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ABSTRACT

A humeral component (20) of a shoulder prosthesis includes a stem (22) configured for implantation within the humerus. A reverse articulating component (26) is mounted to the stem (12) by a connection mechanism (28). The reverse component (26) defines a substantially concave bearing surface. The bearing surface is part of a bearing member that is engaged to a support member (24) that is associated with the connection mechanism. A kit is provided which includes differently configured bearing members and support members to allow intraoperative selection and assembly of an optimum articulating component.

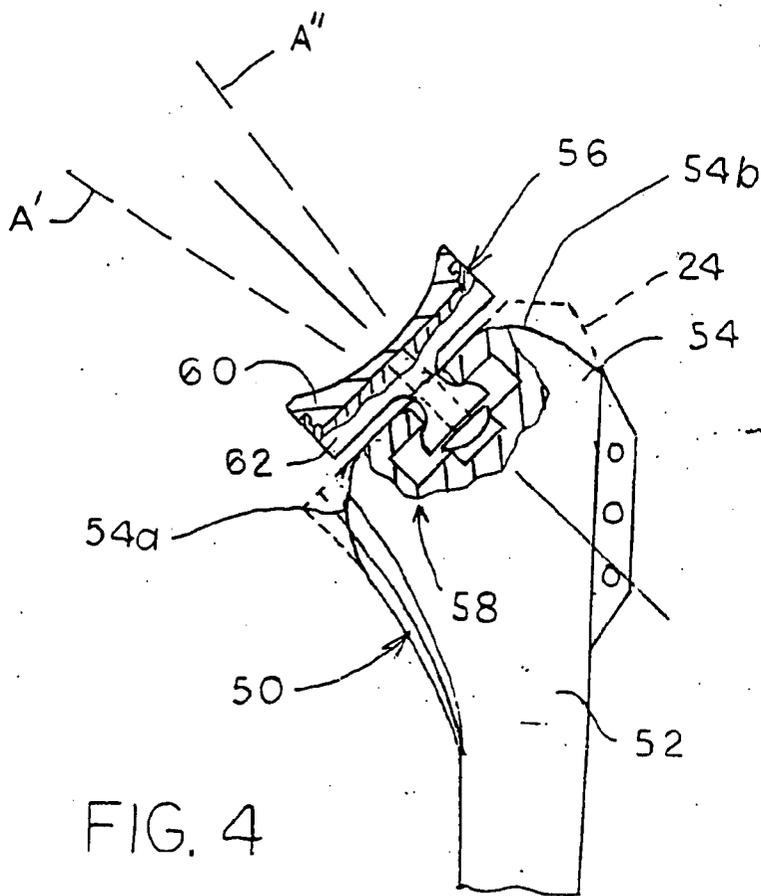


FIG. 4

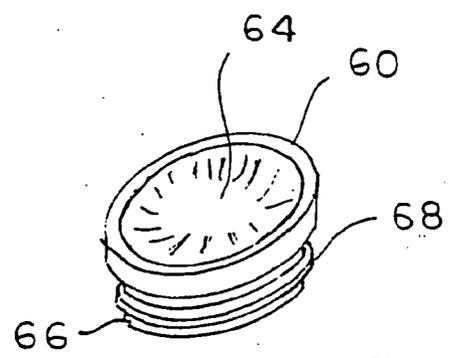


FIG. 5

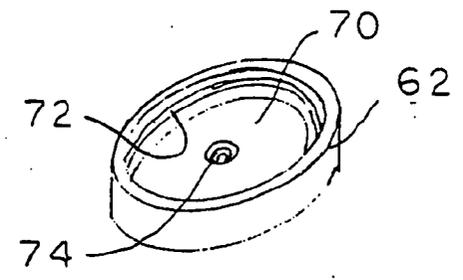


FIG. 6

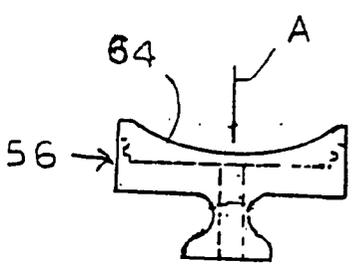


FIG. 8

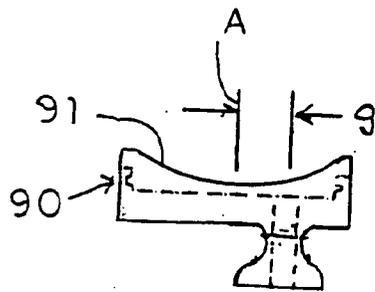


FIG. 9

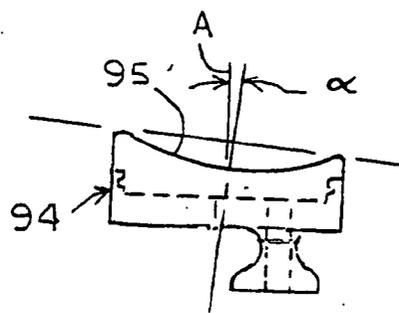


FIG. 10

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COMPLETE SPECIFICATION STANDARD PATENT

Invention Title: **Reverse-type humeral prosthesis**

The following statement is a full description of this invention, including the best method of performing it known to us:

REVERSE-TYPE HUMERAL PROSTHESIS

Background of Invention

The present invention relates generally to prosthetic joints, and more particularly to a shoulder prosthesis. The invention has specific application with respect to the humeral component of the shoulder prosthesis.

Conventional prostheses for the replacement of the shoulder joint include a segment engaged within the humerus bone and a mating articulating segment associated with the glenoid bone. In the typical shoulder prosthesis, the upper portion of the humerus is replaced by a unitary structure. This structure includes a stem designed to extend downwardly into a bore or cavity formed within the humerus. This stem is secured within the bone by bone cement or through the use of coatings configured to promote bone ingrowth to secure the stem in place. Again with the conventional prosthesis, the stem is attached to a body portion that is designed to replace portions of the humerus at the anatomical neck of the bone. A generally spherical head portion projects from a surface of the body. This spherical head mates with a complementary concave articulating component mounted within the glenoid.

In recent years, modular shoulder prostheses have been developed to account for the different anatomies of the shoulder joint among patients. For instance, differently sized prostheses are necessary to accommodate the different bone sizes of prospective patients. Similarly, different shoulder joints may require different angles of inclination of the articulating elements relative to the long axis of the humerus bone. Thus, a variety of modular prostheses have been developed that permit substitution of particular components of the prosthesis as necessary prior to implantation.

