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(71) Applicant *(for all designated States except US)*: **SHEFFIELD HALLAM UNIVERSITY** [GB/GB]; City Campus, Howard Street, Sheffield S1 1WB (GB).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **WHITELEY, Graham, Paul** [GB/GB]; Art and Design Research Centre, Sheffield Hallam University, Psalter Lane, Sheffield S11 8UZ (GB). **RUST, Christopher** [GB/GB]; Art and Design Research Centre, Sheffield Hallam University, Psalter Lane, Sheffield S11 8UZ (GB).

(74) Agents: **WALSH, David, Patrick** et al.; Appleyard Lees, 15 Clare Road, Halifax HX1 2HY (GB).

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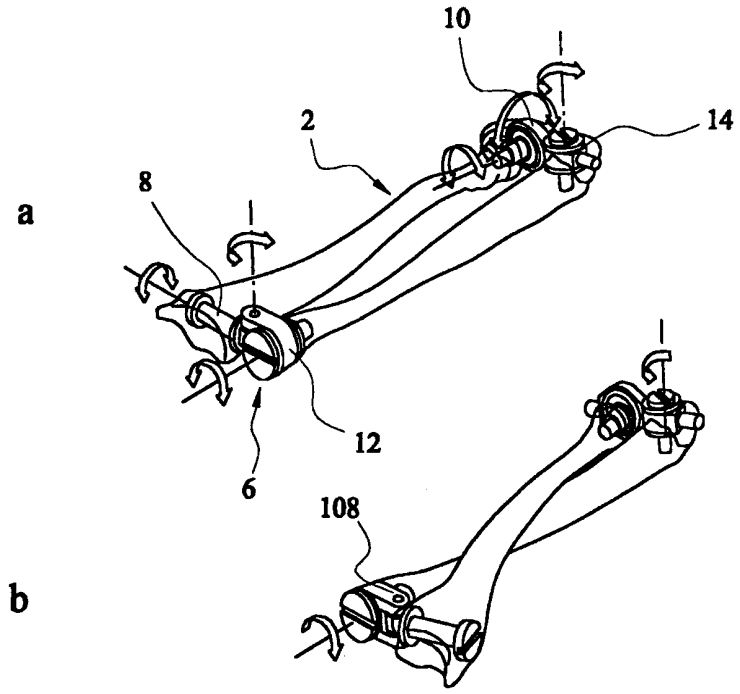
(54) Title: AN ELBOW PROSTHESIS



(57) Abstract: The invention describes a forearm prosthesis (2) comprising a proximal radio-ulna component (4) for flexion-extension co-operation with a humeral component (not shown) and a distal radio-ulna component (6). Each component has a radius engaging element (8, 10) and an ulna engaging element (12, 14) so that the replicated ulna extends between the ulna part of distal radio-ulna component and the ulna part of the proximal radio-ulna component.

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AN ELBOW PROSTHESIS

The present invention relates to an elbow prosthesis and, in particular, but not exclusively, to an elbow prosthesis which improves pronation and supination of the forearm.

Hinge joints providing flexion-extension by connecting the humeral component to the ulna are common in this field and have been described in US 5,782,923, US 4,224,695, EP 0913133, US 4,822,364, US 5,314,500 and US 5,888,235. Although these have met with some success, only two address the mobility of the radius joint. The radio-humeral joint described in US '695 is a ball and socket type joint which has three degrees of freedom, providing for flexion-extension of the radius, rotary movement of the shank about the longitudinal axis of the radius and axle movement of the shank along the longitudinal axis of the radius. Although this device provides improved freedom, it does not provide the same degree of freedom as found in the natural joint.

US'923 also provides a ball and socket arrangement at the radio-humeral joint and the socket component is also slidable laterally with respect to the humero-ulnar joint and this provides improved movement of the radius during articulation. Accordingly, the ulna joint is only provided with flexion-extension and is still relatively rigid compared with the natural joint. Furthermore, none of the above documents addresses the problem of pronation-supination of the wrist joint.

