US008840673B2

(12) United States Patent
Linares et al.

(10) **Patent No.: US 8,840,673 B2**

(45) **Date of Patent: Sep. 23, 2014**

(54) **IMPLANTABLE ELBOW JOINT ASSEMBLY WITH SPHERICAL INTER-SUPPORT**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 11 days.

(21) Appl. No.: **13/624,403**

(22) Filed: **Sep. 21, 2012**

(65) **Prior Publication Data**

US 2013/0103158 A1 Apr. 25, 2013

Related U.S. Application Data

(60) Provisional application No. 61/537,123, filed on Sep. 21, 2011.

(51) **Int. Cl.**

A61F 2/38 (2006.01)
A61F 2/30 (2006.01)

(52) **U.S. Cl.**

CPC ***A61F 2/3804*** (2013.01); *A61F 2002/3021* (2013.01); *A61F 2002/3064* (2013.01); *A61F 2002/30652* (2013.01); *A61F 2002/30642* (2013.01); *A61F 2002/30649* (2013.01); *A61F 2002/30892* (2013.01); *A61F 2002/30878* (2013.01); *A61F 2002/30637* (2013.01); *A61F 2002/30644* (2013.01)

USPC **623/20.11**

(58) **Field of Classification Search**

CPC ... A61F 2/3804; A61F 2/3854; A61F 2/4202; A61F 2002/30242; A61F 2002/30649; A61F 2002/3065

USPC 623/20.23, 21.17, 21.18, 19.11–19.14, 623/20.11–20.13, 21.13, 21.16, 17.14, 623/20.22, 22.18

See application file for complete search history.

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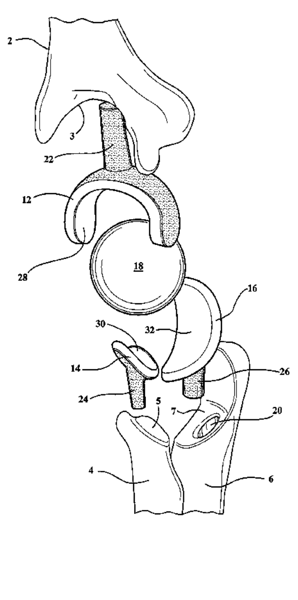
(57) **ABSTRACT**

A multi-component elbow joint assembly incorporated into reconditioned end surfaces established between an upper humerus bone and opposing lower radius and ulna bones. The assembly includes a first component anchored into the upper humerus reconditioned end surface and exhibits a first exposed support surface. A second component is anchored into the lower reconditioned bone end surface of at least one of the radius and ulna bones and exhibits a second exposed support surface. An intermediate component is supported in at least one of eccentric or rotational fashion between the first and second anchored components.

6 Claims, 8 Drawing Sheets



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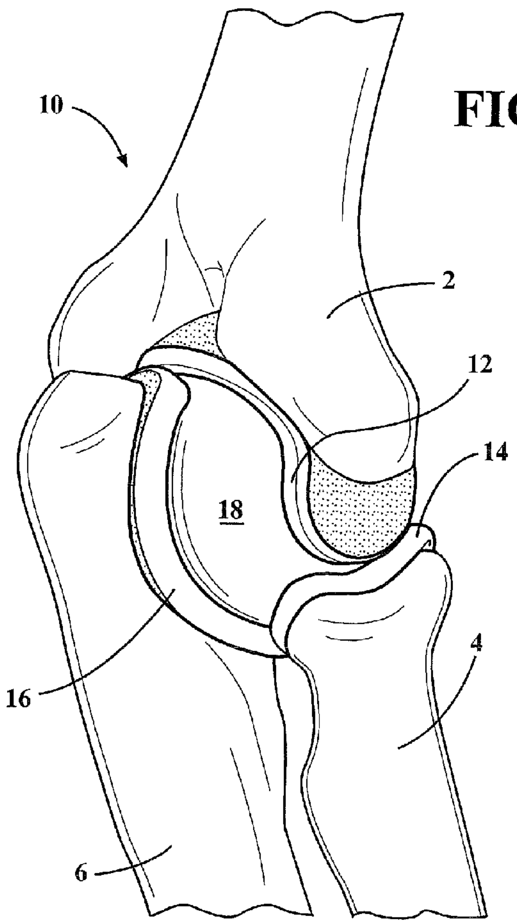