One problem faced by both the conventional and the modular shoulder prostheses is the deterioration of the shoulder joint that can accompany a shoulder arthroplasty. For instance, a patient who has undergone shoulder arthroplasty may experience loss of soft tissue and soft tissue strength, which can eventually lead to a total loss of key constraints that maintain the patency of the joint. This loss of soft tissue and soft tissue strength can allow unnatural joint loads to be produced, which can compromise the function of the prosthetic joint and/or lead to joint pain.

One solution for this problem is revision of the shoulder prosthesis. This revision can entail the substitution of different articulating components, or differently sized prosthetic components. In one treatment, the shoulder prosthesis is changed to a "reverse" type prosthesis. A typical prosthetic shoulder replicates the current anatomy of the joint. Specifically, the humeral component provides a convex articular surface, much like the natural end of the humerus. This convex surface mates with a concave glenoid component. A "reverse" type prosthesis essentially reverses the arrangement of the articulating surfaces. Specifically, the glenoid component includes a convex or partially spherical component, while the complementary concave surface is integrated into the humeral implants.

One consideration involved in the use of a reverse prosthesis is that the concave articular surface, that is now part of the humeral component, may actually protrude into the metaphyseal region of the humerus. This modified geometry can require modification of the metaphyseal portion of the bone as well as the prosthesis.

In order to address these needs, prior systems have required total revision of the joint. A total revision entails removal of the entire implant, including the stem that

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is fixed within the diaphyseal portion of the humerus. Of course, this surgical procedure is very difficult and invasive, and can place the patient and the shoulder joint at risk.

Reference to any prior art in the specification is not, and should not be taken as, an acknowledgment, or any form of suggestion, that this prior art forms part of the common general knowledge in Australia or any other jurisdiction or that this prior art could reasonably be expected to be ascertained, understood and regarded as relevant by a person skilled in the art.

As used herein, except where the context requires otherwise, the term "comprise" and variations of the term, such as "comprising", "comprises" and "comprised", are not intended to exclude other additives, components, integers or steps.

SUMMARY OF THE INVENTION

The invention contemplates a humeral component for a shoulder prosthesis that comprises a stem configured for implantation within the humerus bone, the stem including a proximal portion configured for positioning in the metaphysis of the humerus. The humeral component also comprises an articulating component including a support member and a bearing member removably mounted within the support member and defining a substantially concave articulating surface. A connection mechanism is provided for connecting the articulating component to the proximal portion of the stem. In a preferred embodiment, the connection mechanism is configured to permit connection of the articulating component at variable angles relative to the stem.

In one feature of the invention, the articulating component is mounted to the implanted stem so that the component is not engaged within the bone. In a preferred embodiment, the articulating component is situated outside the prepared end of the humerus. In an alternative embodiment, portions of the articulating component can reside within the envelop of the proximal end of the bone without being engaged to the component. Thus, the articulating component can be readily removed and replaced without disturbing the bone. This approach can be particularly useful in a trial procedure.

In one aspect of the invention, a kit can be provided which includes a plurality of differently configured support members and differently configured bearing members. The differently configured components can be combined to provide a reverse articulating element that is ideally suited for the patient's anatomy and that optimally emulates the original natural shoulder joint of the patient.

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5 In another aspect of the invention there is provided a humeral component for a shoulder prosthesis comprising: a stem configured for implantation within the humerus bone, the stem including a proximal portion configured for positioning in the metaphysis of the humerus; an articulating component including a support member and a bearing member removably mounted within said support member so that said articulating component does not engage the humerus bone, said bearing member defining a substantially concave articulating surface; and a connection mechanism operable to clamp said articulating component in relation to said proximal portion of said stem at any one of a plurality of angular positions.

0 In another aspect of the invention there is provided a humeral component of a shoulder implant, comprising: a stem configured for implantation within the humerus bone, said stem including a proximal portion configured for positioning in the metaphysis of the humerus; a reverse component kit including a combination of either; a support member and a plurality of bearing members; a plurality of support members and a bearing member; or a plurality of support members and a plurality of bearing members; and a connection mechanism associated with said support members and said proximal portion of said stem, operable to clamp any support member of said reverse component kit in relation to said proximal portion of said stem at any one of a plurality of angular positions, wherein each of said bearing members are configured for
5 removable engagement with each of said support members, each of said bearing members defines a substantially concave bearing surface, said plurality of support members are mutually differently configured, and said plurality of bearing members are mutually differently configured.
10

25 In another aspect of the invention there is provided a humeral prosthesis, comprising: a humeral implant having a stem configured to be implanted within a humerus; a bearing support; a bearing member coupled to said bearing support; and a connection mechanism operable to secure said bearing support in fixed relation to said humeral implant at any one of a plurality of angular positions, wherein said humeral implant has a cavity defined in a proximal position thereof, and wherein said connection
30 mechanism includes (i) a clamping member positioned within said cavity and having an internally threaded opening defined therein, and (ii) an adjustment screw positioned within said cavity and having an externally threaded member configured to meshingly engage with said internally threaded opening.

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5 In another aspect of the invention there is provided a humeral prosthesis, comprising: a humeral implant having a stem configured to be implanted within a humerus; a bearing support; a bearing member coupled to said bearing support; and a connection mechanism operable to secure said bearing support in fixed relation to said humeral implant at any one of a plurality of angular positions, wherein said connection mechanism includes a tapered member, wherein said bearing support has defined therein a tapered cavity, wherein said tapered member is configured to be received within said tapered cavity so as to form an interference connection between said bearing support and said tapered member.

0 In another aspect of the invention there is provided a humeral prosthesis, comprising: a humeral implant having a stem configured to be implanted within a humerus; a bearing support; a bearing member coupled to said bearing support; and a connection mechanism operable to secure said bearing support in fixed relation to said humeral implant at any one of a plurality of angular positions, wherein one of said 5 bearing member and said bearing support has defined therein a circumferential engagement recess, and wherein another of said bearing member and said bearing support includes a circumferential engagement rib configured to be received within said circumferential engagement recess.

10 In another aspect of the invention there is provided a humeral prosthesis, comprising: a humeral implant having a stem configured to be implanted within a humerus, said humeral implant having a receiving space defined in a proximal portion thereof; a bearing support having defined therein (i) a first cavity, and (ii) a tapered second cavity; a bearing member positioned within said first cavity; and a connection mechanism including (i) a clamping member positioned within said receiving space and 25 having an internally threaded opening defined therein, (ii) an adjustment screw positioned within said receiving space and having an externally threaded member configured to meshingly engage with said internally threaded opening, and (iii) a tapered member received in said tapered second cavity in a friction fit manner so as to form a mechanical connection between the bearing support and the tapered member.