According to a first aspect of the present invention, there is provided an elbow prosthesis comprising first

articulation means to provide a spherical degree of freedom for the radius or its synthetic equivalent about the radio-humeral joint and second articulation means to provide a medio-lateral swivel of the ulna bone or its synthetic equivalent about the humero-ulnar joint.

Preferably, in an endoprosthetic embodiment, a proximal radio-ulnar component is provided which is associated with a humeral component for flexion-extension of the arm.

Preferably, the radio-ulnar component has radio-connection means suitable for connection with the proximal end of a radius bone or its synthetic equivalent. Preferably, the radio-connection means is adapted to provide said spherical degree of freedom about the radio-humeral joint.

Preferably, ulnar-connection means are also provided on the radio-ulnar component. Preferably, said means are adapted to provide said medio-lateral swivel of the ulna bone or its synthetic equivalent about the humero-ulnar joint.

Therefore, for endoprosthetic applications there is provided according to a second aspect of the present invention, a prosthesis for an elbow joint comprising:

a humeral component,

and a proximal radio-ulnar component,

the radio-ulnar component and the humeral component being associated for flexion-extension of the arm, the radio-ulnar component having radio-connection means suitable for

interconnection with a radius bone or its synthetic equivalent and an ulnar connection means suitable for interconnection with an ulnar bone or its synthetic equivalent, wherein the radio-connection means is adapted to allow spherical rotation of the radius or its equivalent synthetic member about the radio-humeral joint and the ulnar connection means is adapted to allow medio-lateral swivel of the ulna bone or its equivalent synthetic member.

Advantageously, supination to pronation of the forearm is possible by radius rotation about its longitudinal axis, lateral to medial swivel, inferior to superior swivel and superior to inferior swivel of the radius or its equivalent and simultaneous medial to lateral swivel of the ulna. The reverse rotation and swivels then take place in pronation to supination.

Preferably, the radio-ulnar component forms a hinge joint with the humeral component to allow flexion-extension movement with respect thereto. Preferably, the radio-ulnar component has a pair of lugs extending outwardly therefrom on the medial and lateral side of the component respectively, the lugs being journalled in corresponding sockets on the humeral component for flexion-extension movement about the medio-lateral axis of the lugs.

Preferably, at least part of the radio-connection means fixedly engages with the proximal end of the radius. Preferably, the radius connection means comprises a spherically articulatable member for fixation to the radius and which, preferably, articulates, in use, with the radio-ulnar component for spherical articulation

therewith. In one embodiment, the connection means comprises a stem portion adapted for engagement in the bone canal of a radius or its synthetic equivalent. Preferably, at least part of the ulnar connection means fixedly engages with the proximal end of the ulna. Preferably, said fixedly engaged part is rotatable with respect to the radio-ulnar component with which it articulates, in use, for medio-lateral swivel of the ulna. In one embodiment, the fixedly engaged part comprises a stem portion adapted for engagement through the bone of the ulna at the proximal end of the bone, preferably, along a superior-inferior axis through the superior surface of the bone or its equivalent and into the bone canal of the ulna. References to superior or inferior throughout this specification may be interchanged with the equivalent terms anterior or posterior respectively. For consistency, only the terms superior and inferior are used. The term medial or medio- refers to the side of the arm which is adjacent to the ulna at the elbow and lateral refers to the side of the arm which is adjacent to the radius at the elbow.

Preferably, the radio-connection means is adapted to allow spherical rotation by means of the articulation of a convex frusto-spherical surface and close fitting frusto-spherical socket. Preferably, one of the close fitting frusto-spherical socket or the convex frusto-spherical surface is fixedly engaged with the radio-ulnar component whilst the other is fixedly engaged with the proximal end of the radius to allow spherical rotation between the radius and the radio-ulnar component. Preferably, the stem portion of the radio connection extends from the frusto-spherical surface, preferably, with the stem

extending from the flat base thereof. Preferably, the frusto-spherical surface and close fitting socket allow sufficient movement to cover the angular range of movement of a natural arm.

