between the two cylindrical parts 52 and 54.

[0059] The dimensions of the section of these cylindrical parts 52 and 54 correspond to the dimensions of drilled holes P produced in the glenoid cavity G for implanting the component 2. If these cylindrical parts 52 and 54 are of circular section, the dimensions taken into account to define the geometry of the cylindrical parts is that of the drill used to produce the drilled holes P in the glenoid cavity G. A slightly tight fit may be chosen in order to obtain greater stability of the implantation of the component 2.

[0060] In this embodiment, the fins 6 may be made of a deformable material able to exert a pressure on the walls of a slot produced in the glenoid cavity G to connect the two drilled holes P. For example, the fins 6 may be made of a polymer material or polyethylene.

[0061] In a sixth embodiment of the invention shown in FIG. 8 the body 5 of the keel 4 includes at least one elastic ring 62. The function of this elastic ring 62 is to exert pressure on the wall of the drilled hole produced in the glenoid cavity G in order to strengthen the firmness of the implantation.

[0062] The elastic ring 62 is housed in a peripheral external groove 64 formed on the body 5 of the keel 4 that extends over the whole of the perimeter of the keel.

[0063] The exterior dimensions of the elastic ring 62 in the relaxed configuration are greater than the dimensions of the drilled hole P produced in the glenoid cavity G. Moreover, the elastic ring 62 has an oblique peripheral edge 66 converging toward the longitudinal main axis X-X' of the body 5 of the keel 4 in the direction of the end 8 of the keel. When inserting the glenoid component 2 in the glenoid cavity G, this particular geometry enables sliding of the cortical wall C of the glenoid cavity along the oblique edge 66 of the elastic ring 62 and retraction of the elastic ring into the peripheral groove 64. Once the component has been inserted in the glenoid cavity G, the elastic ring 62 relaxes into the spongy part of the glenoid cavity G, blocking the movements of the component 2 along the longitudinal axis X-X' of the body 5 of the keel 4 thanks to its exterior dimensions being greater than the dimensions of the drilled hole in the cortical wall. A plurality of elastic rings 62 may be used in this embodiment.

[0064] It will be noted that the presence of such a ring 62 may be considered independently of the presence of the fins 6.

[0065] In a seventh embodiment of the invention shown in FIG. 9, the body 5 of the keel 4 has on a plane perpendicular to its longitudinal axis X-X' a star-shaped cross section including at least three branches.

[0066] The keel 5 then consists of at least three contiguous flanges 71, 72 and 73 each oriented relative to the other two at two substantially equal angles. The fins 6 are implanted on the three contiguous flanges 71, 72 and 73.

[0067] This keel geometry makes it possible to obtain increased stability about the longitudinal axis X-X' by preventing rotation of the glenoid component 2 about that axis.

[0068] The position of the keel 4 on the bearing face S_G may then be eccentric relative to an axis A_{70} passing through the geometrical centre of the face S_G and substantially perpendicular to that surface.

[0069] In an eighth embodiment of the invention shown in FIG. 10 the fins 6 have surfaces 11 and 12 with semicircular free edges. If the body 5 has substantially the shape of a substantially plane thick wall, the fins 6 may extend from each side 81 and 82 of that wall.

[0070] In a ninth embodiment shown in FIG. 11, the keel 4 comprises two separate series 91 and 92 of fins 6. These two series of fins are staggered along the longitudinal main axis X-X' of the body 5. The series 91 of fins adjoins the end 8 of the keel and the second series 92 of fins is on the longitudinal axis X-X' between the first series 91 of fins and the bearing face S_G on the glenoid cavity.

[0071] The series 92 of fins is wider than the series 91 of fins, i.e. the average distance d_1 between the external surface of the body 5 of the keel 4 and the free edge of the fins of the series 91 is less than the distance d_2 between the external surface of the body 5 of the keel 4 and the free edge 94 of the fins of the series 92.

[0072] This particular geometry makes it possible for the fins of the series 92 to fulfil the primary fixing function, which consists in stable implantation of the component in the glenoid cavity, thanks to their width being greater than those of the fins of the series 91. Thanks to their narrow width, the first fins 91 fulfil the secondary fixing function by virtue of bone growth in the gaps that they delimit.

[0073] In a tenth embodiment of the invention shown in FIGS. 12 and 13 the keel 4 of the glenoid component 2

comprises two series **101** and **102** of fins **6**, the series **102** of fins closer to the bearing face S_G having surfaces geometrically similar to the bearing surface S_G . The series **102** of fins thus has surfaces **103** that may be superposed on the bearing face S_G of the glenoid cavity G . This geometry enables these fins to exert forces on the glenoid cavity G in the same direction as the bearing forces exerted by the face S_G , which creates increased stability of the fixing of the glenoid component **2**.

[0074] In an eleventh embodiment of the invention shown in FIG. **14** the glenoid component **2** is made up of two elements. One element **112**, preferably made of a polymer material and carrying the articulation surface S_A , is mounted in a preferably metal shell **114**. The metal shell **114** carries the bearing face S_G of the socket and forms a part of the body **5** of the keel **4**. The metal shell **114** is intended to be implanted in glenoid cavity G of the shoulder and to this end includes fins **6**. The shell **114** may equally be made of ceramic and have a partly porous surface.

[0075] In order to provide a space for movement of the polymer material element **112**, the geometry of the metal shell **114** provides a clearance J_{11} between the surfaces of contact between the polymer element **112** and the metal shell **114** at the level of an area of the glenoid component **2** situated outside the glenoid cavity G . By authorizing this freedom of movement of the polymer element **112**, plastic deformation of that element is prevented and the forces exerted on the component **2** where it is implanted in the glenoid cavity G are reduced, which makes it possible to increase its service life and stability.