30 In another aspect of the invention there is provided a method for implanting a humeral component of a shoulder prosthesis comprising the steps of: implanting a stem within a bore prepared in the proximal end of the humerus, the stem having a proximal

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5 end adjacent the prepared end of the bone; constructing a reverse component from
selected ones of a plurality of bearing members and bearing support members, each of
the bearing members defining mutually differently oriented bearing surfaces and each of
the support members having mutually differently configured connection mechanisms,
operable to connect any support member of said reverse component in relation to said
stem at any one of a plurality of angular positions, at least some of the connection
mechanisms permitting multiple degrees of freedom of orientation of the reverse
component relative to the stem; connecting the reverse component to the stem using
the connection mechanism; orienting the reverse component relative to the stem for
0 proper alignment with the glenoid component of the shoulder prosthesis; and fixing the
reverse component in position on the stem.

In certain embodiments, the support member defines an axis, and the connection mechanism is configured to connect the support member along that axis. The concave bearing surface can then adopt different orientations relative to that axis. For example, the bearing surface can define a central axis projecting from the centroid of the concave surface, in which the central axis is substantially aligned with the axis of the support member. Alternatively, the central axis can be laterally offset, angularly offset, or both, relative to the axis of the support member. These different reverse concave surface orientations can be produced by differences in the bearing member or differences in the support member.

In one preferred feature of the invention, the support member defines a cavity and the bearing member includes a body sized to fit within the cavity. The cavity of the support member and the body of the bearing member can define snap-fit features therebetween. For example, the snap-fit features can include a circumferential rim defined on the body and a complementary circumferential recess defined in the cavity. The snap-fit feature can also be accomplished by a snap-ring and groove arrangement in which both components are provided with a groove. Alternatively, the cavity of the support member and the body of the bearing member define a press-fit engagement therebetween.

In certain embodiments, the cavity and the body can also define an anti-rotation feature therebetween to prevent relative rotation between the support member and the bearing member. In other embodiments, the bearing member and support member can be connected to permit relative rotation between the two components about an axis projecting from the articulating surface of the bearing member.

The present invention contemplates a surgical procedure in which the stem of the humeral component is implanted within a humerus. The support member of the reverse articulating component can be mounted to the proximal end of the stem by way of the connection mechanism. The orientation of the articulating component can be fixed relative to the stem to produce an optimum prosthetic joint.

In some circumstances, a convex articulating element may be initially provided. In a revision procedure or during the initial shoulder arthroplasty procedure, the convex element can be removed and replaced with a reverse articulating component of the present invention. The component, or more specifically its bearing member and support member, can be selected from among a plurality of differently configured members to produce an artificial humeral joint implant that best fits the current anatomy of the patient.

It is one object of the invention to provide a humeral implant that can be readily altered based on the conditions of the patient's shoulder. Another object is to provide such a humeral implant that can be easily modified during an initial shoulder arthroplasty procedure or in a revision surgery. These and other objects and benefits will become apparent upon consideration of the following written description, along with the accompanying figures.

DESCRIPTION OF THE FIGURES

FIG. 1 is side elevational view of a humeral component of a shoulder prosthesis in accordance one prior art system.

FIG. 2 is a side elevational partial view of a humeral component of a shoulder prosthesis in accordance with one embodiment of the present invention.

FIG. 3 is a side view of a bearing member of the reverse prosthesis shown in **FIG. 2**.

FIG. 4 is side partial cross-sectional view of the humeral component of a shoulder prosthesis in accordance with a further embodiment of the present invention.

FIG. 5 is a perspective view of the bearing member of the humeral component shown in **FIG. 4**.

FIG. 6 is a bearing support of the humeral component shown in **FIG 4**.

FIG. 7 is an enlarged cross sectional view of an adjustable connection mechanism for use with the humeral component shown in **FIG. 4**.

FIG. 8 is a side elevational view of a reverse component for use with the humeral component shown in **FIG. 4**.

FIG. 9 is a side elevational view of an alternative embodiment of a reverse component for use with the humeral component shown in **FIG. 4**.

FIG. 10 is a side elevational view of yet another embodiment of a reverse component for use with the humeral implant shown in **FIG. 4**.

FIG. 11 is a side cross-sectional view of a further embodiment of a reverse component for use with the humeral implant shown in **FIG. 4**.

FIG. 12 is a side cross-sectional view of still another embodiment of a reverse component for use with the humeral implant shown in **FIG. 4**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

For the purposes of promoting an understanding of the principles of the invention, references will now be made to the embodiments illustrated in the drawings and described in the following written specification. It is understood that no limitation to the scope of the invention is thereby intended. It is further understood that the present invention includes any alterations and modifications to the illustrated embodiments and includes further applications of the principles of the inventions as would normally occur to one skilled in the art to which this invention pertains.

The context of the present invention can be understood with reference to a humeral component of a shoulder prosthesis of the prior art. For instance, a humeral implant **10**, as shown in **FIG. 1**, can include a stem **12** configured to be implanted within a bore prepared in the humerus bone. The proximal portion **14** of the stem is at the prepared proximal end of the bone. The proximal portion supports a prosthetic humeral head **16** by way of a connection mechanism **18**.

In this type of prior implant, the humeral implant carries a convex surface, such as the semi-spherical prosthetic head **16**. A complementary concave surface is supported by the glenoid. However, in some instances, difficulties arise in the shoulder anatomy of the patient, such as deterioration of the adjacent soft tissue, which makes the typical humeral component, such as the implant **10** shown in **FIG. 1**, problematic.

In order to address those circumstances, the present invention contemplates a "reverse-type" humeral implant. A reverse-type implant incorporates the concave surface of the humeral component, rather than the component supported by the glenoid. As a consequence, the convex bearing surface is carried by the glenoid. One embodiment of the present invention contemplates a humeral implant **20** as shown

in FIG. 2. The implant 20 can include a stem 22 that is configured similar to known stems, such as stem 12 shown in FIG 1. Specifically, the stem 22 is configured to be implanted in a bore prepared in the humerus bone. The stem can be implanted by way of a bone cement or can include a prepared surface that encourages or enhances bone ingrowth.

The proximal portion 24 of the stem 22 resides in the proximal or metaphyseal portion of the humerus bone. Typically, the proximal portion 24 is flared outwardly to emulate the increased cross sectional area of the humerus at its proximal end. In accordance with this embodiment of the invention, the proximal portion 24 supports an articulating component 26 by way of a universal connection mechanism 28. In accordance with one aspect of the invention, the articulating component is a reverse-type component.

