



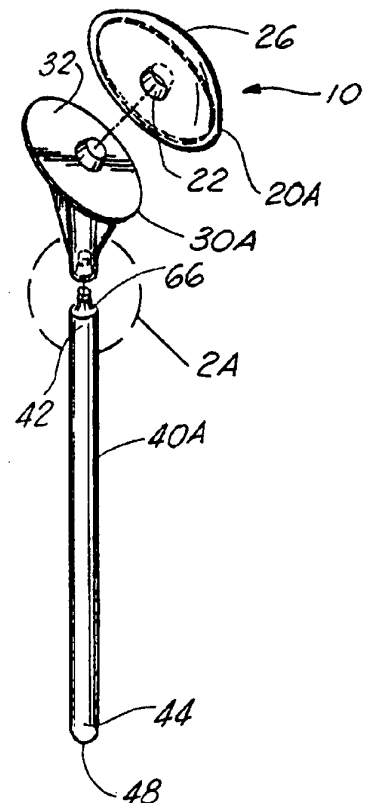
## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(54) Title: MODULAR HUMERAL COMPONENT SYSTEM

(57) Abstract

A modular humeral prosthesis (10) that can be custom fitted to a particular patient by interchanging sizes of the various components by a surgeon inter-operatively. The prosthesis (10) features a humeral head (26) having a hemispherically shaped outer surface for placement within the glenoid cavity, the head (26) including on its undersurface a recessed center portion having a first cooperating connecting means (22). The body (30A) has a proximal end and a distal end, with the proximal end including an angled platform (32) having a second cooperating connecting means (34) for engagement with the first connecting means, and the distal end having a third cooperating connecting means (37). The body (30A) also includes a plurality of fins (54). A cylindrical primary stem (40A) has a proximal cooperating connecting means (66) for engagement with the third connecting means, and the distal end having a fourth cooperating connecting means (76).



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**MODULAR HUMERAL COMPONENT SYSTEM****SPECIFICATION****FIELD OF THE INVENTION**

The present invention relates to an improved modular humeral prosthetic system where various component parts of the prosthetic implant can be selected during the surgical procedure in order to custom fit the implant to a patient, even in revision cases wherein components of differing diameters can connect together such as when proximal tissue is eroded with removal of the old prosthesis.

**BACKGROUND OF THE INVENTION**

Increasingly surgeons want to be able to custom fit humeral prosthesis to patients. Instead of having to choose a properly sized prosthesis from a group of preformed implants, it would be advantageous to have a basic design which can be modified with various component parts. This would eliminate the need to maintain a large inventory and would provide better fitting implants.

Custom fitted implants are particularly important in revision cases where an implant has to be removed and replaced. In this situation old cement must be removed and, in many cases, bone reabsorption occurs causing unpredictable proximal and/or distal bone loss or deformity which must be accommodated by the replacement prosthesis.

For initial implants, basic variations in patient anatomy are often confronted by the surgeon. Known humeral prosthetic implants do not achieve true anatomic compatibility with the proximal end of the humerus and do not provide the capability for modification of the humeral head size during surgery other than by replacement of the entire implant. Some patients have

humeral necks that can be significantly longer or shorter than others. Also, shaft defects, which are not uncommon, are often not discovered until surgery. Variations in intramedullary canal diameter can also occur, which if not  
5 accompanied by a properly sized implant, can result in distal toggle. Currently available modular heads only fill the joint space of the glenoid cavity and not the proximal humeral bone cavity. Additionally, a patient's humeral anatomy can exhibit a wide proximal humeral cavity with a distal medullary canal  
10 that is half the size. Current humeral prosthesis do not allow for this type of mismatch.

Prior humeral prosthetic implants in use have a stem portion for implantation within the medullary canal of a human humerus and a head portion for engagement within the glenoid  
15 cavity of the human scapula. Such implants do not, however, achieve true anatomic compatibility with the proximal end of the human humerus, and do not provide a capability for modification of the stem during surgery other than by replacement of the entire implant.

A modular humeral prosthesis is known which is formed of a humeral stem and a head component which is readily attachable and detachable to and from each other for allowing  
20 intraoperative modifications of the implant. U.S. patent 4,919,607 entitled "Modular Humeral Prosthesis" issued to Dale et al. describes a modular prosthetic device which is anatomically compatible with the proximal human humerus and scapula and provides a modular head mechanism that can be interchangeable. U.S. patent 4,865,605 entitled "Modular  
25 Shoulder Prosthesis" issued to Dines et al describes a shoulder prosthesis which includes a humeral component and a glenoid component. These patents describe modular prosthesis which have only a head component and a stem component.

None of these modular humeral components address the problem of proximal humeral canal fill or variations in  
35 intramedullary canal diameter or length. This problem frequently occurs in revision cases wherein bone cement held an older prosthesis. The multiple part modular system of the present invention allows a surgeon to exchange parts intraoperatively to achieve optimal fixation of a humeral  
40 prosthesis, such as in revision cases wherein bone cement

causes bone tissue removal upon removal of an earlier prosthesis.

The object of the invention therefore is to provide modular humeral prosthetic components which are anatomically compatible with the scapula, the proximal humerus and the distal stem portion of the humerus.

Another object of the invention is to provide a modular humeral prosthetic system of component parts which reduces the number of standard components and custom devices needed to achieve optimal fixation.

#### SUMMARY OF THE INVENTION

The present invention solves the problems discussed above by providing modular humeral prosthetic components which can be custom fitted to a particular patient by a surgeon prior to and during surgical insertion of the prosthesis. The component parts allow the surgeon to exchange the pieces intraoperatively to achieve optimal fixation.