FIG. 1

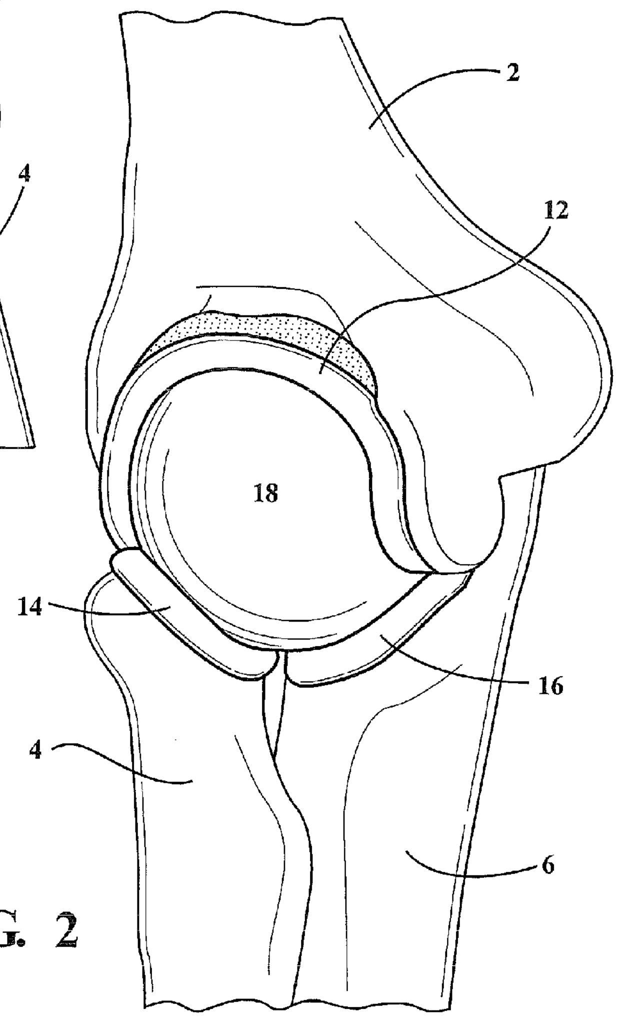


FIG. 2

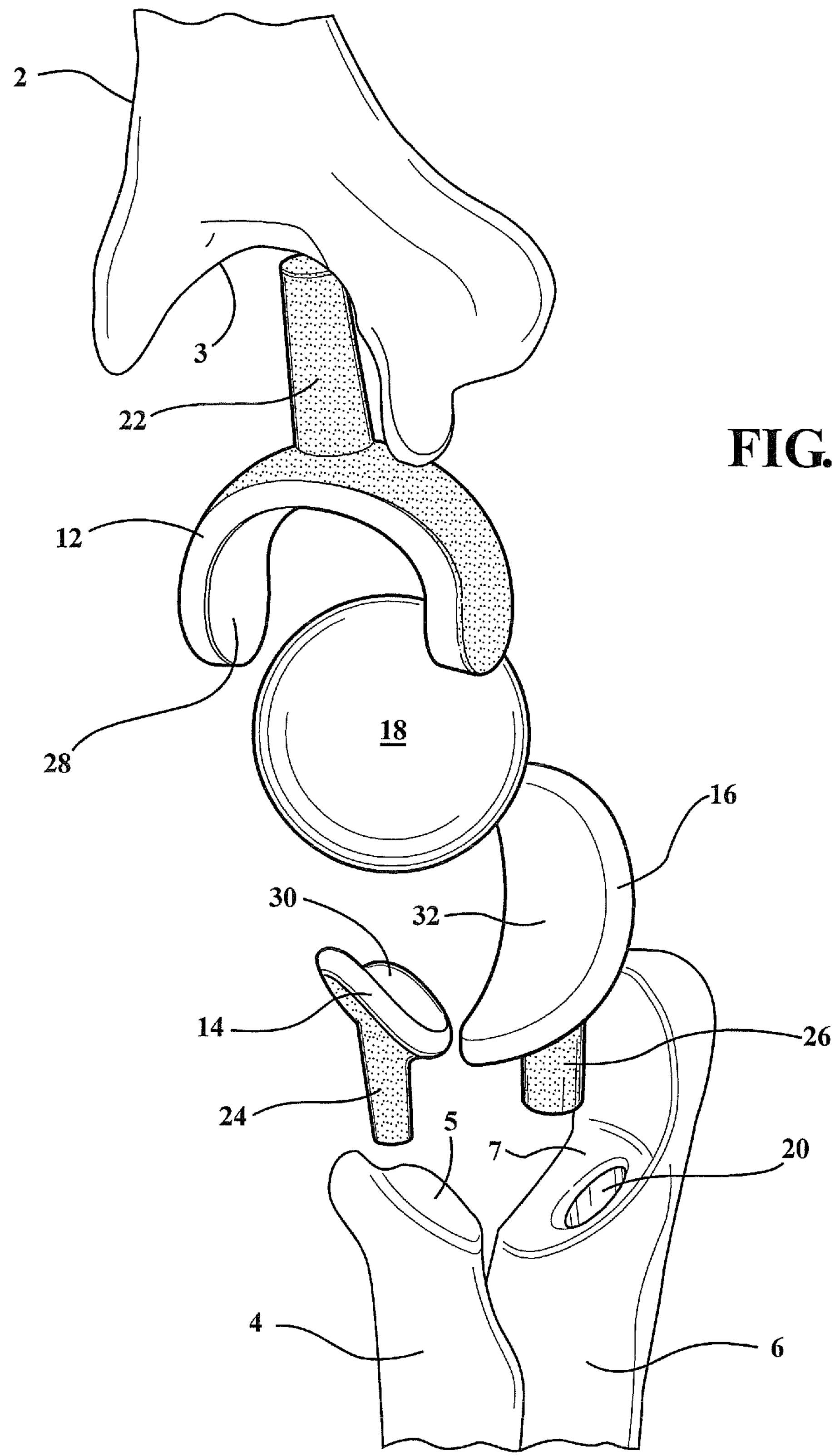


FIG. 3

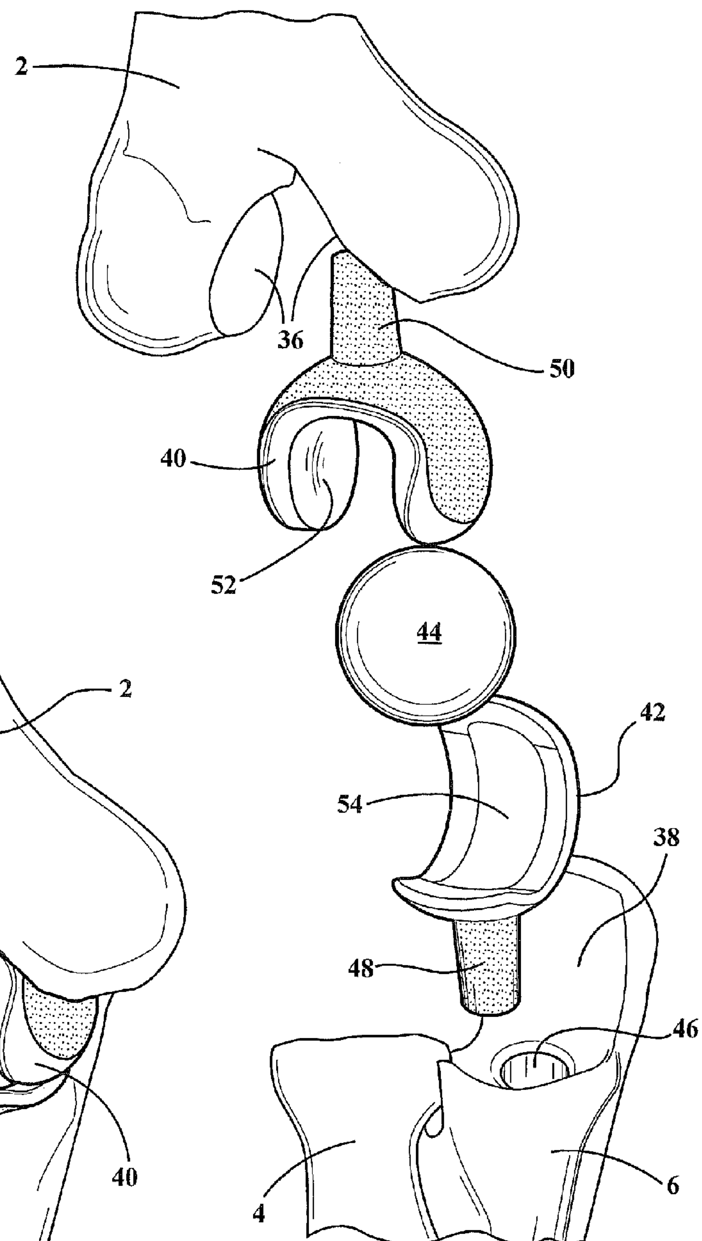


FIG. 4

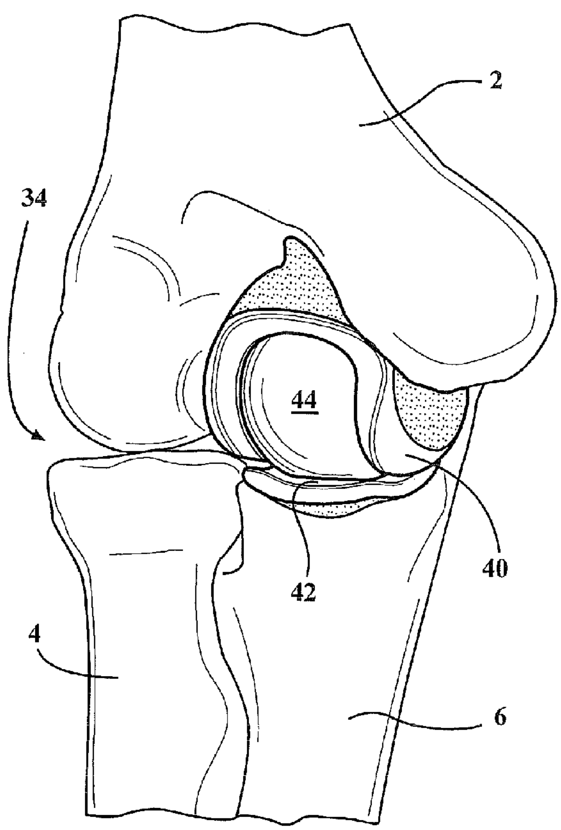


FIG. 5

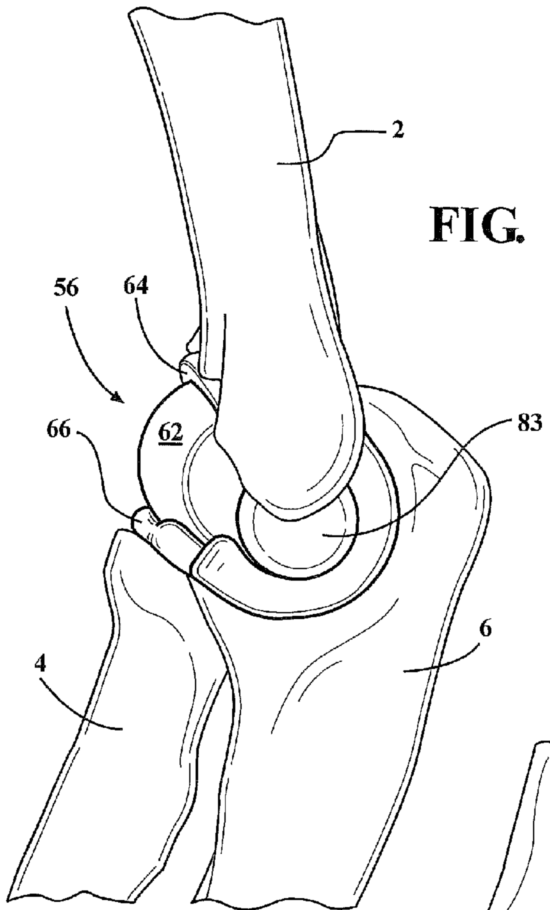


FIG. 6

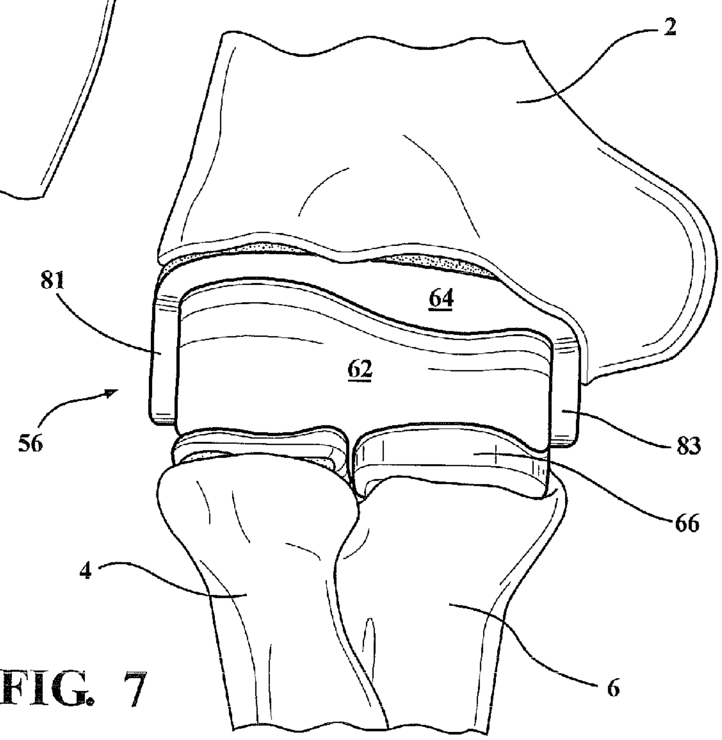


FIG. 7

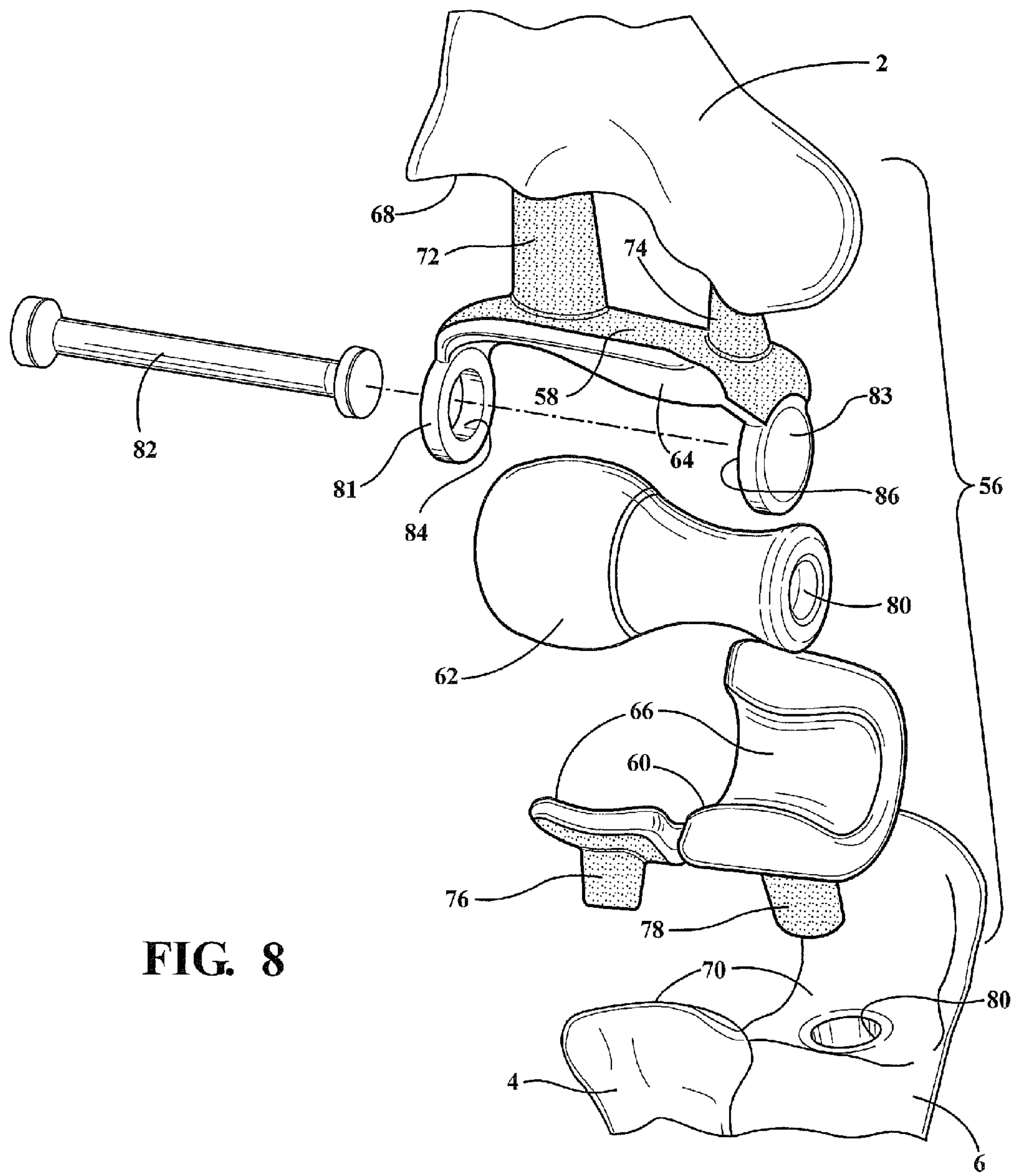


FIG. 8

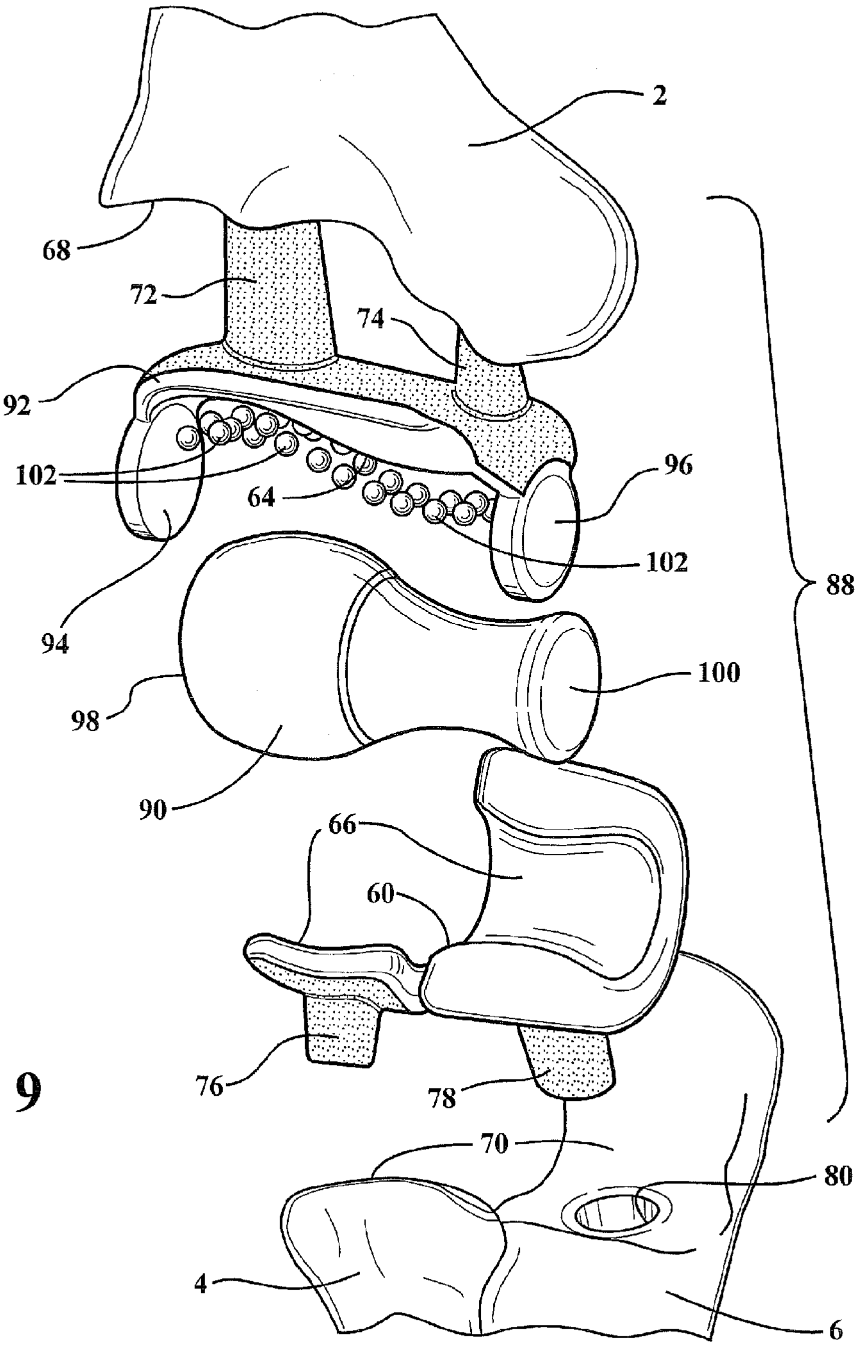


FIG. 9

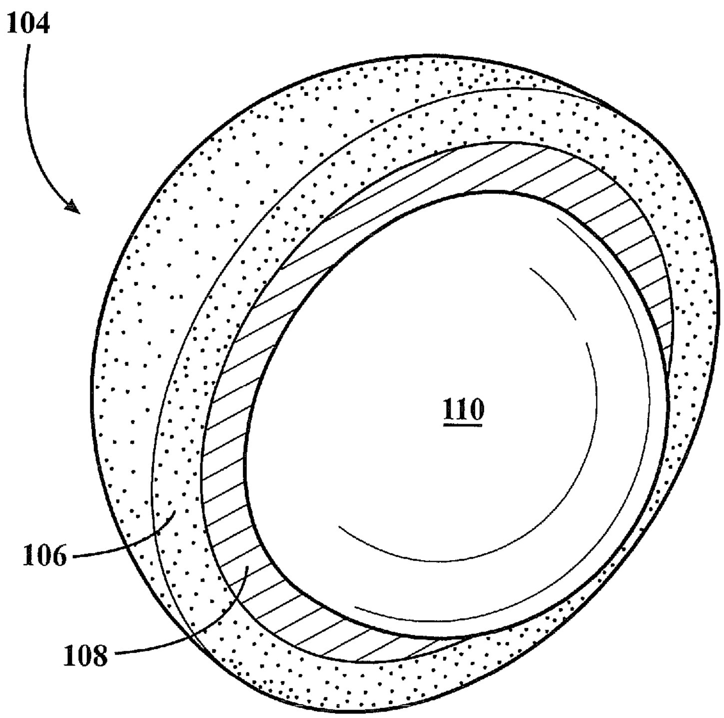


FIG. 10

FIG. 11

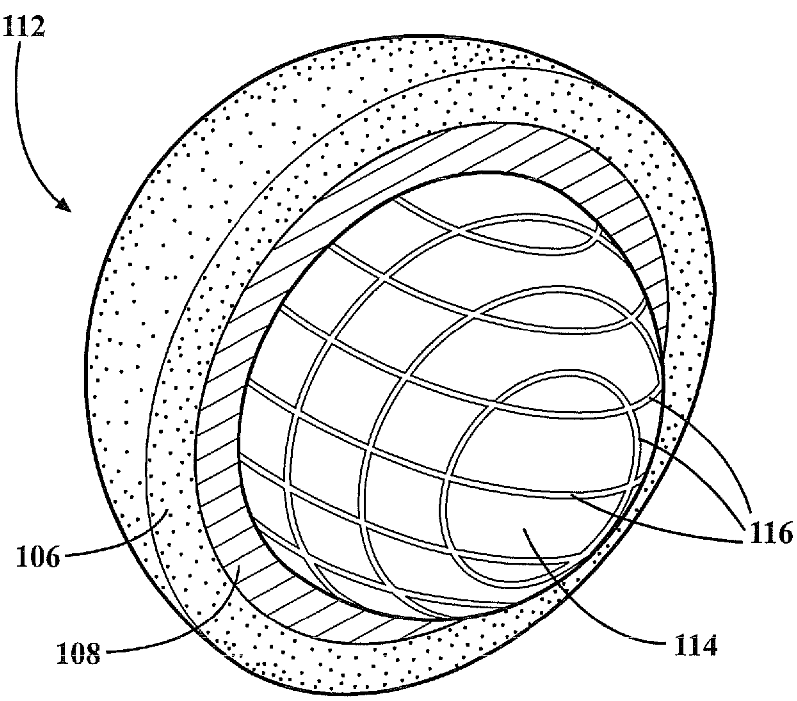
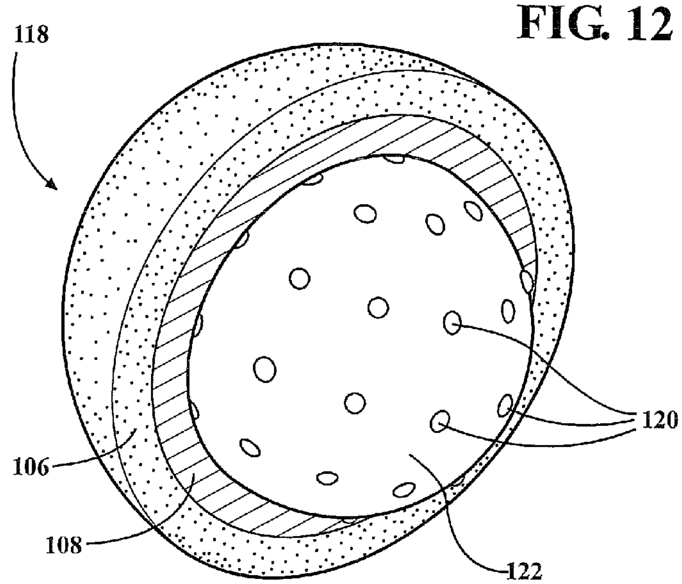


FIG. 12