The universal connection mechanism 28 can be configured to permit three-dimensional orientation of the reverse component 26 relative to the proximal portion 24 of the stem. More specifically, the universal connection mechanism 28 allows the reverse component to be oriented at an angle relative to the longitudinal axis of the humerus that is dictated by the anatomy of the patient's natural shoulder. The object, of course, is for the resulting shoulder prosthesis to accurately replicate the movement of the patient's natural shoulder. In accordance with one specific embodiment, the universal connection mechanism 28 can constitute a socket 30 defined in the proximal portion 24 of stem 22. A ball element 32 is connected to the reverse component 26. The ball is configured for articulating bearing movement within the socket 30. Means can be provided within the ball and socket arrangement to fix the two components relative to each other.

In accordance with one aspect of the invention, the reverse component **26** can include a support cup **34** that can be connected to the ball element **32** by way of a post **36**. In one embodiment, the support cup **34**, post **36** and ball element **32** are integrally formed. In an alternative embodiment, the post is integral with either the ball element or the support cup, and a fixation element is used to connect the two components together.

The support cup **34** defines a recess **38** for receiving a bearing member **40** therein. With reference to **FIG. 3**, it can be seen that the bearing member in accordance with one embodiment of the present invention constitutes an insert body **42** that fits within the recess **38** of the support cup **34**. Preferably, the insert body **42** includes a plurality of anti-rotation features **44** that can be in the form of circumferentially spaced ribs. These ribs can fit within corresponding complementary features defined in the recess **38**. Alternatively or in addition, both the insert body **42** and the anti-rotation features **44** can form a press-fit engagement with the recess **38**.

The bearing member **40** includes a circumferential rim **46** that fits or bears against the proximal edge of the support cup **34**. The bearing member **40** further defines an articulating surface **48** that is concave, in the form of the reverse-type component contemplated for the present invention.

In accordance with one feature of the invention, the bearing member **40** allows for a variety of geometries for the articulating surface **48**. In the illustrated embodiment of **FIGS. 2** and **3**, the surface **48** is generally spherical and is symmetrically positioned around the positioning axis A (see **FIG. 2**) of the reverse component **26**. Moreover, the shape of the articulating surface **48** can be modified from the spherical shape shown in **FIG. 3**.

An alternative embodiment of the invention is shown in **FIGS. 4 –10**. A humeral implant **50** includes a stem **52**, that can be similar to the stem **22** described above. The stem **52** includes a proximal portion **54** that can also be similar to the corresponding proximal portion **24** of the stem **22**. However, in accordance with the preferred features of this embodiment, the proximal portion **54** includes angulation relief portions **54A** and **54B** at the medial and lateral aspects, respectively, of the proximal portion. These relief portions **54a**, **54b** represent areas of the proximal portion **24**, shown in dashed lines in **FIG. 4**, that are removed from the proximal portion **54** of the humeral implant **50**. These relief portions allow for different angular positions of an articulating component **56**, as described in more detail herein.

As with the previous embodiment, the articulating component **56** is a reverse-type component. The component **56** is connected to the stem **52** by way of an adjustable connection mechanism **58**. Preferably, the adjustable connection mechanism permits three-dimensional movement and orientation of the reverse component **56** relative to the stem **52**, and ultimately the humerus bone. As explained above, the adjustable connection mechanism **58** can allow fine tuning of the position of the reverse component **56** relative to the complementary glenoid component of the shoulder prosthesis. This optimum orientation can be determined intra-operatively or can be predetermined and verified by pre-surgery x-rays demonstrating the anatomy of the patient's natural shoulder.

As shown in more detail in **FIGS. 5** and **6**, the reverse component **56** includes a bearing member **60** (**FIG. 5**) mounted on a bearing support **62** (**FIG. 6**). The bearing member **60** defines a bearing or articulating surface **64** that corresponds to the articulating surface **48** of the bearing member **40** of the previous embodiment. The

bearing surface **64** is configured to mate with a corresponding convex surface associated with the glenoid component of the shoulder prosthesis.

In the preferred illustrated embodiment, the bearing member **60** includes a hub **56** projecting below the bearing surface **64**. A circumferential engagement rib **68** can be defined along the length of the hub **66**, as shown in **FIG. 5**. The bearing support **62** then defines a cavity **70** that is sized to receive the hub **66** of the bearing member **60**. In addition, the cavity **70** defines a circumferential engagement recess **72** that is configured to receive the engagement rib **68** of the bearing member **60**. In one aspect of the invention, engagement rib **68** and hub **66** can be configured for a snap-fit engagement within the corresponding recess **72** and cavity **70**. In addition, the hub cavity can incorporate press-fit features, such as mating Morse tapers.

In accordance with the preferred embodiment, the two members of the reverse component **56**, namely the bearing member **60** and the bearing support **62**, can be formed of a biocompatible, but strong, material. The bearing support **62** can be a metal, while the bearing member **60** can be formed of a non-metallic material that provides a smooth and long-life articulating bearing surface. Preferably, the engagement ribs **68** of the bearing member **60** is formed of a material that can be slightly deformed to allow the rib to be snapped through the cavity **70** and into the engagement recess **72** of the bearing support **62**.

As indicated above, the reverse component **56** is mounted to the stem **52** of the humeral implant **50** by way of an adjustable connection mechanism **58**. The adjustable connection mechanism can take on a variety of forms that permit varying degrees of positional adjustment of the reverse component relative to the stem. In the preferred embodiment, the adjustable connection mechanism **58** allows the reverse

component **56** to be aligned at a wide range of conical angles relative to the stem **52**. One specific adjustable connection mechanism **58** is shown in detail in **FIG. 7**. In particular, the proximal portion **54** of the stem **52** can define an adjustment cavity **80**. A clamping member **82** is slidably disposed within the cavity **80**. An adjustment screw **84** is threadedly engaged with the clamping member **82**. The adjustment screw **84** can include an internal drive feature that allows the screw to be extended into contact with the cavity **80** once the appropriate position of the reverse component **56** has been accomplished. As the adjustment screw is driven into contact with the cavity, it tends to push the clamping member **82** upward and also into contact with the cavity.

The clamping member **82** and the bearing support **62** can incorporate a press-fit interface **86** to allow the two components to be engaged together. Alternatively, the clamping member **82** can be integrally formed with the bearing support **62**. However, in the embodiment illustrated in **FIG. 7**, a Morse-taper provides the press-fit interface **86** between the two components. In order to allow access to the adjustment screw **84**, the bearing support **62** defines an access opening **74**, shown in **FIGS. 6** and **7**. Thus, a driving tool can be passed through the access opening **74** to engage the screw **84**. Once the position of the reverse component **56** has been established, the screw **84** can be tightened to push the screw **84** and the clamping member **82** into clamping engagement with the wall of the adjustment cavity **80**.