Preferably, the fixedly engaged part of the ulnar connection means is rotatable about the superior-inferior axis thereof with respect to the radio-ulnar component to allow medio-lateral swivelling of the ulna to which it is fixed. Preferably, the extent of rotation of the said part with respect to the radio-ulnar component at least covers the range of natural swivel of the natural ulna in use.

Preferably, the radio-ulnar component is provided with a bearing to receive, for medio-lateral swivel about a superior-inferior axis, a portion of the ulna connection means protruding, in use, from the superior surface of the ulna.

In prosthetic devices, the radius and ulna may be natural or artificial depending upon the extent of arm replacement required.

The distal end of the radius and ulna may be provided with a distal radio-ulnar component. Preferably, the distal radio-ulnar component accommodates the range of movement of the proximal radio-ulnar component.

Preferably, the distal component couples both bones together at the distal ends thereof. The component preferably allows rotation of the distal end of the radius about the distal end of the ulna for pronation-supination

of the wrist. Preferably, the distal coupling mechanism allows relative pivoting about a superior-inferior axis which extends through the couple. Preferably, the radio-securing means extends from the said couple laterally into the radius. Preferably, the radio-securing means is rotatable about a medio-lateral axis to facilitate pronation-supination of the wrist.

According to a third aspect of the present invention there is provided a distal forearm prosthesis comprising a radio-ulnar component coupling the distal ends of the radius and ulna bones or their equivalent synthetic members, the component incorporating means to allow rotation of the distal region of the radius over the ulna during wrist pronation-supination whilst the ulna remains substantially stationery with respect to rotation about its longitudinal axis.

Preferably, said rotation of the distal end of the radius over the ulna is effected by means of an axle substantially aligned with the longitudinal axis of the ulna and an axle bearing member. Preferably, the axle is fixed to the ulna and is journalled in the bearing. Preferably, the radius is coupled to the axle bearing member in such a manner that rotation of the bearing causes rotation of the radius over the ulna.

Preferably, the bearing member and ulnar axle or ulnafixation device rotate relative with each other between pre-determined limits. Preferably, the limits are defined by the co-engagement of respective members on the bearing member and ulna fixation device. Preferably, the first such member is a recessed track of limited length

and the second member slideably engages with the track between the ends thereof, with the limits of the track being defined by the said ends. Preferably, the track length defines the limits of relative rotation of the bearing member and fixation device. In one embodiment, the track is arced and, preferably, concentric with the axis of rotation of the bearing member. In one embodiment, a protrusion engages the arc. Preferably, the protrusion and recess are formed on respective abutting faces of the bearing member and fixation device. Preferably, the protrusion is formed on the fixation device and extends into an arced recessed track on the abutting face of the bearing member so that rotation of the fixation device causes the angular rotation of the protrusion in the track between the limits of relative movement required. Preferably, the second member and first member are formed and respectively located so as to substantially allow the range of natural movement between the distal ends of the radius and ulna.

Preferably, the radio-ulnar couple comprises a superior-inferior axis pivoting member to allow relative pivoting of the distal ends of the ulna and radius about the said superior-inferior axis pivoting member during pronation-supination of the wrist. In one embodiment, the said pivoting member comprises a coupling pin and socket arrangement to allow relative pivoting of the distal ends of the ulna and radius about a superior-inferior distal axis therebetween during pronation-supination of the wrist.

Preferably, the pivoting member is connected to the ulna and radius by means of suitable ulnar and radio-pivot

member couplings. In one embodiment, a pair of spaced flanges extend from the bearing member and have apertures therein to receive a coupling pin. Similarly, a lug is secured to and extends from the medial side of the radius and also provides a socket to receive a coupling pin. Preferably, the radius lug is sandwiched between the bearing flanges so that the flange apertures and lug socket are in superior-inferior alignment.and the coupling pin extends therethrough to provide the said couple.