The prosthesis includes a head which lies in the glenoid cavity, a body that is placed in the proximal end of the humerus, and a primary and secondary stem which fits in the humeral canal. The head attaches to a platform on the proximal end of the body and the primary stem attaches to the distal end of the body with a male/female locking mechanism. The secondary stem attaches to the primary stem with male/female locking mechanism. In a preferred embodiment the male/female locking mechanism is anti-rotational.

The head has a hemispherically shaped outer surface that fits within the glenoid cavity of a human scapula. The undersurface of the head has a recessed center portion which contains a female locking mechanism for connecting with a male locking mechanism on the platform at the proximal end of the body. The recessed center allows the platform to fit within the humeral head.

The body is a unitary cone shaped structure with the conical flare extending from its distal end. The platform mounted on the proximal end of the body is generally circular. A male locking mechanism is centrally located on the platform for connecting with the head of the modular humeral prosthesis. The platform is angled relative to the central longitudinal axis of the body.

Mounted on the body are four fins which run from the distal portion of the body to the platform at the proximal end. These four fins are evenly spaced along the axis of the body. The distal end of the body has a female locking mechanism for connecting with the male locking mechanism on the primary stem.

The primary stem of the modular humeral component system is cylindrical and has a proximal end with a male locking mechanism for connection with the distal end of the body. The distal end of the stem may have either a tip for insertion into the medullary canal of a resected human humerus or a female locking mechanism for connecting to a secondary stem.

The secondary stem is cylindrical and has a proximal end with a male locking mechanism for connecting to the primary stem and a rounded or bullet shaped tip at its distal end. The primary and secondary stem may have transverse bores or slots extending through the stem to receive fixation screws.

In a preferred embodiment, the modular humeral components are made from a biocompatible material. The head may come in a variety of sizes, both in height and diameter. The body may come in a variety of cross-sectional diameter sizes and in a preferred embodiment the platform diameter of the various body sizes is generally uniform. The primary and secondary stems of the system may come in a variety of lengths and diameter sizes and the distal ends may be either bullet shaped or rounded, or squared off with a female locking mechanism. The male/female locking mechanism on all the body/stem components is of the same diameter and may have a two-way connection such that the components can be used as left or right side implants. In a preferred embodiment of the system, all of the component parts are interchangeable.

In an alternate embodiment, the body and primary stem may be one piece with the distal end of the stem having a female locking mechanism for connecting to a secondary stem. In another alternate embodiment, the body and primary stem may be one piece but of a smaller cross-sectional diameter for use in the humerus of a child or small adult.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The objects, advantages and features of the invention will become more apparent when the detailed description of

exemplary embodiments is considered in conjunction with the appended drawings, in which:

Figure 1 is a frontal view of a modular humeral prosthesis according to the present invention as shown being  
5 implanted in the medullary canal of a human humerus;

Figures 2-4 are perspective exploded views illustrating the preferred embodiment of the apparatus of the present invention in different stem diameters;

Figure 2A is an enlarged fragmentary view of the  
10 preferred embodiment of the apparatus of the present invention illustrating the respective cooperating connector portions between adjacent components;

Figure 2B is a section view taken along lines 2B-2B of Figure 2A;

15 Figure 5 is a perspective view illustrating an alternate embodiment of the apparatus of the present invention for use with small children;

Figure 6 is a fragmentary view of the preferred  
20 embodiment of the apparatus of the present invention illustrating primary and secondary stem portions;

Figure 7 is a fragmentary view of the preferred  
embodiment of the apparatus of the present invention illustrating a primary and secondary stem portions;

25 Figure 8 is a fragmentary view of primary and secondary stem portions for use with the preferred embodiment of the apparatus of the present invention;

Figure 9 is a partial sectional view of the preferred  
embodiment of the apparatus of the present invention;

30 Figure 10 is a fragmentary perspective view of the preferred embodiment of the apparatus of the present invention showing the prosthesis head portion thereof;

Figure 11 is a fragmentary side view of the preferred  
embodiment of the apparatus of the present invention showing the body portion thereof; and

35 Figure 12 is an exploded plan view of the preferred embodiment of the apparatus of the present invention.

#### DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Referring to Figure 1, reference letter A identifies the  
40 arm of a patient which has been surgically opened to expose the humerus H. A modular humeral prosthesis 10 is being

implanted into the humerus H. A dotted line 11 illustrates the path of the humeral prosthesis 10 as it is implanted into the humerus H of the patient.

5 As shown in Figure 2, the modular humeral prosthesis 10 has a head 20A, a body 30A, and a primary stem 40A. The head 20A has a hemispherically shaped outer surface 26 for placement within the glenoid cavity of a human scapula, the outer spherical surface 26 being, for example, less than half the surface of a complete sphere.

10 As shown in Figure 10, the undersurface 24 of the head 20A has a recessed center 28 which contains a centrally located female locking mechanism 22 for engagement with a correspondingly shaped male locking mechanism 34 on a platform 32 of body 30A of the modular humeral prosthesis 10. The  
15 recessed center 28 allows the platform 32 of the body 30A to fit within the head 20A.

Body 30A of the modular humeral prosthesis 10 has a proximal end 35 and a distal end 36 (see Figure 11). The body 30A is a unitary, generally cone shaped structure with the  
20 conical flare extending from the distal end 36 of the body 30A to its proximal end 35. A generally circular platform 32 is mounted on the proximal end 35 of the body 30A. The platform 32 is angled relative to the central longitudinal axis of the body 30A and an attached cylindrical stem 40A (see Figures 2  
25 and 9).