Referring still to **FIG. 7**, it can be seen that the angulation relief **54b** allows the bearing support **62** to be pivoted toward the right in **FIG. 7** through a significant angle before contacting the proximal portion **54**. In the illustration of **FIG. 7**, the medial relief portion **54a** has not been depicted, since the stem **52** can be modified depending upon the degree and direction of angulation desired between the reverse component **56**

and the stem **52**. However, in the preferred instance, the reverse component **56** can be tilted both medially and laterally, as reflected by the different axis lines **A'** and **A''** shown in **FIG. 4**. It should also be understood that the adjustable connection mechanism **56** can also allow angulation into and out of the plane of the figure for the arrangement shown in **FIGS. 4** and **7**.

In a further feature of the invention, it is contemplated that the reversible component **56** can be provided in variety of configurations. For instance the reverse component can appear in the different configuration shown in **FIGS. 8-10**. The reverse component **56** shown in **FIG. 8** is generally uniform and symmetric about the central axis **A**. The bearing surface **64** is uniformly concave, and preferably spherical. On the other hand, as shown in **FIG. 9**, the centroid of the bearing surface **A** can be offset from the line of engagement between the reverse component **56** and the proximal portion **54** of the stem **52**. Thus, the centroid of the bearing surface **91** of the reverse component **90** shown in **FIG. 9** can be offset by a gap **G**.

Similarly, the angulation of the bearing surface can be modified from perpendicular. Thus, the reverse component **94** can include a bearing surface **95** that is aligned at an offset angle α relative to the centerline of the reverse component. It should be understood that the orientation and configuration of the various bearing surfaces can be modified further still depending upon the particular anatomical requirements for the shoulder prosthesis. For instance, the bearing surface **95** can be shallower or deeper, to mate with a correspondingly configured convex component engaged to the glenoid. In addition, the bearing surface can be offset within the reverse component itself. In this instance, a common bearing support, such as support **62**, can

be provided for engagement with a variety of different bearing members, such as bearing members 60.

It should be understood that the humeral implant 50 in accordance with the present invention provides a great degree of flexibility intraoperatively. Thus, a surgeon can readily substitute components of the implant as necessary to accommodate the natural anatomy surrounding the shoulder prosthesis. Not only can the orientation of the reverse component be controlled, the configuration of the articulating or bearing surface can also be controlled and modified intraoperatively. One beneficial feature of the invention is that the articulating component, such as reverse components 26 and 56, do not engage the patient's bone. While portions of the components may reside within the envelope defined by the proximal end of the bone, the components are free to move, thus allowing the components to be repositioned or even replaced. This feature makes the present invention particularly suited for trial procedures, as well as for revisions surgeries.

In accordance a surgical method of the present invention, it is contemplated that the humerus is modified to accept the humeral implants described above. In a shoulder arthroplasty, the head of the humerus can be resected to roughly match the implant neck-to-bone shaft angle. The bone canal can be prepared to receive the stem or trial, depending upon the particular surgical procedure. Once the stem is appropriately implanted, a first approach may be to provide a standard convex humeral head prosthesis, engaged to the proximal end of the stem by way of an adjustable connection mechanism, such as the mechanism described above. The humeral head prosthesis can be adjusted and locked in place at an appropriate angle

relative to the stem. In many cases, this standard procedure may be sufficient so the standard convex humeral component can remain in place.

However, under certain circumstances the need for a reverse prosthesis may be identified. For instance, if there is joint destruction in the glenoid, soft tissue laxity (such as comprise of the rotator cuff), fracture, or some other instability in the natural shoulder tissue, then the prosthesis can be identified as a candidate for the reverse component. The convex humeral head prosthesis can be removed in anticipation of the addition of a reverse component, such as the components 26 or 56 described above. Since the articular angle is essential to proper functioning of the shoulder prosthesis, additional resection of the proximal portion of the humerus may be required. For instance, additional resection may be necessary if a particularly large articular angle is necessary between the bearing surface of the reverse component and the longitudinal axis of the bone shaft. Once the proximal end of the bone is appropriately prepared, the reverse component can be engaged to the stem and fixed at an appropriate position.

In a preferred method of the invention it is contemplated that the determination of the need for the reverse components would be made intraoperatively during the shoulder arthroplasty procedure. At that point, the particular reverse component can be selected and mounted to the proximal end of the stem by way of an adjustable connection mechanism. However, in some instances, the implantation of the reverse components may be as a result of modification surgery. In a modification procedure, the shoulder implant is modified long after the original arthroplasty procedure has been preformed. Such a modification surgery may arise due to deterioration of the soft tissue surrounding the shoulder prosthesis. In this instance, the

modification procedure is greatly simplified by the use of the modular components of the humeral implant, such as the implants **20** and **50**. It can be readily appreciated that an existing convex humeral head prosthesis can be removed intraoperatively and readily replaced with one of the reverse components described above. This modification can occur without the need for removing the stem of the humeral implant.

In one aspect of the invention, a humeral component kit can be provided. The kit can include a number of stems, such as stem **52**, having different lengths and angles at the proximal portion. In addition, a number of support members, such as members **62**, can be provided that incorporate different offsets and angular orientation. Likewise, a number of bearing members, such as member **60**, can also be included in the kit. The number of bearing members can have different bearing surface configurations and orientations. For instance, a kit can include members sufficient to construct each of the reverse components **56**, **90**, and **94**, shown in **FIGS. 8-10**, as well as other reverse component configurations.

While the invention has been illustrated and described in detail in the drawings and foregoing description, the same should be considered as illustrative and not restrictive in character. It is understood that only the preferred embodiments have been presented and that all changes, modifications and further applications that come within the spirit of the invention are desired to be protected.

For instance, the reverse component **56** is illustrated in **FIGS. 4-6** with the bearing member including a hub **66** and the support member including a cavity **70**. In an alternative embodiment, the hub and cavity elements can be reversed on the two components, as shown in **FIG. 11**. A reverse component **100** can include a bearing member **102** and a bearing support **104**. The bearing support **104** can define a hub

106 having a circumferential rib **108** projecting therefrom. The bearing member **102** can include a circumferential skirt **110** that is sized to fit snugly over the hub **106**. The skirt defines an interior circumferential recess **112** that is configured for snap-fit engagement with the rib **108**.

As a further alternative, a reverse component **120** can include a bearing member **122** and a bearing support **124**, as shown in **FIG. 12**. Like the embodiment in **FIG. 11**, the bearing member **122** can include a circumferential skirt **130** that defines an interior circumferential recess **132**. The bearing support **124** can also include a hub **126** that fits snugly within the skirt **130**. In contrast to the embodiment of **FIG. 11**, the hub **126** defines a circumferential recess or groove **128** that is coincident with and facing the recess **132** in skirt **130**. A snap-ring **134** is provided that snaps into both recesses **128**, **132** to hold the two parts of the reverse component **120** together.