Preferably, lateral rotation means are provided to permit relative rotation of the radius and the said couple about the medio-lateral axis of the distal end of the radius. Preferably, an extension member extends laterally into the radius from the couple and is relatively rotatable with respect to the radius. Preferably, the extension member is journalled in a bearing member within the radius bone to provide the said relative rotation.

Preferably, the radius lug is secured to a pin which is journalled in a sleeve extending laterally through the radius and which permits relative rotation of the radius with respect to the medial lug about the medio-lateral axis of the pin during pronation-supination.

According to a fourth aspect of the present invention there is provided a prosthesis for a forearm comprising an upper arm component for securement to the upper arm and a forearm component for securement to the forearm, the upper arm component and forearm component being pivotably associated for flexion-extension of the forearm with respect to the upper arm, wherein the forearm component provides a first elongate member parallel with the

longitudinal axis of the forearm and adapted for medio-lateral swivel about a superior-inferior axis located at the elbow region and a second elongate member parallel with the longitudinal axis of the forearm and which is also adapted for medio-lateral swivel about a superior-inferior axis located at the elbow region and which includes a ring at the distal end thereof which ring includes guide means on the interior surface thereof and a third elongate member parallel with the longitudinal axis of the forearm and which is slidably mounted on the inside of the ring and guided around the ring by the guide means.

Advantageously, the fourth aspect of the invention allows spherical freedom for the existing radius of the patient and provides medio-lateral swivel for the existing ulna of the patient. This provides the same freedom as the rotary elements of the first and second aspects of the invention but the elements of the design are offset along their axes so that a prosthetic elbow mechanism may be provided outside an existing elbow but acting in tandem with it. This further provides for true wrist pronation-supination and also allows attachment above and below the elbow in a manner which distributes more widely the stresses arising from prosthesis use.

Preferably, the prostheses of the third and second aspect of the invention are utilised in tandem. The ulna and radius may be existing or replacement synthetic devices.

In the particularly preferred embodiment of the invention, the prosthesis of the second aspect of the invention is combined with the prosthesis of the third aspect of the

invention to provide improved pronation-supination of the forearm.

The invention extends to methods of construction of anthropomorphic models, animated anthropometric computer models for computer aided design and animation, anthropomorphic robots and the production of demonstration models for teaching and learning in healthcare. The invention also extends to methods of surgery which incorporate the fixation of the devices according to any one or more of the first-fourth aspects of the invention in the human or animal subject. The invention also extends to methods of using such prosthetic devices.

Suitable materials for the components of the invention include high density polyethylene (HDPE), cobalt/chromium/molybdenum alloy or combinations thereof on articulating surfaces. Other suitable materials will be known to those skilled in the art.

Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings in which:-

figure 1a shows replica radius and ulna bones connected to radio-ulnar components at the proximal and distal end thereof;

figure 1b shows the components of figure 1a in the prone position;

figure 2a shows the distal radio-ulnar component;

figure 2b shows the component parts of the component in figure 2a;

figure 3a shows the proximal radio-ulnar component journalled in a humeral component;

figure 3b shows the radio-ulnar component of figure 3a with the radius and ulna stems removed;

figure 3c shows the radio-ulnar component of figure 3b with the stems; and

figure 4 shows an external adaptation of the invention.

Referring to figures 1-3, the forearm prosthesis 2 comprises a proximal radio-ulnar component for flexion-extension co-operation with a humeral component (not shown) and a distal radio-ulnar component 6. Each component has a radius engaging element 8, 10 and an ulna engaging element 12, 14 so that the replicated ulna extends between the ulna part of the distal radio-ulnar component and the ulna part of the proximal radio-ulnar component. Similarly, the replicated radius extends between the corresponding radius parts of the respective components. Figures 3a-c show the proximal component in greater detail. The radio-ulnar component comprises an ulnar stem bearing member 16 and a radius stem bearing member 18 which are both annular rings with flattened sides having upper and lower edges defined by arcs concentric with the respective centres of the bearings and lateral and medial sides defined by tangential chords that extend into the flattened side edges of the rings. The bearing members are orthogonal to each other and have the