The platform 32 has a centrally located male locking mechanism 34 for engagement with the female locking mechanism 22 of the head 20A. The platform 32 also prevents the modular humeral prosthesis 10 from subsiding within the medullary  
30 canal of the humerus H. Body 30A has four fins 33 which are preferably evenly spaced circumferentially along the central longitudinal axis of the body 30A. As best shown in Figure 11, fins 33 have one side 31 integral with the body 30 and extend a predetermined length distally from the underside 38  
35 of the platform 32. Fins 33 extend outwardly to restrict rotational movement of the implant. Fin 33A is on the medial side of the body portion 30 and fins 33B and 33D (not shown) extend from the mid-line of body portion 30. Fin 33C extends from the lateral side of body portion 30. The fins 33A, B,  
40 and D are generally triangular in shape and do not extend beyond the diameter of the platform 32. The lateral fin 33C



does extend a distance beyond the diameter of the platform 32 and is of a greater dimension than fins 33A, 33B and 33D.

When modular humeral prosthesis 10 is implanted in the humerus H, the lateral fin 33C preferably resides in the area posterior to the bicipital groove in the greater tuberosity of the humerus H. The lateral fin 33C may also have fixation holes 39 which aid in the fixation of the modular humeral prosthesis 10 after implantation in the humerus H.

As shown in Figure 2, the primary stem 40A is an elongated cylinder having a linear axis defining a proximal end 42 and a distal end 44. The proximal end 42 of the primary stem 40A has a male locking mechanism 66 for engagement with the female locking mechanism 37 on the distal end 36 of the body 30A. The distal end 44 of primary stem 40A has a rounded or bullet shaped tip 48 for insertion into the medullary canal of a resected humerus H.

Figure 3 and Figure 4 show two different sizes (i.e., different diameters) of the modular humeral prosthesis 10. The cross-sectional diameter of the body 30B is greater than the cross-sectional diameter of the body 30A and the cross-sectional diameter of 30C is greater than the cross-sectional diameter of the body 30B. However, the dimensions of the platform 32 of the bodies 30A, 30B and 30C are generally the same. Likewise, the primary stem 40B and 40C is of a greater cross-sectional diameter than primary stem 40A. The heads 20B and 20C are also of differing dimensions. It should be understood however, that while a number of different size heads, bodies, and stems are provided, the sizes of male and female connectors 34, 22 remain the same between head components and body components of different size. Similarly, the locking mechanisms 37, 66 are the same size and configuration for different sizes of head and stem components. The locking components 68, 76 are also the same size and configuration for different diameter and different length stems. This allows components of different diameters to be connected together, such as in revision cases, wherein the proximal humerus may have been enlarged because of the earlier use of bone cement to secure a previous prosthesis.

In Figure 2A and 2B, female 37 and male 66 connectors are shown as conically shaped with hexagonal portions 37A, 66A to prevent rotation between components. When the connections are

made between the various female/male connectors (illustrated by the female 37 and male 66 connectors), as the various components are assembled using a mall or an impact driver, an interference or wedge lock fit is formed. The coordinating transverse surface 37B of the female connector 37 and the coordinating transverse surface 66B of the male connector 66 will be slightly spaced apart upon complete assembly of the connectors 37 and 66 so that a full interference or wedge lock fit can be achieved.

Figures 6, 7 and 8 show an alternate embodiment of the primary stem 40A, plus a secondary stem 70A, 70B and 70C. As shown in Figure 6, a primary stem 60A has a proximal end 62 and a distal end 64. At the proximal end 62 is a male locking mechanism 66 for engagement with the female locking mechanism 37 on the body 30A. At the distal end 64 is a female locking mechanism 68 for engagement with a male locking mechanism 76 on the secondary stem 70A. The secondary stem 70A has a proximal end 72 and a distal end 74. The proximal end 72 has a male locking mechanism 76 for engagement with the female locking mechanism 68 on the distal end 64 of the primary stem 60A. The distal end 74 has a rounded or bullet shaped tip 78 for insertion into the medullary canal of a resected humerus H.

In Figure 7, another alternate embodiment of the present invention is shown. A primary stem 60B has a distal end 64 with a female locking mechanism 68. A secondary stem 70B, having a smaller cross-sectional diameter, may connect to the primary stem 60B having a greater cross-sectional diameter. The secondary stem 70B is shown with transverse bores or slots 79 extending through it. The bores or slots 79 receive fixation screws in order to maintain fragmented bone segments in a relative stable alignment with one another. Thus, the present invention allows custom replacement of the proximal humerus with simultaneous repair of the distal humerus using bone screws that fit one or more bores or slots 79. In an alternate embodiment not shown, the bores or slots 79 may be placed on the primary stem 40A and its alternate embodiments or on the secondary stems 70A, C, and D.

Figure 8 illustrates a primary stem 60C and a secondary stem 70C of a greater cross-sectional diameter than either the primary stem 60A or 60B or the secondary stem 70A or 70B.

Another alternate embodiment of the present invention can be seen in Figure 5, where the body 30A and stem 40A is combined in a one piece stem 50 of a very small cross-sectional diameter having a proximal end 52 and a distal end 53. In this alternate embodiment, the proximal end 52 has a plurality of fins 54 and a platform 51. The fins 54 are evenly spaced along the axis of the stem 50 and the fins 54 have one side 58 integral with the stem 50 and extend a predetermined length distally from the platform 51. The fins 54 extend outwardly to restrict rotational movement of the implant. One fin 54 is on the medial side of the stem 50, two of the fins 54 extend from the mid-line of the stem 50, and another fin 54 extends from the lateral side of the stem 50. The fins 54 are generally triangular in shape and do not extend beyond the diameter of the platform 51. A male locking mechanism 55 is centrally located on the platform 51 of the stem 50 for engagement with the female locking mechanism 22 of the head 20D. Any of the heads 20A-D will fit on the platform 51. The distal end 53 has a rounded or bullet shaped tip 56 for insertion into the medullary canal of a resected humerus H. The stem 50 is of a small cross-sectional diameter in order to accommodate the humerus of a child or a small adult.