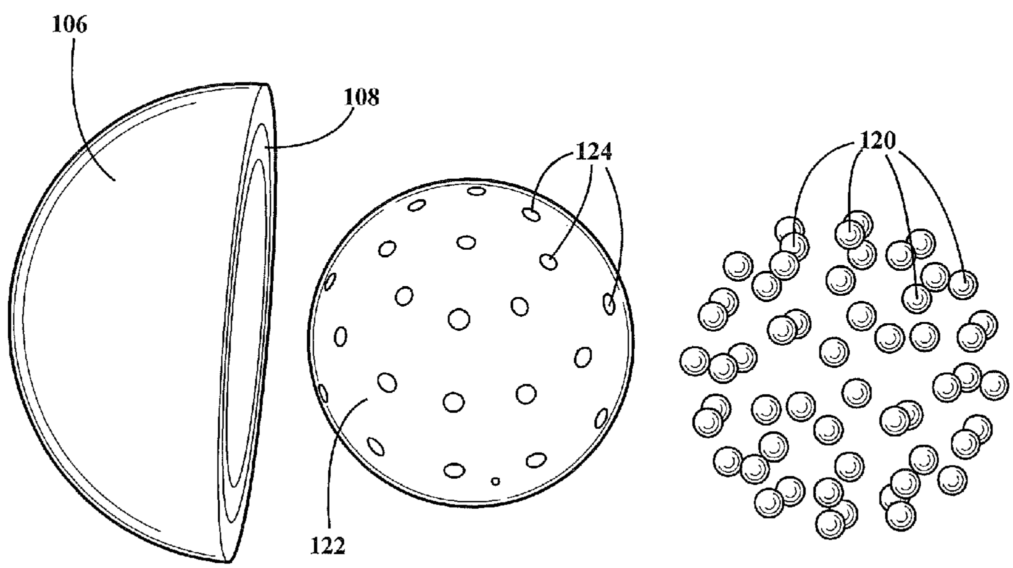


FIG. 13

IMPLANTABLE ELBOW JOINT ASSEMBLY WITH SPHERICAL INTER-SUPPORT

The present application claims the priority of U.S. Ser. No. 61/537,123 filed Sep. 21, 2011.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention discloses an artificial joint assembly, such as is particularly configured for employing as a retrofit elbow joint, and which combines multiple artificial components incorporated into first and second reconditioned joint defining surfaces for providing increased wear life in tandem with evenly distributed wear pattern/profile as well as enhanced flexibility and mobility.

2. Background Description of the Prior Art

The prior art is documented with examples of artificial implant assemblies. Among these are included the artificial elbow joint of Ikegami 8,100,980 which teaches a humeral component made of metal and an ulnar component made of resins for replacing an elbow joint. The humeral component is configured by a substantially cylindrical trochlea and a stem extending from the trochlea that is inserted into the humeral. An ulnar component is configured by a joint surface member which receives the trochlea in a rotatable manner and a stem which extends from the joint surface member and is inserted into the ulna. The stem of the humeral component is curved gently downward overall so as to comply with the lordotic shape of the humeral, and the trachea is turnable about the centerline of the stem.

A further example of a minimally thick orthopedic prosthesis which closely matches a minimally reshaped joint defining bone surface by an orbital or lineally oscillating orthopedic resurfacing tool in the minimally invasive orthopedic surgical repair or reconstruction of a variety of joints.