With the embodiments shown in **FIGS. 11** and **12**, the bearing member can be engaged to the bearing support to permit relative rotation between the two parts. For example, the snap-ring **134** can fit within the facing recesses **128**, **132** so that the snap-ring only prevents separation of the members but still allows them to rotate relative to each other. In some embodiments, a certain amount of "play" can be incorporated into the snap-ring and recesses so that the members can translate slightly relative to each other. These same degrees of freedom and restriction can be implemented in the embodiments of **FIGS. 4-10** as well.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A humeral component for a shoulder prosthesis comprising:

a stem configured for implantation within the humerus bone, the stem including a proximal portion configured for positioning in the metaphysis of the humerus;

an articulating component including a support member and a bearing member removably mounted within said support member so that said articulating component does not engage the humerus bone, said bearing member defining a substantially concave articulating surface; and

a connection mechanism operable to clamp said articulating component in relation to said proximal portion of said stem at any one of a plurality of angular positions.

2. The humeral component according to claim 1, wherein said connection mechanism is configured to permit connection of said articulating component at variable angles relative to said stem.

3. The humeral component according to claim 1 or 2, wherein:

said support member defines an axis; and

said connection mechanism is configured to connect said support member along said axis.

4. The humeral component according to claim 3, wherein said concave bearing member defines a central axis projecting from said concave surface, said central axis being substantially aligned with said axis of said support member.

5. The humeral component according to claim 3, wherein said concave bearing member defines a central axis projecting from said concave surface, said central axis being substantially parallel to and offset from said axis of said support member.

6. The humeral component according to claim 3, wherein said concave bearing member defines a central axis projecting from said concave surface, said central axis being non-parallel with said axis of said support member.

7. The humeral component according to any one of the preceding claims, wherein:

one of said support member and said bearing member defines a cavity; and the other of said support member and said bearing member includes a body sized to fit within said cavity.

8. The humeral component according to claim 7, wherein said cavity and said body define snap-fit features therebetween.

9. The humeral component according to claim 8, wherein said snap-fit features include:

a first circumferential recess defined on said body;

a second circumferential recess defined in said cavity coincident with said first recess defined in said body; and

a snap-ring configured for snap-fit engagement within first and second recesses.

10. The humeral component according to claim 8, wherein said snap-fit features include:

a circumferential rim defined on said body; and

a complementary circumferential recess defined in said cavity.

11. The humeral component according to claim 7, wherein said cavity and said body define a press-fit engagement therebetween.

12. The humeral component according to claim 7, wherein said cavity and said body define an anti-rotation feature therebetween to prevent relative rotation between said support member and said bearing member.

13. A humeral component of a shoulder implant, comprising:

a stem configured for implantation within the humerus bone, said stem including a proximal portion configured for positioning in the metaphysis of the humerus;

a reverse component kit including a combination of either;

a support member and a plurality of bearing members;

a plurality of support members and a bearing member; or

a plurality of support members and a plurality of bearing members; and

a connection mechanism associated with said support members and said proximal portion of said stem, operable to clamp any support member of said reverse component kit in relation to said proximal portion of said stem at any one of a plurality of angular positions,

wherein each of said bearing members are configured for removable engagement with each of said support members,

each of said bearing members defines a substantially concave bearing surface, said plurality of support members are mutually differently configured, and said plurality of bearing members are mutually differently configured.

14. The humeral component according to claim 13, wherein said plurality of bearing members of said reverse component kit define said concave bearing surface at mutually different angular orientations relative to said support members when said bearing members are engaged to said support members.

15. The humeral component according to claim 13 or 14, wherein:

each of said support members defines an axis and said connection mechanism is configured to connect said support members along said axis.

16. The humeral component according to claim 15, wherein said plurality of bearing members of said reverse component kit define said concave bearing surface at mutually different angular orientations relative to said axis.

17. The humeral component according to claim 15, wherein said plurality of bearing members of said reverse component kit define said concave bearing surface such that said bearing surface defines a central axis that is offset from said axis of said support members.

18. The humeral component according to any one of claims 13 to 17, wherein each of said support members and each of said bearing members define mutually snap-fit features.

19. The humeral component according to claim 18, wherein said mutually snap-fit features include a circumferential rim defined on said body and a complementary circumferential recess defined in said cavity.

20. A humeral prosthesis, comprising:

a humeral implant having a stem configured to be implanted within a humerus;

a bearing support;

a bearing member coupled to said bearing support; and

a connection mechanism operable to secure said bearing support in fixed relation to said humeral implant at any one of a plurality of angular positions,

wherein said humeral implant has a cavity defined in a proximal position thereof, and

wherein said connection mechanism includes (i) a clamping member positioned within said cavity and having an internally threaded opening defined therein, and (ii) an adjustment screw positioned within said cavity and having an externally threaded member configured to meshingly engage with said internally threaded opening.

21. The humeral prosthesis of claim 20, wherein:

said cavity possesses a truncated spherical configuration, and
said clamping member possesses a partially spherical outer surface.

22. The humeral prosthesis of claim 20 or 21, wherein:

said connection mechanism further includes a tapered member,
said bearing support has defined therein a tapered cavity,

said tapered member is configured to be received within said tapered cavity so as to form an interference connection between said bearing support and said tapered member,

said tapered member has a passageway defined therethrough that is axially aligned with said internally threaded opening,

said adjustment screw has a driver orifice configured to receive a driver tool therein, and

said driver orifice is located within said internally threaded opening.

23. A humeral prosthesis, comprising:

a humeral implant having a stem configured to be implanted within a humerus;

a bearing support;

a bearing member coupled to said bearing support; and

a connection mechanism operable to secure said bearing support in fixed relation to said humeral implant at any one of a plurality of angular positions,

wherein said connection mechanism includes a tapered member,

wherein said bearing support has defined therein a tapered cavity,

wherein said tapered member is configured to be received within said tapered cavity so as to form an interference connection between said bearing support and said tapered member.

24. The humeral prosthesis of claim 23, wherein said tapered member has a passageway defined therethrough that is axially aligned with said internally threaded opening.

25. A humeral prosthesis, comprising:

a humeral implant having a stem configured to be implanted within a humerus;

a bearing support;

a bearing member coupled to said bearing support; and

a connection mechanism operable to secure said bearing support in fixed relation to said humeral implant at any one of a plurality of angular positions,

wherein one of said bearing member and said bearing support has defined therein a circumferential engagement recess, and

wherein another of said bearing member and said bearing support includes a circumferential engagement rib configured to be received within said circumferential engagement recess.