A further alternate embodiment is shown in Figure 9, where the body 30A and stem 60A is combined in a one piece primary stem 80 with a secondary stem 70D. The primary stem 80 and secondary stem 70D can be of the same cross-sectional diameters as those shown in the primary stems 60A-C and the secondary stems 70A-C. The primary stem 80 has a proximal end 82 and a distal end 84. At the proximal end 82 is a body portion 30D identical to the body 30 as illustrated in Figure 11 but without the female locking mechanism 37. At the distal end 84 is a female locking mechanism 88 for engagement with a male locking mechanism 76 on the secondary stem 70D. The secondary stem 70D has a proximal end 72 and a distal end 74. The proximal end 72 has a male locking mechanism 76 for engagement with the female locking mechanism 88 of the distal end 84 of the primary stem 80. The distal end 74 has a rounded or bullet shaped tip 78 for insertion into the medullary canal of a resected humerus H.

In a preferred embodiment of the present invention, as shown in Figure 12, the modular humeral component system

includes a plurality of heads 20 of different sizes; a plurality of bodies 30 in a variety of cross-sectional diameters; and a plurality of primary stems 40 and 60, and secondary stems 70 having different lengths and diameters with  
5 both rounded distal ends 48 and 78 and squared off distal ends 68. The connections between the head 20 and the body 30 are achieved by a male/female locking mechanism which is identical in size and shape among all the component parts of the system. The primary stem 40 and 60, and the secondary stem 70 have a  
10 different identical male/female locking mechanism. All of the various sizes of the head 20, the body 30, the primary stem 40 and 60, and the secondary stem 70 are interchangeable among each other. These compatible modular humeral components, which may be supplied in a kit, allow a surgeon to exchange  
15 parts intraoperatively in order to achieve optimal fixation in humeral prosthetic implant procedures, such as in revision cases wherein differing diameters of stems 60b and 70a are needed, for example.

Because many varying and different embodiments may be  
20 made within the scope of the inventive concept herein taught, and because many modifications may be made in the embodiments herein detailed in accordance with the descriptive requirements of the law, it is to be understood that the details herein are to be interpreted as illustrative and not  
25 in a limiting sense.

## CLAIMS - PROPOSED AMENDMENTS

What is claimed is:

(amend)

- 1           1. A modular humeral prosthesis kit apparatus that can  
2 be custom fitted to a particular patient by a surgeon  
3 interoperatively, comprising:  
4           a) multiple humeral head portions, each having a  
5 hemispherically shaped outer surface for placement within the  
6 glenoid cavity of a human scapula[, ] and an undersurface;  
7           b) a plurality of modular body portions each  
8 having a proximal end and a distal end, said proximal end  
9 including an angled platform;  
10           c [d]) multiple cylindrical primary modular stem  
11 members, each having a proximal end and a distal end;  
12           d [e]) multiple cylindrical secondary modular  
13 stem members each having a proximal end and a distal end;  
14           e [c]) the body portions and the head and stem  
15 portions having respective first and second cooperating ~~taper~~  
16 locking ~~connecting~~ means for connecting a selected modular  
17 ~~body portion with a selected~~ humeral head and with a selected  
18 ~~stem~~ [modular body portion];  
19           f) [an end of each of said primary and secondary  
20 stem members having cooperating first and second connecting  
21 means for engagement with corresponding connecting means of a  
22 selected body portion or stem member, ] at least one of said  
23 ~~stem~~ distal ends having a tip for insertion within the  
24 medullary canal of a resected human humerus;  
25           g [f]) a selected number of components selected from  
26 said humeral head portions, body portions, primary stem  
27 portions, and secondary stem portions being affixable together  
28 end to end thereby forming a modular prosthesis that can be  
29 custom fitted to a particular patient by selectively  
30 interchanging different diameter sizes of the head portions,  
31 body portions, and stems to fit a prosthesis to the patient.

1           2. The modular humeral prosthesis of claim 1, wherein  
2 the humeral head is generally hemispherically shaped.

1           3. The modular humeral prosthesis of claim 1, wherein  
2 the body is a unitary structure with a conically-shaped

3 portion extending [proximally] from the proximal [distal] end  
4 of the body.

1 4. The modular humeral prosthesis of claim 1, wherein  
2 the platform is angled relative to the central longitudinal  
3 axis of the body portion.

1 5. The modular humeral prosthesis of claim 1, further  
2 comprising a body portion having at least one fin extending  
3 from the body portion.

1 6. The modular humeral prosthesis of claim 5, wherein  
2 the fin is integral with the body.

1 7. The modular humeral prosthesis of claim 5, wherein  
2 the fin extends outwardly to restrict rotational movement of  
3 the prosthesis during use.

1 8. The modular humeral prosthesis of claim 5, wherein  
2 the fin has at least one fixation hole.

1 9. The modular humeral prosthesis of claim 1, wherein  
2 at least one of the primary stems has a tip for insertion into  
3 the medullary canal of a resected human humerus.

1 10. The modular humeral prosthesis of claim 1, wherein,  
2 the primary stem has a taper at its distal end.

1 11. An implantable modular humeral prosthesis that can  
2 be custom fitted to a particular patient by a surgeon  
3 interoperatively, comprising:

4 a) a humeral head portion having a hemispherically  
5 shaped outer surface for placement within the glenoid cavity  
6 of a human scapula and an undersurface for engagement with a  
7 body portion [, said head portion including on its  
8 undersurface a first cooperating connecting means];

9 b) a body portion having a proximal end and a  
10 distal end, said proximal end including an angled platform  
11 [having a second cooperating connecting means for engagement  
12 with said first connecting means, said distal end having a  
13 third cooperating connecting means];

14 c) a primary stem portion having a proximal end  
15 and a distal end [, said proximal end having a fourth  
16 cooperating connecting means for engagement with said third  
17 connecting means, said distal end having a fifth cooperating  
18 connecting means];

19 d) a secondary stem portion having a proximal end  
20 and a distal end, [said proximal end having a sixth  
21 cooperating connecting means for engagement with said fifth  
22 connecting means,] said distal end having a tip for insertion  
23 within the medullary canal of a resected human humerus;

24 e) the said humeral head portion, body portion,  
25 primary stem portion, and secondary stem portion each  
26 providing cooperating connecting means for [being coupled  
27 together thereby] forming a modular prosthesis that can be  
28 custom fitted to a particular patient by interchanging sizes  
29 of the various selected humeral head, body portion, and stem  
30 portion components.