SUMMARY OF THE PRESENT INVENTION

The present invention discloses a multi-component elbow joint assembly incorporated into reconditioned end surfaces established between an upper humerus bone and opposing lower radius and ulna bones. The assembly includes a first component anchored into the upper humerus reconditioned end surface and exhibits a first exposed support surface. A second component is anchored into the lower reconditioned bone end surface of at least one of the radius and ulna bones and exhibits a second exposed support surface. An intermediate component is supported in at least one of eccentric or rotational fashion between the first and second anchored components.

Additional features include the intermediate component having at least one of a spherical shaped or roller shaped component. Each of the anchored components further exhibits a concave surface for supporting the intermediate component.

The anchored components may also include a widened uneven surface for supporting a corresponding uneven profile associated with an intermediate positioned roller. Each of the first, second and intermediate components may be constructed from any of metal, plastic, polymer or composite material.

The arrangement of components can also include a ½ implant assembly associated with a selected side of the joint defining bones. The spherical shaped component may also exhibit a multi layer composition including a softer outer layer and at least one harder interior layer. The first and second inner layers establishes an eccentric rotational interface therebetween.

Additional features include a plurality of surface projecting bearings mounted within an innermost spherical shaped portion of the spherical component for facilitating the eccentric rotational interface. A grid pattern of lubricating grooves may also be defined in a surface of an innermost spherical shaped portion of the spherical component and likewise facilitating the eccentric rotational interface.

BRIEF DESCRIPTION OF THE DRAWINGS

Reference will now be made to the attached drawings, when read in combination with the following detailed description, wherein like reference numerals refer to like parts throughout the several views, and in which:

FIG. **1** is a perspective view of an elbow implant assembly according to a first embodiment of the invention;

FIG. **2** is a rotated perspective view of the assembly in FIG. **1** and better depicting the spherical inter support arranged between upper and lower arm bone end secured implants;

FIG. **3** is an exploded view of the elbow implant assembly of FIG. **1** and better illustrating the reconditioned end-configurations established between the upper humerus and lower radius and ulna arm bones, combined with the implant support inserts and intermediate positioned and eccentrically supported spherical portion;

FIG. **4** is a perspective view of a modified and reduced (½) sized elbow implant assembly for installation at the humerus/ulna joint interface;

FIG. **5** is an exploded view of the elbow implant assembly in FIG. **4** and again better illustrating the reconditioned end-configurations established between the upper humerus and lower ulna arm bones, combined with the implant support inserts and intermediate positioned and eccentrically supported spherical portion;

FIG. **6** is a side perspective of an elbow implant assembly according to a yet further preferred variant;

FIG. **7** is a rotated front plan view of the elbow implant assembly of FIG. **6** and better depicting the roller shape associated with the intermediate support element;

FIG. **8** is an exploded view of the elbow implant assembly of FIGS. **6** and **7** and better illustrating the reconditioned end-configurations established between the upper humerus and lower radius and ulna arm bones, combined with the configuration of the implant support inserts and intermediate positioned and pseudo bowling pin shape associated with the intermediate positioned roller support;

FIG. **9** is a further exploded view similar to as shown in FIG. **8** of a slightly modified variant of roller pin supporting elbow implant assembly and which depicts in further exploded fashion a plurality of ball bearings substantially integrated into the anchored implant associated with the reconditioned end face of the humerus and which provide additional rotational support to the intermediate roller;

FIG. **10** is a pseudo cutaway view of a spherical shaped intermediate support such as integrated into the variants depicted in FIGS. **1-5**, and which illustrates its multi-material construction with softer outermost shell material and intermediate harder material in cutaway, combined with innermost harder core material in spherical perspective and which further evidences an eccentric rotatable interface established between said intermediate and innermost layers;

FIG. **11** is a pseudo cutaway view of a spherical shaped intermediate support similar to that in FIG. **10** and further depicting a plurality of lubricant supporting grooves defined in a surface grid pattern associated with the innermost hardened core;

FIG. **12** is a further cutaway view which is again similar to FIG. **10** and further depicting a plurality of substantially surface embedded ball bearings associated with the inner most core; and

FIG. **13** is an exploded view of the cutaway of FIG. **12** and which better illustrates the arrangement of micro sized ball bearings in combination with the seating locations arranged about the spherical exterior surface of the harder core material.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

As will be disclosed with succeeding reference to the several depicted embodiments, the present invention discloses an artificial joint assembly, such as is particularly configured for employing as a retrofit elbow joint, and which combines multiple artificial components incorporated into first and second reconditioned joint defining surfaces for providing increased wear life in tandem with evenly distributed wear pattern/profile as well as enhanced flexibility and mobility.

The joint assemblies described herein are particularly configured for such as in situ reconditioned installation within a patient's elbow (between the lower end of the upper humerus bone and corresponding upper ends of the lower radius and ulna bones), however it is further understood that certain applications could in theory include other joint applications, either human or other mammalian. For purposes of ease and clarify of illustration, the various embodiments depicted further do not include reference to additional necessary components of the elbow joint, such as including associated muscles, tendons and ligaments, the inclusion of which are assumed and which collectively define a functioning and articulating elbow.

Referring now to FIG. **1**, a perspective view is generally shown at **10** of an elbow implant assembly according to a first embodiment of the invention and which is incorporated between an upper arm (humerus) bone **2** and a lower arm bones represented by radius **4** and ulna **6**. As best shown in the exploded view of FIG. **3**, the present invention contemplates such as in situ reconditioning of the bone ends, illustrated by conditioned end profiles **3** configured into the bottom most end surface of the humerus **2**, as well as opposing upper end facing and recessed/reconditioned profiles **5** and **7** defined in the upper most opposing ends of the radius **4** and ulna **6**.

Such reconditioning occurs following incision or removal of any remaining damaged bone and/or cartilage associated with the damaged joint and during an appropriate surgical procedure utilizing medical drilling, boring and shaping instruments in order to recondition the joint defining bone ends and to create the desired shaping and profile of the joint. As previously indicated, it is advantageous to refashion the joint end profiles in situ during an appropriate surgical procedure, a further objective being to retain or repair, where possible, natural ligament, cartilage and muscle associated with a normal functioning joint.

Although not shown, such reconditioning can be employed with minimal interference to such necessary additional elements of the elbow joint including associated ligaments, muscles and tendons. Without limitation, it is further understood that the joint assemblies described in each of the illustrated variants can be integrated into either of human or synthetic bones (such as which can also contemplate both human and synthetic bones in a single joint application), with such

joint assemblies also capable of surgically implanted in either total or partial fashion (as depicted in FIGS. **4** and **5**) concurrent with any necessary degree of refashioning or removal of damaged bone or joint.

Referring again collectively to FIGS. **1-3**, the multi-component assembly **10** better illustrates the reconditioned end-configurations **3**, **5** and **7** (again FIG. **3**) established between the upper humerus **2** and lower radius **4** and ulna **6** bones. A set of bone end installable implant portios are depicted at **12**, **14** and **16** with each exhibiting a rear facing profile suitable for anchoring into the respective end face configurations **3**, **5** and **7**.