appearance of being mated together at the lateral flattened end of the ulna bearing member 16 and the medial flattened end of the radius bearing member 18. However, the component is, typically, machined from a simple solid piece. The ulna bearing member 16 has a centrally disposed hole 20 extending in superior-inferior direction. The radius bearing member 18 has a centrally disposed hemispherically shaped cup 22 formed therein in which is articulated a close fitting convex hemispherical stem head 24 which has a centrally disposed cylindrical recess 26 formed therein for insertion of a cylindrical stem base 28. The flattened medial side 30 of the radio-ulnar component 4 has a cylindrical lug 32 extending perpendicularly therefrom and a corresponding lug 34 extends perpendicularly from the lateral flattened side 36 of the radio-ulnar component. A narrower centrally disposed cylindrical stem 38 extends distally from the wider stem base 28, for engagement with the central canal of the radius at the proximal end thereof. The centrally disposed aperture 20 in the ulna component 16 receives the ulna stem 40 and head 42. The stem is rotatable with respect to the bearing member 16 about an inferior-superior axis. A washer 44 is located between the head 42 of the stem 40 and the ulna component 16. In use, a washer 45 is also located between the ulna and the bearing member 16. The stem 40 extends inferiorly below the inferior surface of the ulna component 16 for engagement with the proximal end of the ulna.

Figure 3a shows the radio-ulnar component of figure 3c journalled in the humeral component 46. The humeral component 46 is not shown connected to the humerus but conventional fixation is envisaged and a replica humerus

may be utilised. The humeral component 46 is shaped like the natural distal end of the humerus. The proximal end comprises a narrower cylindrical section 48 which widens in the distal direction like the natural elbow. A pair of spaced flanges 50, 52 extend distally from the widest section 54 of the humeral component 46 and the radio-ulnar component is fitted in the space between the flanges 50, 52. Each flange has a bearing aperture formed therein for close fitting journalling of the lateral and medial lugs 32, 34 at either side of the radio-ulnar component. The flange apertures extend outwardly in the lateral and medial direction respectively to form humeral component lugs 56, 58 each of which has an aperture extending therethrough to accommodate the lugs 32, 34 of the radio-ulnar component. A first routing lug 60 extends anteriorly from the anterior surface of the narrower proximal section 48 of the humeral component. The lug 60 has a centrally disposed blind bore extending therein. Medial and lateral routing lugs 64, 62 of the same construction of superior routing lug 60 extend outwardly from the respective sides of the humeral component 46 midway between the narrower proximal section 48 and the wider elbow section 54 of the humeral component. The routing lugs provide attachments and routing for muscle/tendon fixation or fixation of a prosthetic equivalent. The journalling of the radio-ulnar component in the distal flanges 50, 52 of the humeral component 46 provide flexion-extension of the forearm with respect to the upper arm.

The ulna stem 40 extends through the surface of the ulna bone member at the proximal end thereof and into the bone canal of the ulna. The stem 40 is rotatable in the bearing member 16 which provides for medio-lateral swivel

of the ulna bone about the humero-ulnar joint. As has been previously described, the radius stem 38 extends longitudinally into the proximal end of the bone canal of the radius for securement therein. The bone stem 38 is capable of spherical rotation via the articulation of the convexed hemispherical head 24 and the hemispherical socket 22 to which it is connected. This allows for spherical rotation and movement of the radius about the radio-humeral joint. In this manner, the radius may be rotated over the ulna during movement from the supine to the prone position of the wrist ends of the radius and ulna. As is most clearly seen from a comparison of figure 1a and figure 1b, rotation of the radius over the ulna in the aforesaid movement causes the ulna to swivel slightly laterally with respect to the humero-ulnar joint and this combination provides improved freedom during supination-pronation of the wrist.