1 12. The modular humeral prosthesis of claim [1 or] 11,  
2 wherein at least one of the stem members have transverse bores  
3 extending therethrough to receive fixation screws in order to  
4 maintain fragmented bone segments in relative stable alignment  
5 with one another.

1 13. The modular humeral prosthesis of claim [1 or] 11,  
2 wherein at least one of the stem members have transverse slots  
3 extending therethrough to receive fixation screws in order to  
4 maintain fragmented bone segments in relative stable alignment  
5 with one another.

1 14. The modular humeral prosthesis of claim [1 or] 11,  
2 wherein the cooperating connecting means is formed with  
3 rotational restraint means.

1 15. An implantable modular humeral prosthesis that can  
2 be custom fitted to a particular patient by a surgeon  
3 interoperatively, comprising:

4 a) a humeral head portion having a convex-shaped  
5 outer surface for placement within the glenoid cavity of a  
6 human scapula and an undersurface for engagement with a body  
7 portion[, said head portion including on its undersurface a

- 8 recessed center portion having a first cooperating connecting  
9 means];
- 10 b) a cylindrical primary stem portion having a  
11 proximal end and a distal end, said proximal end having a body  
12 portion including an angled platform and a plurality of fins,  
13 said angled platform having a second cooperating connecting  
14 means for engagement with said first connecting means, said  
15 distal end having a third cooperating connecting means;
- 16 c) a cylindrical secondary stem portion having a  
17 proximal end and a distal end[, said proximal end having a  
18 fourth cooperating connecting means for engagement with said  
19 third connecting means,] said distal end having a tip for  
20 insertion within the medullary canal of a resected human  
21 humerus;
- 22 d) taper locking means for coupling the [said]  
23 humeral head portion, primary stem portion, and secondary stem  
24 portion being [coupled] together thereby forming a modular  
25 prosthesis that can be custom fitted to a particular patient  
26 by interchanging sizes of the various components.

1 16. The modular humeral prosthesis of claim 15, wherein  
2 the humeral head is generally hemispherically shaped.

1 17. The modular humeral prosthesis of claim 15, further  
2 comprising a [wherein the] recessed center portion on the  
3 undersurface of the head that allows the platform of the body  
4 to fit within the periphery of the humeral head.

1 18. The modular humeral prosthesis of claim 15, wherein  
2 the body is a unitary structure and the taper locking means  
3 includes [with] a conically-shaped portion extending  
4 proximally from the distal end of the body.

1 19. The modular humeral prosthesis of claim 15, wherein  
2 the platform is angled relative to the central longitudinal  
3 axis of the body portion.

1 20. The modular humeral prosthesis of claim 15, further  
2 comprising at least one fin extending from the body portion.



1           21. The modular humeral prosthesis of claim 15, wherein  
2 the fin has one side integral with the body portion and  
3 extends a predetermined length distally from the platform.

1           22. The modular humeral prosthesis of claim 15, wherein  
2 the fin extends outwardly to restrict rotational movement of  
3 the prosthesis.

1           23. The modular humeral prosthesis of claim 20, wherein  
2 there are a plurality of fins including one fin on the medial  
3 side of the primary stem, a second and third fin extending  
4 from the midline of either side of the primary stem and a  
5 fourth fin extending from the lateral side of the primary stem.

1           24. The modular humeral prosthesis of claim 23, wherein  
2 the outward extension of several of the fins is no greater  
3 than the diameter of the platform.

1           25. The modular humeral prosthesis of claim 20, wherein  
2 one fin has at least one fixation hole.

1           26. The modular humeral prosthesis of claim 15, wherein  
2 the primary stem and secondary stem have transverse bores  
3 extending therethrough to receive fixation screws in order to  
4 maintain fragmented bone segments in relative stable alignment  
5 with one another.

1           27. The modular humeral prosthesis of claim 15, wherein  
2 the primary stem and secondary stem have transverse slots  
3 extending therethrough to receive fixation screws in order to  
4 maintain fragmented bone segments in relative stable alignment  
5 with one another.

1           28. An implantable modular humeral prosthesis that can  
2 be custom fitted to a particular patient by a surgeon  
3 interoperatively, comprising:

4           a) a humeral head portion having a hemispherically  
5 shaped outer surface for placement within the glenoid cavity  
6 of a human scapula and an undersurface for engagement with a  
7 body portion, said head portion including on its undersurface

- 8 a recessed center portion [having a first cooperating  
9 connecting means];
- 10 b) a cylindrical stem portion having a proximal  
11 end and a distal end, [said proximal end having a body portion  
12 including an angled platform and a plurality of fins, said  
13 angled platform having a second cooperating connecting means  
14 for engagement with said first connecting means,] said distal  
15 end having a tip for insertion within the medullary canal of  
16 a resected human humerus;
- 17 c) the stem portion being elongated and of a very  
18 small cross-sectional diameter to accommodate the humerus of  
19 a child or a small adult;
- 20 d) the humeral head portion and stem portion being  
21 coupled together thereby forming a modular prosthesis that can  
22 be custom fitted to a particular patient by interchanging  
23 sizes of the head portion.

1 29. The modular humeral prosthesis of claim 1 or 11,  
2 wherein the connecting means cooperates by means of an  
3 interference fit.