Each of the implant portions **12**, **14** and **16** are constructed of any arrangement of metal, polymer, plastic, composite or other suitable material, with it further being understood that the individual pairs of components can be arrayed with any pattern of alternating materials, such that the components **12**,**14** and **16** can be constructed of a first material, with an intermediate and inter-positioned spherical shaped bearing or ball portion **18** positioned therebetween being constructed of a second material. In this fashion, the desired wear properties and profiles are adjusted in part based upon the material selection of the individual components with concurrent objectives being both equalization of overall wear patterns established between the respective pairs of components and determining those situations in which metal on metal or plastic on plastic contact between the components is either desired or, more often, not.

A suitable medical adhesive, cement or other fastener can be employed for securing each of the upper component **12** and lower components **14** and **16** into the respective reconditioned joint defining ends **3**, **5** and **7** of the humerus **2**, radius **4** and ulna **6**. As further best shown in FIG. **3**, each of the reconditioned bone ends includes an interior extending aperture, best depicted by selected aperture **20** associated with reconditioned ulna end face **7**. In this manner, a rearward extending anchoring stem (see at **22** for upper implant component **12** and further at **24** and **26** for lower implant components **14** and **16**) is configured for seating within the associated bone end face interior aperture, thereby assisting in seating the end mounted implants in the manner depicted in FIGS. **1** and **2**.

Each of the end face mounted implants **12**, **14** and **16** exhibits a concave exterior facing profile (this including a generally modified "U" shaped profile **28** associated with upper implant **12** and corresponding partial **30** and crescent **32** concave shaped profiles. The arrangement of the concave support faces **28**, **30** and **32** are such that, upon securing the implants **12**, **14** and **16** within the reconditioned end face locations **3**, **5** and **7** of the bones **2**, **4** and **6**, collectively define upper and lower seating locations for supporting the interposed spherical element **18** in a designed range of eccentric articulating fashion.

As further previously noted, the concave spherical supporting faces **28**, **30** and **32** can each be constructed of a smooth lubricant entrained or other polished plastic, composite or metal surface, with the exterior configuration of the spherical support **18** again being constructed of an alternating material, such as to reduce and equalize wear profiles, as well as to enhance operational range and effectiveness.

As again previously indicated, additional configurations of muscles, ligaments, tendons are provided and can include both natural and/or synthetic materials which can be implanted or reconstructed in order to provide a dynamic and long-term implantable assembly. Also, the seating or inserting rear faces of the end face mounted implant portions **12**, **14** and **16** as best shown in FIG. **3** further include an undercut textured or otherwise roughened consistency, this contributing to promotion of bone marrow in-growth into the implant portions following such as initial adhesive and seating affixation, such bone growth contributing to long term retention of the implant.

FIG. **4** is a perspective view generally at **34** of a modified and reduced (½) sized elbow implant assembly for installation at the humerus/ulna joint interface. In combination with the exploded view of FIG. **5**, modified reconditioned end-configurations are depicted at **36** and **38** established between the upper humerus **2** and lower ulna **6** arm bones, combined with implant support inserts (upper **40** and lower **42**) and intermediate positioned and eccentrically supported intermediate (and smaller sized in comparison to FIG. **1**) spherical portion **44**.

As previously described, the implant configuration **34** of FIG. **4** is considered to be a partial implant assembly, such as in which the humerus to radius joint portion may constitute and undamaged and enduring portion of the overall elbow joint and in which the original configuration of ligaments, tendons and muscles (not shown) may remain. As previously also described, the present invention contemplates either retention of such supporting elbow joint structure and/or partial or total replacement of the damaged ligaments, tendons and muscles in the course of an associated joint reconstruction procedure.

As with the prior embodiment, the reconditioned joint end faces (see ulna **6** end face **38**) can again include a recessed aperture (define by inner perimeter wall **46**) for seating an associated mounting post **48** of the lower implant **42** as well as a corresponding post **50** associated with the upper implant **40** which is otherwise largely similar to the implant **12** depicted in FIG. **3**. The upper **40** and lower **42** implants, similar to those described in the initial variant, likewise include concave support surfaces (see pair at **52** and **54**) which define eccentric support locations of the interposed spherical ball **44** (see FIG. **4**) and such that the partial elbow joint reconstruction exhibits a substantial range of bendable arm motion, combined with limited lateral/eccentric motion. As with the first disclosed variant, the reverse end mounting surfaces of the implants **40** and **42** can again exhibit a textured or undercut consistency which promotes bone in growth over time and to insure against loss of initial contact adhesion resulting from the use of medical cement or the like for anchoring the plasticized, composite or metal implant into the reconditioned bone end faces **36** and **38**.

Referring now to FIGS. **6-8** in succession, a series of side perspective, front plan and exploded views are depicted of an elbow implant assembly **56** according to a yet further preferred variant and which combines a further arrangement of end surface attachable implant portions **58** and **60** in combination with an interposed and substantially irregular (e.g. vase like or pseudo bowling pin) shaped roller **62** which seats within concave widened surface profiles **64** and **66**. Both the upper humerus **2** and lower radius **4**/ulna **6** joint surfaces are again reconditioned, such as shown by profiles **68** and **70** in FIG. **8**, and such that the widened implants **58** and **60** are seated in end-anchoring fashion in the manner best depicted in the frontal view of FIG. **7**.

As again shown in the exploded view of FIG. **8**, the implants **58** and **60** each again include reverse side extending (pairs) of stems (see at **72** and **74** for upper implant **58** and further at **76** and **78** for lower implant **60**) for respectively seating within aligning recessed apertures (exemplified at **80** for ulna bone **6**) defined in each of the reconditioned elbow joint end faces. As previously described, roughened undercut patterns are exhibited on the reverse adhering faces of the implants **58** and **60** and promote long term bone in-growth to permanently anchor the implants in place.

The width extending and irregular surfaces **64** and **66** associated with the implants **58** and **60** exhibit a combination of both concave and uneven profiles (again FIG. **8**) such that the irregular shaped (bowling pin like) roller **62** seats in a mating rotatable fashion therebetween as best depicted in the frontal plan view of FIG. **7**. As again best shown in FIG. **8**, a central aperture **80** extending longitudinally through an interior of the roller **62** is engaged by a pin shaft **82** upon pre-positioning the roller **62** between a pair of downward extending end lobes **81** and **83** associated with the upper implant **64**, the first end lobe **81** including an inner aperture **84** for permitting initial insertion of the shaft **82**, with the opposite end located lobe **83** exhibiting an abutting inner end face **86** defining an end stop of the inserting shaft **82** and thereby mounting the roller **62** in a stationary rotatable position.