The distal radio-ulnar component is shown in greater detail in figures 2a and 2b. The distal radio-ulnar component 6 comprises an ulna engaging part 12 and a radius engaging part 8. The ulna engaging part 12 comprises an ulna stem 66 which, in use, extends longitudinally into the distal end of the ulna bone canal for securement therein. The ulna stem 66 is coupled via the bearing member 68 to the radius pin and bearing member 70. The distal radio-ulnar component parts are shown in greater detail in figure 2b. The distal ulna stem 66 extends proximally from a circular flange plate 72 and an axle 74 extends centrally from the distal side of the flange plate 72 in the opposite direction to the ulna stem 66, the axle 74 is, in use, journalled in the bearing member 68. Washers 76, 78 are located on either side of

the bearing member 68 and the axle 74 extends through the central aperture of the bearing member 68 and through both washers to be secured on the distal side of the bearing member 68 by a flat head screw 80. By arranging the mechanism in this manner, the bearing member 68 may rotate, in use, about the axle 74 whilst the axle, flange 72 and the ulna securing stem 66 remain stationery with respect to the distal end of the ulna. The ulna stem 66 and stem washer 76 have a small screw 77 fixed therein so that the head of the screw protrudes above the surface of the washer 76. The screw 77 slides within an arced recess (not shown) on the reverse side of bearing member 68, the extent of the slot determines the range of relative angular rotation of the radius with respect to the ulna and may be pre-determined to suit the application. The bearing member 68 has a pair of spaced flanges extending laterally therefrom and a superior-inferior extending aperture is formed in each flange and the flange apertures are aligned so that they may receive coupling pin 82 therethrough as will be described in greater detail below.

The distal end of the radius receives a pin 84 and sleeve pin 86 therethrough in the medio-lateral direction. The pin 84 is rotatable in the sleeve 86 and extends completely therethrough to be secured by axle securing flat head screw 88 at the opposite end of the sleeve. A pair of washers 90, 92 are located at either end of the sleeve 86 so that the pin 84 extends completely through the sleeve 86 and terminal washers 90, 92. The head 94 of the pin 84 has a flat head for abutting engagement against the exterior of the radius. A lug 96 extends from the exterior surface of the pin head 94 and includes a superior-inferior extending aperture therethrough to

facilitate coupling with the ulna distal component. The lug 96 includes a bush 98 and, in use, the lug and bush are sized for close fitting engagement between the spaced flanges of the bearing member 68 so the pin 82 may extend through the apertures 102, 104 formed in the flanges 106, 108 of the bearing member 68 and simultaneously through the bush 98 of the external lug 96. By arranging the couple in this manner, the distal end of the radio-ulnar joint may swivel about the superior-inferior axis of the pin 82 to facilitate ease of pronation-supination of the wrist end of the forearm. It is also found that during pronation-supination of the wrist end of the forearm, the pin and sleeve which extend laterally through the distal end of the radius also rotate slightly relative to each other and the provision of this pin and sleeve arrangement allows the natural movement of the joint during pronation and supination.

The fixation of the pins and stems as previously described are merely carried out using material and techniques known to those skilled in the art.

Referring to figure 4, an external elbow prosthesis has been adapted from the endoprostheses as previously described. For comparative purposes, the radio-ulnar component 110 is shown schematically in its usual endoprosthetic position and dotted lines are extended from its rotating elements to external features which provide the same utility. Accordingly, attachment means are provided for the upper arm (not shown). The upper arm attachment has straps 112, 114 extending downwardly therefrom on the lateral and medial side of the upper arm. The straps extend as far as lateral and medial flexion

extension pins 116, 118 which also engage the straps 112, 114 with inferior lateral strap 120 and inferior medial strap 122 which extend from the flexion extension pins 116, 118 respectively. The inferior strap 122 provides support on the inferior side of the ulna around the medial exterior of the elbow and terminates on the inferior side adjacent opposite strap 120 also extending inferiorly and around the external lateral side of the radius. A pair of swivel pins 124, 126 are located adjacent to each other on the inferior side of the elbow and are each respectively secured to the inferior ends of inferiorly extending straps 122 and 120. In addition, an arm extends longitudinally from each swivel pin 124, 126. The first ulnar arm 128 extends distally from ulnar swivel pin 124 and terminates in an inferior to superior extending bracket 130 which is provided with an aperture 132 at its superior end which is adapted for suitable wrist connections.Although not shown, aperture 132 is adapted to receive stem 66 and bridging boss 140 has hole 141 extending laterally therethrough which is designed to accept sleeve 86 shown in figure 2(b). The arm 128 may swivel laterally and medially with respect to the swivel pin 124 as appropriate during supination-pronation and vice versa of the wrist joint.