1 30. The modular humeral prosthesis of claim 15 or 28,  
2 wherein the connecting means cooperates by means of an  
3 interference fit.

1 31. The modular humeral prosthesis of claim 1 or 11,  
2 wherein the connecting means cooperates by means of a wedge  
3 lock fit.

1 32. The modular humeral prosthesis of claim 15 or 28,  
2 wherein the connecting means cooperates by means of a wedge  
3 lock fit.

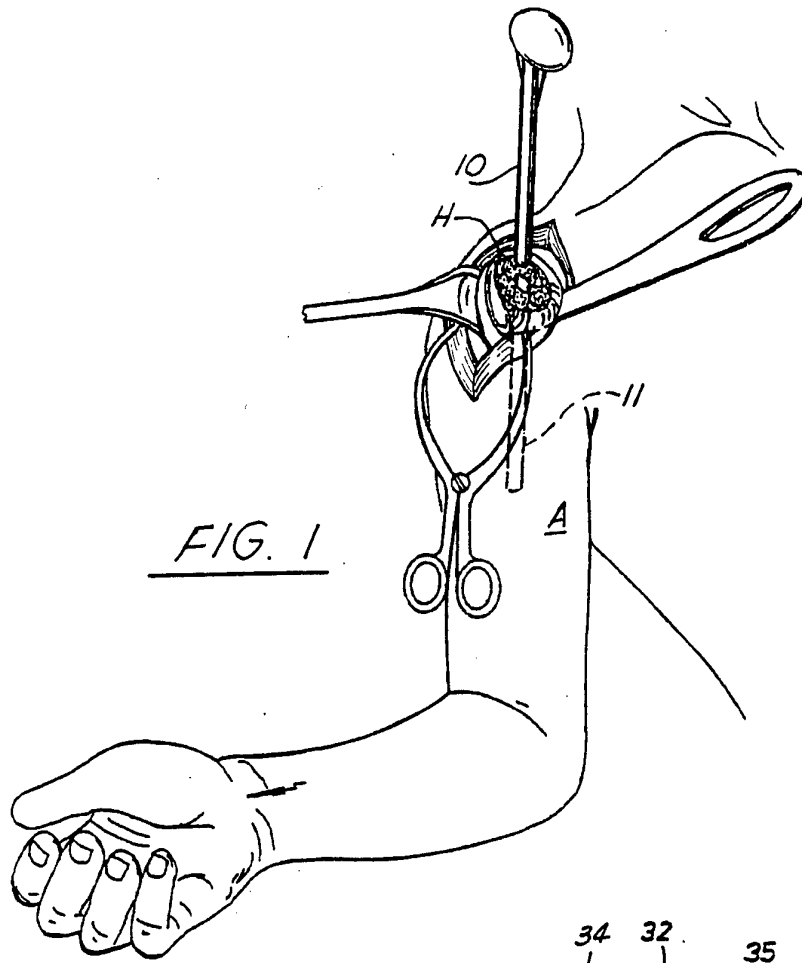


FIG. 1

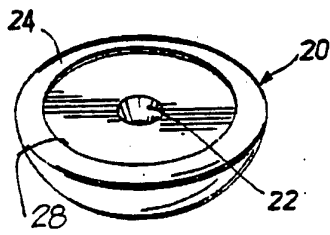


FIG. 10

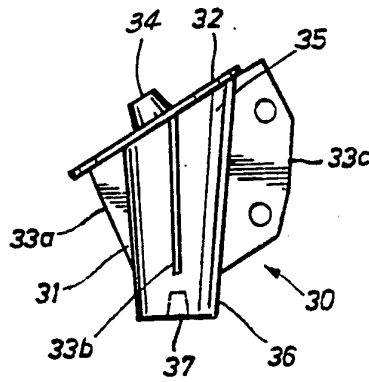


FIG. 11

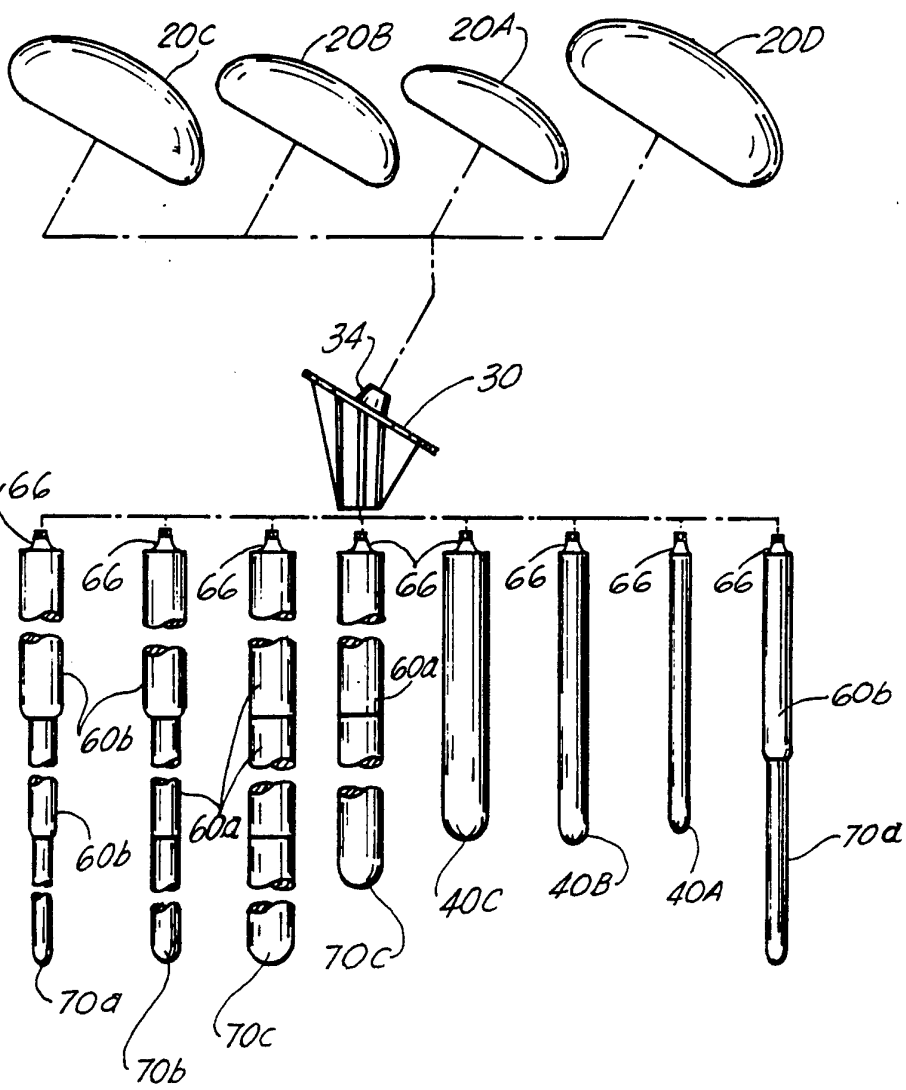
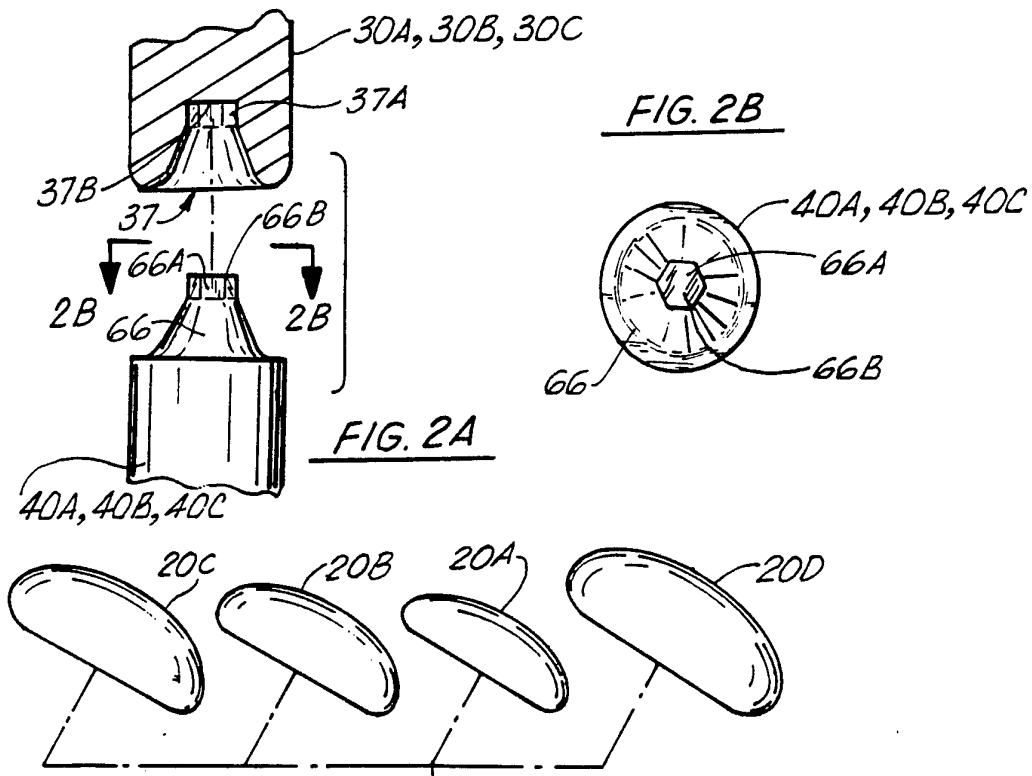