26. A humeral prosthesis, comprising:

a humeral implant having a stem configured to be implanted within a humerus, said humeral implant having a receiving space defined in a proximal portion thereof;

a bearing support having defined therein (i) a first cavity, and (ii) a tapered second cavity;

a bearing member positioned within said first cavity; and

a connection mechanism operable to secure said bearing support in fixed relation to said humeral implant at any one of a plurality of angular positions, including (i) a clamping member positioned within said receiving space and having an internally threaded opening defined therein, (ii) an adjustment screw positioned within said receiving space and having an externally threaded member configured to meshingly engage with said internally threaded opening, and (iii) a tapered member received in said tapered second cavity in a friction fit manner so as to form a mechanical connection between the bearing support and the tapered member.

27. The humeral prosthesis of claim 26, wherein:

said tapered member has a passageway defined therethrough that is axially aligned with said internally threaded opening,

said adjustment screw has a driver orifice configured to receive a driver tool therein, and

said driver orifice is located within said internally threaded opening.

28. The humeral prosthesis of claim 27, wherein said bearing member covers said tapered second cavity of said bearing support when said bearing member is received within said first cavity of said bearing support.

29. A method for implanting a humeral component of a shoulder prosthesis comprising the steps of:

implanting a stem within a bore prepared in the proximal end of the humerus, the stem having a proximal end adjacent the prepared end of the bone;

constructing a reverse component from selected ones of a plurality of bearing members and bearing support members, each of the bearing members defining mutually differently oriented bearing surfaces and each of the support members having mutually differently configured connection mechanisms, operable to connect any support member of said reverse component in relation to said stem at any one of a plurality of angular positions, at least some of the connection mechanisms permitting multiple degrees of freedom of orientation of the reverse component relative to the stem;

connecting the reverse component to the stem using the connection mechanism;

orienting the reverse component relative to the stem for proper alignment with the glenoid component of the shoulder prosthesis; and

fixing the reverse component in position on the stem.

30. A humeral component of a shoulder prosthesis, the component being substantially as described herein with reference to Figures 2 to 12 of the accompanying drawings.

31. A method for implanting a humeral component of a shoulder prosthesis, the method having the steps substantially as hereinbefore described.

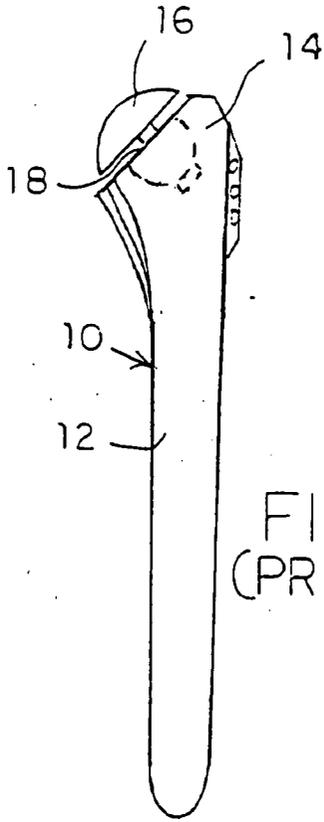


FIG. 1
(PRIOR ART)