A second longitudinal arm 134 extends distally from the radio swivel pin 126 and terminates on the inferior side of forearm ring 136 which, in use, may extend around the circumference of the forearm. Accordingly, the ring 136 may swivel laterally and medially about radio-swivel pin 126 during articulation, in particular, pronation-supination of the wrist. The radius cupping member 138 extends longitudinally both distally and proximally from

the ring 136. The radius cupping member extends distally along the lateral side of the exterior of the forearm and terminates in a bridging boss 140 which extends in a medial direction towards the superior end of wrist bracket 130 of ulna arm 128. The bridging boss extends longitudinally slightly distally further than bracket 130 to accommodate the radio-ulnar component 6 as previously described. The radius cup 138 has a guide track engaging member 142 depending from the convexed side thereof and engaging with guide track 144 which extends circumferentially round the inside surface of the ring 136 so that during pronation and supination of the forearm the radius cup 138 may be guided around the circumference of the ring 136. During such articulation, the ring itself may swivel about the swivel pin 126 and 116 and the elongate ulna arm 128 may also swivel about the ulna swivel pin 124 to provide additional freedom during pronation-supination of the wrist.

The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment(s). The invention extend to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

CLAIMS

1. An elbow prosthesis comprising first articulation means to provide a spherical degree of freedom for the radius or its synthetic equivalent about the radio-humeral joint and second articulation means to provide a medio-lateral swivel of the ulna bone or its synthetic equivalent about the humero-ulnar joint.

2. An elbow prosthesis according to claim 1, wherein a proximal radio-ulnar component is provided which is associated with a humeral component for flexion-extension of the arm.

3. An elbow prosthesis according to claim 2, wherein the radio-ulnar component has radio-connection means suitable for connection with the proximal end of a radius bone or its synthetic equivalent, the radio-connection means adapted to provide said spherical degree of freedom about the radio-humeral joint.

4. An elbow prosthesis according to either claim 2 or 3, wherein ulnar-connection means are also provided on the radio-ulnar component, said means are adapted to provide said medio-lateral swivel of the ulna bone or its synthetic equivalent about the humero-ulnar joint.

5. A prosthesis for an elbow joint comprising:

a humeral component,

and a proximal radio-ulnar component,

the radio-ulnar component and the humeral component being associated for flexion-extension of the arm, the radio-ulnar component having radio-connection means suitable for interconnection with a radius bone or its synthetic equivalent and an ulnar connection means suitable for interconnection with an ulnar bone or its synthetic equivalent, wherein the radio-connection means is adapted to allow spherical rotation of the radius or its equivalent synthetic member about the radio-humeral joint and the ulnar connection means is adapted to allow medio-lateral swivel of the ulna bone or its equivalent synthetic member.

6. A prosthesis according to claim 5, wherein the radio-ulnar component forms a hinge joint with the humeral component to allow flexion-extension movement with respect thereto.

7. A prosthesis according to either claim 5 or 6, wherein the radio-ulnar component has a pair of lugs extending outwardly therefrom on the medial and lateral side of the component respectively, the lugs being journalled in corresponding sockets on the humeral component for flexion-extension movement about the medio-lateral axis of the lugs.

8. A prosthesis according to any of claims 5 to 7, wherein at least part of the radio-connection means fixedly engages with the proximal end of the radius.