FIG. 12

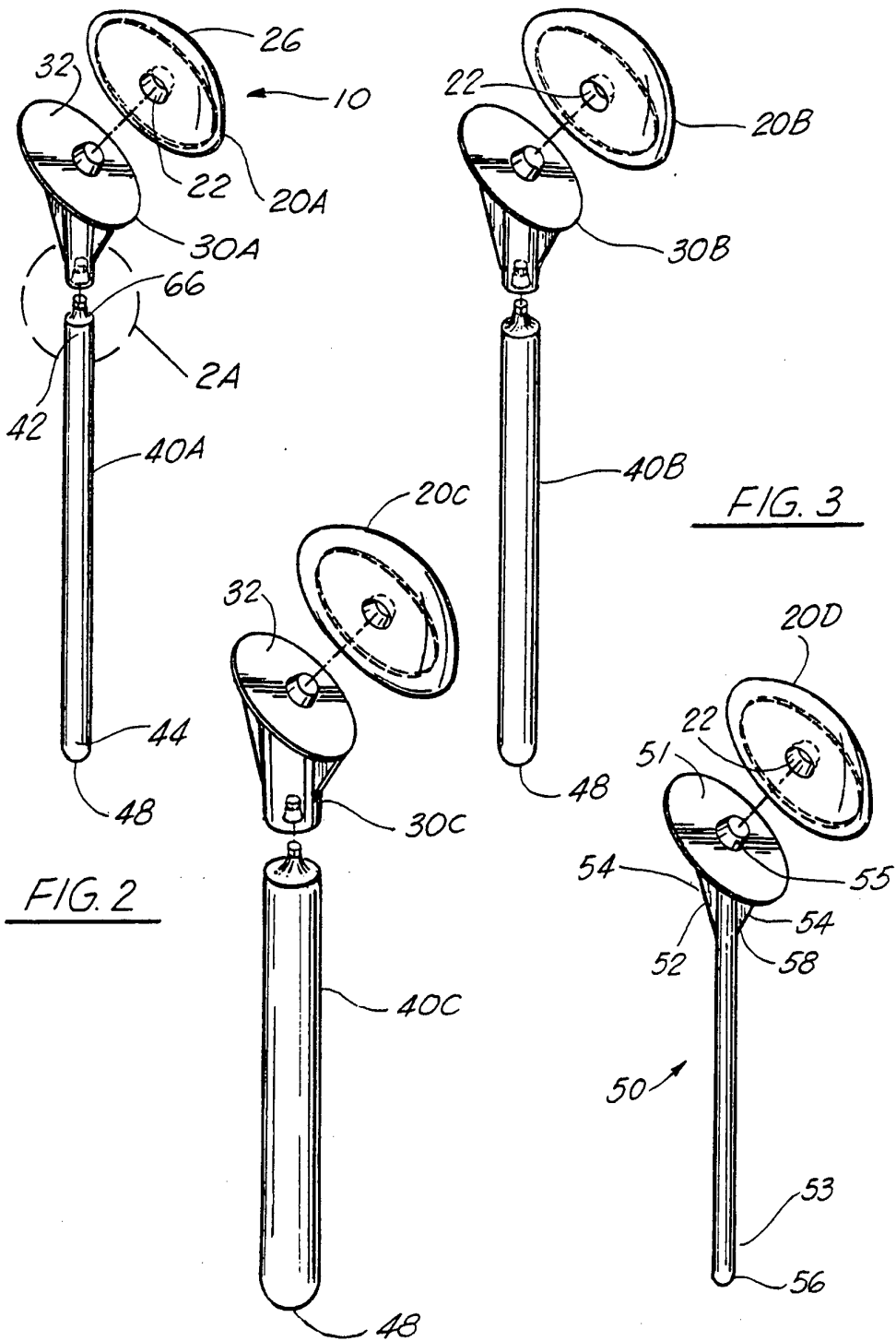


FIG. 2

FIG. 3

FIG. 4

FIG. 5

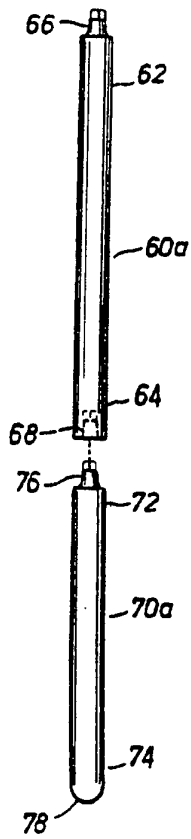


FIG. 6

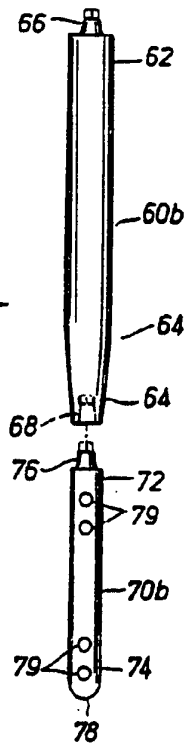


FIG. 7

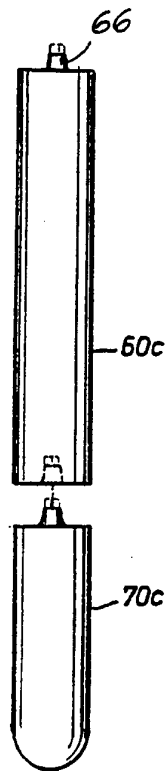


FIG. 8

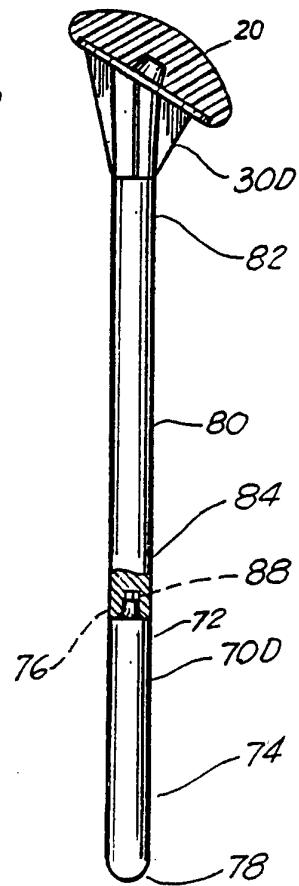


FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US94/00166

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(5) :A61F 02/40  
US CL :623/19

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 623/18, 19, 22, 23

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
None

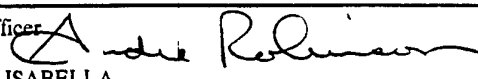
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
None

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 4,865,605, (DINES ET AL.), 12 September 1989. See column 2, lines 10-55.	1-10
Y,P	US, A, 5,181,928, (BOLESKY ET AL.), 26 January 1993. See column 5, lines 5-58.	1-10
Y	US, A, 4,895,572, (CHERNOFF), 23 January 1990. See Figs. 2 and 3.	11-14
Y	US, A, 5,032,130, (SCHELHAS ET AL.), 16 July 1991. See Figs. 1 and 2.	11-14
Y	US, A, 4,645,506, (LINK), 24 February 1987. See elements 8-10	15-32

Further documents are listed in the continuation of Box C.  See patent family annex.

* Special categories of cited documents:	** later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
*A* document defining the general state of the art which is not considered to be part of particular relevance	*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
*E* earlier document published on or after the international filing date	*Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
*L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	* & * document member of the same patent family
*O* document referring to an oral disclosure, use, exhibition or other means	
*P* document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 10 APRIL 1994	Date of mailing of the international search report 18 MAY 1994
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer  DAVID J ISABELLA Telephone No. (703) 308-3060