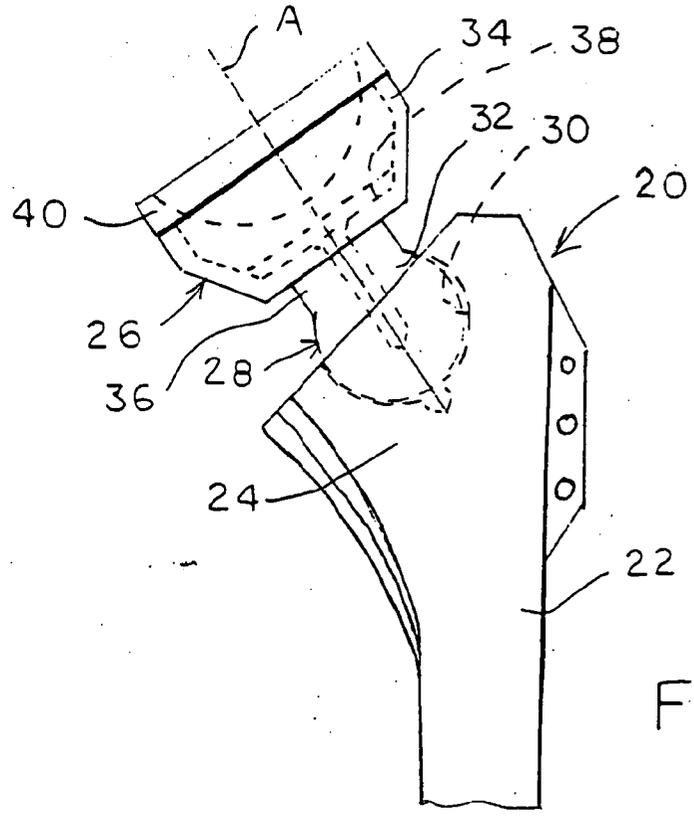


FIG. 2

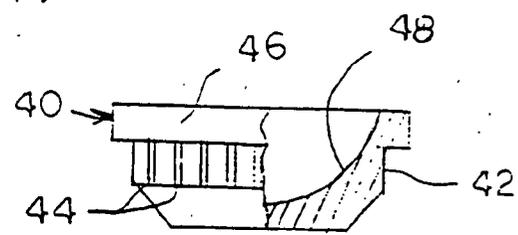


FIG. 3

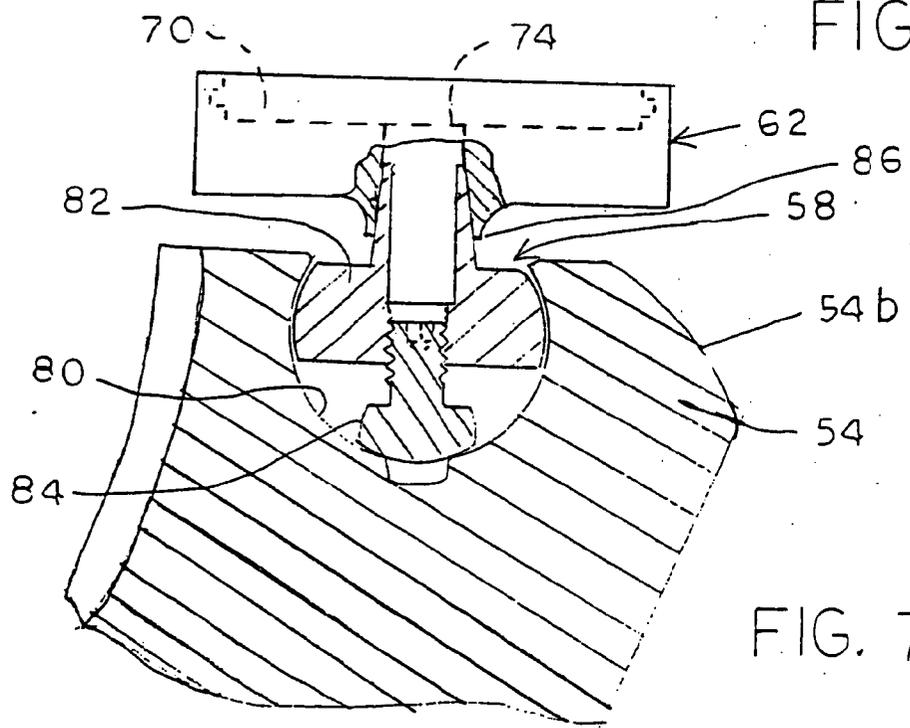


FIG. 7

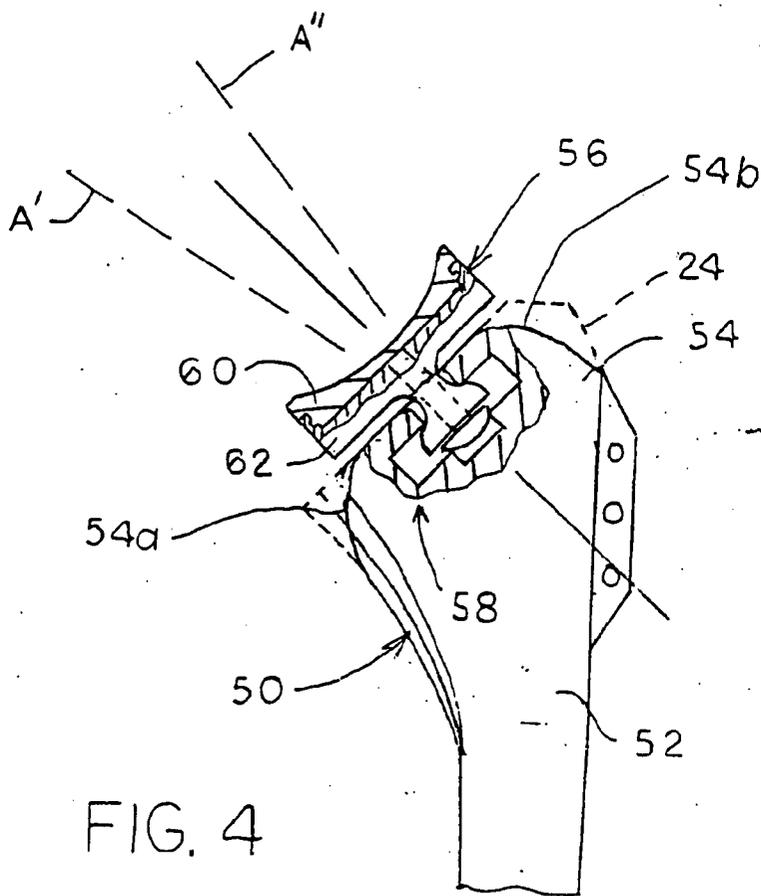


FIG. 4

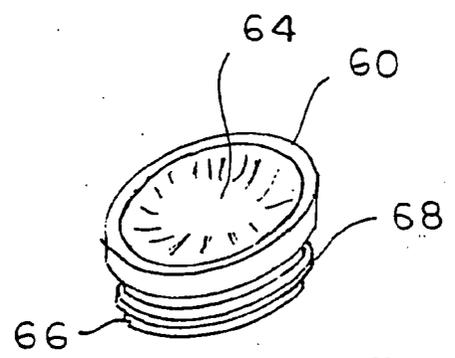


FIG. 5

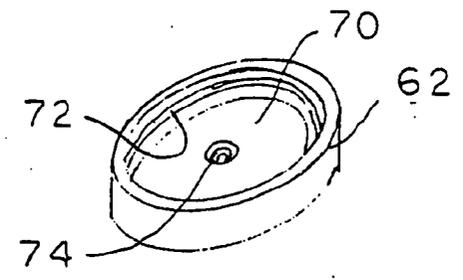


FIG. 6

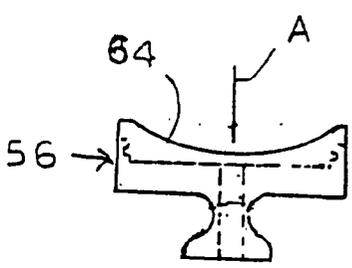


FIG. 8

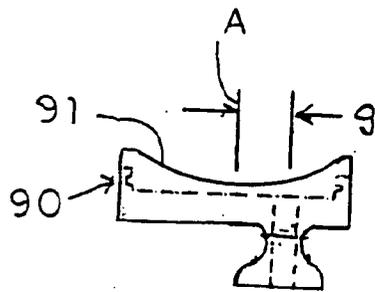


FIG. 9

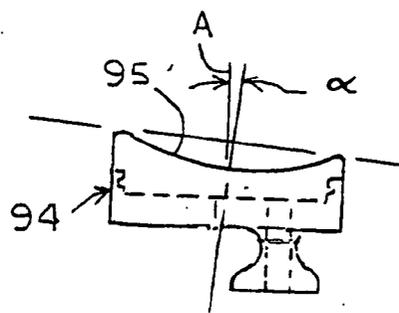


FIG. 10

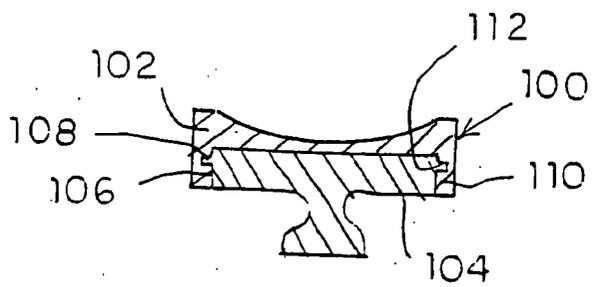


FIG. 11

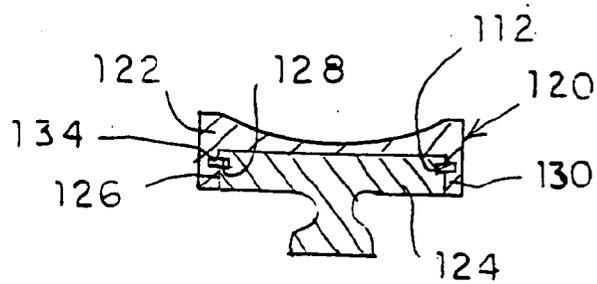


FIG. 12