As with prior embodiments, a suitable arrangement of ligaments, tendons and muscles can be employed for retaining the arrangement of the elbow joint **56**, such as in the same fashion as depicted in the earlier variants **10** and **34**, and such as which can be (to the extent possible) retained from the original joint construction of the patient and which can be avoided to the extent possible during in situ end face reconditioning and implantation of the joint assembly. As also previously described, the material construction of the various components **58**, **60** and **62** can include an arrangement in which either a plastic/composite or metal can be employed in each of the outer implant portions **58** and **60**, with the alternating material employed in the construction of the pseudo roller pin shaped element **62**.

Referring now to FIG. **9**, a further exploded view similar to as shown in FIG. **8** is presented generally at **88** of a slightly modified variant of roller pin supporting elbow implant assembly and in which the only appreciable differences from FIG. **8** include the provision of a roller pin/uneven shaped roller **90** as a solid component (without internal aperture **80** as in FIG. **8**) combined with a reconfigured upper implant **92** with solid end lobes **94** and **96** for snap fitting the opposite end surfaces **98** and **100** therebetween. Although not clearly shown, it is envisioned that the inner facing surfaces of the lobes **94** and **96** can each exhibit one of either a convex or concave shape with alternates with that exhibited by the outer facing end surfaces **98** and **100** of the roller **90**, and so as to maintain the roller **90** without the need of the lateral mounting pin shaft **82**. The implants **92** and **60** otherwise retain the features of the reverse extending mounting stems **72**/**74** and **76**/**78** along with the roughened/undercut bone in-growth promoting reverse surfaces.

Also depicted in FIG. **9** in further exploded fashion are a plurality of, generally micro sized, ball bearings **102**. Although not clearly providing an underside view of the concave/irregular pin supporting surface associated with the underside of the implant **92**, the bearings **102** are substantially seated in distributed fashion along the humerus end face anchored implant **92** (this defined as being substantially embedded within the concave/irregular support face previously identified at **64** in FIG. **8** of the upper implant **92**), and which provides additional rotational support to the intermediate roller **90**.

Referring now to FIG. **10**, a cutaway view is generally shown at **104** of a selected spherical inter-movable support, such as again represented by the various spherical balls **18** and **44** respectively disclosed in the variants of FIGS. **1** and **4**. The pseudo cutaway view of FIG. **10** illustrates one non-limiting example of a multi-layer material construction and which includes a softer (typically plastic or plastic composite) outermost material layer **106**, an intermediate harder **108** material (typically another plastic), and an innermost harder material **110** (which is depicted in un-sectioned spherical perspective shape and can be of a similar hardness as the intermediate layer **108** as well as potentially including either of a relatively harder or softer material based on the specifics and preferences of the application).

In operation, an eccentric rotatable interface is established between the intermediate **108** and innermost (or core) **110** layers, this typically arising from the compressive aspects exerted on the softest outer shell layer **106** by both the upper and lower associated implants resulting in a degree of inter-rotative offset or eccentric give or play established at the interior interface boundary between the intermediate layer **108** and the inner core **110**. The outer compressive exerted forces typically result from any inwardly angular directed force exerted on the intermediate spherical element, and such as is defined as a non-tangential force.

FIG. **11** is a similar pseudo cutaway view, generally at **112**, of a spherical shaped intermediate support similar to that in FIG. **10**, with identical outer soft shell **106** and intermediate harder shell **108**, and in which an innermost core is reconfigured as shown at **114** with a grooved arrangement **116**. The grooves **116** can facilitate eccentric motion in the interior boundary defined between layers **108** and **114**, in the manner previously described, and/or can also includes entrainment of a volume of lubricant supported within the grooves **116** in a fairly evenly distributed fashion associated with the hardened core **114**.

It is also envisioned and understood that the spherical ball, grooves or other supporting structure can include small entrapment channels or pockets for retaining micro particles of debris, either or both plasticized resulting from wear of the implant portions and bone, and such as is further defined as debris osteolysis. The ability to segregate and remove such micro particles (again using the pattern of grooves **116** or other suitable arrangement) assists in extending useful life of the implant along with reducing pain, squeak/noise or other undesirable aspects typical of previous implant designs.

Referring now to FIG. **12**, a further cutaway view is generally shown at **118** which is again similar to FIG. **10** and further depicting a plurality of substantially surface embedded ball bearings **120** associated with a further redesigned version of an inner most core **122**. As best depicted in the further exploded view of FIG. **13**, the ball bearings **122** are separated from the hardened inner core **122**, thereby revealing substantially spherical shaped pockets **124** defined across the exterior profile of the core **122** and which substantially seat the individual bearings **122** in a manner which permits the tips thereof (again FIG. **12**) to project in a manner which facilitates additional eccentric support motion with respect to the interior interface boundary established with the intermediate later **108** in a manner consistent with the dynamic environments referenced in relation to FIGS. **10** and **12**.

Having described my invention, other and additional preferred embodiments will become apparent to those skilled in the art to which it pertains, and without deviating from the scope of the appended claims.

We claim:

1. A multi-component elbow joint assembly incorporated into reconditioned end surfaces established between an upper humerus bone and opposing lower radius and ulna bones, said assembly comprising:

a "U" shaped first component anchored into the upper humerus reconditioned end surface and including a first "U" shaped exterior facing profile defining a concave support surface;

a second component anchored into the lower reconditioned bone end surface of at least one of the radius and ulna bones and exhibiting a second exterior facing profile defining a second concave support surface, said second component further including a pair of components adapted to being secured to each of reconditioned ends of the radius and ulna bones and in opposing and spaced fashion relative opposite perimeter edge locations of said "U" shaped profile; and

a spherical shaped component supported between said first and second anchored components, said concave shaped support surfaces each contacting said spherical component at separate multi-dimensional locations with an end most location of said second concave support surfaces extending between opposing ends of said first "U" shaped component in order to define a spaced apart relationship between said exterior facing profiles of said first and second concave shaped support surfaces, allowing for multi-axial and eccentric motion of said support surfaces relative to both said spherical component and each other during articulation of the bones about said joint.

2. The joint assembly as described in claim **1**, each of said first, second and spherical shaped components further being constructed of at least one of a metal, plastic, polymer or composite material.

3. The joint assembly as described in claim **1**, said spherical shaped component further comprising a multi-layer composition including a softer outer-most layer and at least one harder intermediate layer concentrically arranged between said softer outer layer and an exterior surface of said spherical shaped component.

4. The joint assembly as described in claim **3**, further comprising said intermediate layer being eccentrically displaceable relative to at least one of said outer layer and said exterior surface of said spherical shaped component and upon a compressive force exerted upon said softer outer layer.

5. The joint assembly as described in claim **4**, further comprising a plurality of surface projecting bearings press-fit mounted within substantially spherical shaped pockets formed in said spherical shaped component and such that a portion of each bearing projects from a convex surface of said spherical shaped component and into contact with an inner concave surface associated with said intermediate layer.

6. The joint assembly as described in claim **4**, further comprising a grid pattern of lubricant receiving grooves defined in an exterior convex surface of said spherical shaped component in contact with an inner concave surface associated with said intermediate layer.

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