[0076] In a twelfth embodiment of the invention shown in FIG. **15** the body **5** of the keel **4** comprises a flexible sheath **120** surrounding a rod **121** in one piece with the face S_G on which the fins **6** are implanted. This elastic sheath **120**, which may be made of a polymer material, comprises an end rim **122** adapted to bear on the glenoid cavity G . The part of the flexible sheath **120** intended to be implanted in the glenoid cavity G is elastic so as to be retracted in the relaxed configuration. In this way, the flexible sheath **120** is inserted into the hole P drilled in the glenoid cavity G . The rod **121** is then inserted in the flexible sheath **120**, enlarging it in order for its fin or fins **6** to spread apart in the glenoid cavity G to lock the implantation of the glenoid component **2**.

[0077] To counter the tendency of the flexible sheath **120** to expel the rod **121**, having the rod protrude from the flexible sheath **120** and providing on it a shoulder **126** widening the part of the rod projecting from the flexible sheath may be envisaged. In order to block movements in translation of the rod **121** in the flexible sheath **120**, this shoulder **126** bears against the end **124** of the flexible sheath anchored in the glenoid cavity G .

[0078] The end **8** of the body **5** of the keel **4** carried by the rod **121** advantageously includes at least one hole **128** the function of which is to encourage bone growth in the space created in order to increase the stability of the fixing.

[0079] In a variant that is not shown, the glenoid component **2** may include, in addition to the anchor keel **4**, an eccentric peg projecting from the face S_G and making it possible to improve the fixing of the component in the socket G , in particular blocking its rotation.

[0080] Of course, the features of the embodiments shown may be combined with each other in the context of the present invention.

1. A shoulder prosthesis glenoid component (**2**) having on one of its faces an articulation surface (S_A) adapted to cooperate with a humeral head and having, on an opposite face (S_G) adapted to be immobilized on the glenoid cavity (G) of a shoulder, a keel (**4**) for anchoring it in the glenoid cavity (G), this keel comprising a body (**5**) that extends from said opposite face (S_G), wherein the keel (**4**) comprises at least one fin (**6**) projecting from the body (**5**) which runs over at least a part of the perimeter of the body (**5**).

2. The shoulder prosthesis glenoid component according to claim 1, wherein the body (**5**) of the keel (**4**) has in cross section a non-circular peripheral contour.

3. The shoulder prosthesis glenoid component according to claim 1, wherein the at least one fin (**6**) has a helicoidal shape and winds around the body (**5**).

4. The shoulder prosthesis glenoid component according to claim 1, wherein the body (**5**) comprises at least one internal passage (**22**) opening onto the external surface of the body (**5**) and connected to an orifice (**24**) for injecting a fluid.

5. The shoulder prosthesis glenoid component according to claim 1, wherein the at least one fin (**6**) extends in a plane substantially perpendicular to a longitudinal main axis ($X-X'$) of the body (**5**).

6. The shoulder prosthesis glenoid component according to claim 1, wherein the body (**5**) comprises at least two separate cylindrical parts (**52**, **54**) the respective axes (A_{52} , A_{54}) of which are substantially parallel to each other and between which the at least one fin (**6**) extends.

7. The shoulder prosthesis glenoid component according to claim 1, wherein the body (**5**) includes at least one external peripheral groove (**64**) for receiving an elastic ring (**62**) adapted to expand in the glenoid cavity (G).

8. The shoulder prosthesis glenoid component according to claim 1, wherein the body (**5**) has a star-shaped cross section including at least three branches and the keel (**4**) has an eccentric position relative to a central axis (A_{70}) of the component (**2**).

9. The shoulder prosthesis glenoid component according to claim 1, wherein the at least one fin (**6**) has a substantially semicircular peripheral contour.

10. The shoulder prosthesis glenoid component according to claim 1, wherein the keel (**4**) comprises a first series (**91**; **101**) of substantially parallel fins (**6**).

11. The shoulder prosthesis glenoid component according to claim 10, wherein the keel (**4**) further comprises at least one second series (**92**; **102**) of parallel fins (**6**), of width (d_2) greater than that (d_1) of the first fins (**91**; **101**) and placed at a distance from the opposite face (S_G) along a longitudinal main axis ($X-X'$) of the body (**5**) less than that of the first series of fins.

12. The shoulder prosthesis glenoid component according to claim 11, wherein the fins (**6**) of the at least one second series (**102**) of fins have a shape that is geometrically similar to the shape of the opposite face (S_G).

13. The shoulder prosthesis glenoid component according to claim 1, wherein the articulation surface (S_A) is carried by an element (**112**) adapted to be mounted in a preferably metal shell (**114**) of the component (**2**) carrying the opposite face (S_G) and in one piece with the body (**5**) of the keel (**4**).

14. The shoulder prosthesis glenoid component according to claim 1, wherein the body (**5**) of the keel (**4**) comprises a flexible sheath (**120**) provided with the at least one fin (**6**) into which a part (**121**) in one piece with the opposite face (S_G) is adapted to fit.

15. The shoulder prosthesis glenoid component according to claim **1**, wherein the at least one fin (**6**) is made of a deformable material.

16. The shoulder prosthesis glenoid component according to claim **1**, wherein the body (**5**) of the keel (**4**) includes a hole (**31**, **128**) passing through the body (**5**).

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