9. A prosthesis according to any of claims 5 to 8, wherein the radius connection means comprises a spherically articulatable member for fixation to the

radius and which articulates, in use, with the radio-ulnar component for spherical articulation therewith.

10. A distal forearm prosthesis comprising a radio-ulnar component coupling the distal ends of the radius and ulna bones or their equivalent synthetic members, the component incorporating means to allow rotation of the distal region of the radius over the ulna during wrist pronation-supination whilst the ulna remains substantially stationery with respect to rotation about its longitudinal axis.

11. A distal forearm prosthesis according to claim 10, wherein said rotation of the distal end of the radius over the ulna is effected by means of an axle substantially aligned with the longitudinal axis of the ulna and an axle bearing member.

12. A prosthesis for a forearm comprising an upper arm component for securement to the upper arm and a forearm component for securement to the forearm, the upper arm component and forearm component being pivotably associated for flexion-extension of the forearm with respect to the upper arm, wherein the forearm component provides a first elongate member parallel with the longitudinal axis of the forearm and adapted for medio-lateral swivel about a superior-inferior axis located at the elbow region and a second elongate member parallel with the longitudinal axis of the forearm and which is also adapted for medio-lateral swivel about a superior-inferior axis located at the elbow region and which includes a ring at the distal end thereof which ring includes guide means on

the interior surface thereof and a third elongate member parallel with the longitudinal axis of the forearm and which is slidably mounted on the inside of the ring and guided around the ring by the guide means.

13. A prosthesis for a forearm according to any of claims 10 to 12, wherein the prostheses of claims 10 and 12 are utilised in tandem.

14. A method of implanting a prosthesis according to claim 1 onto the arm of a patient.

FIG. 1(a)

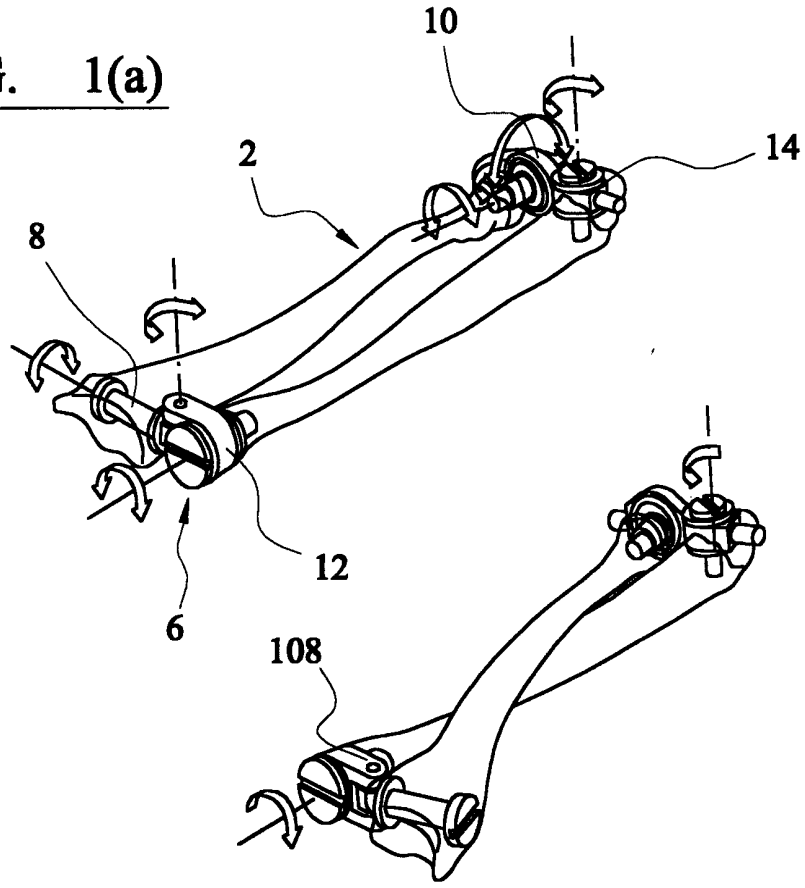

FIG. 1(b)

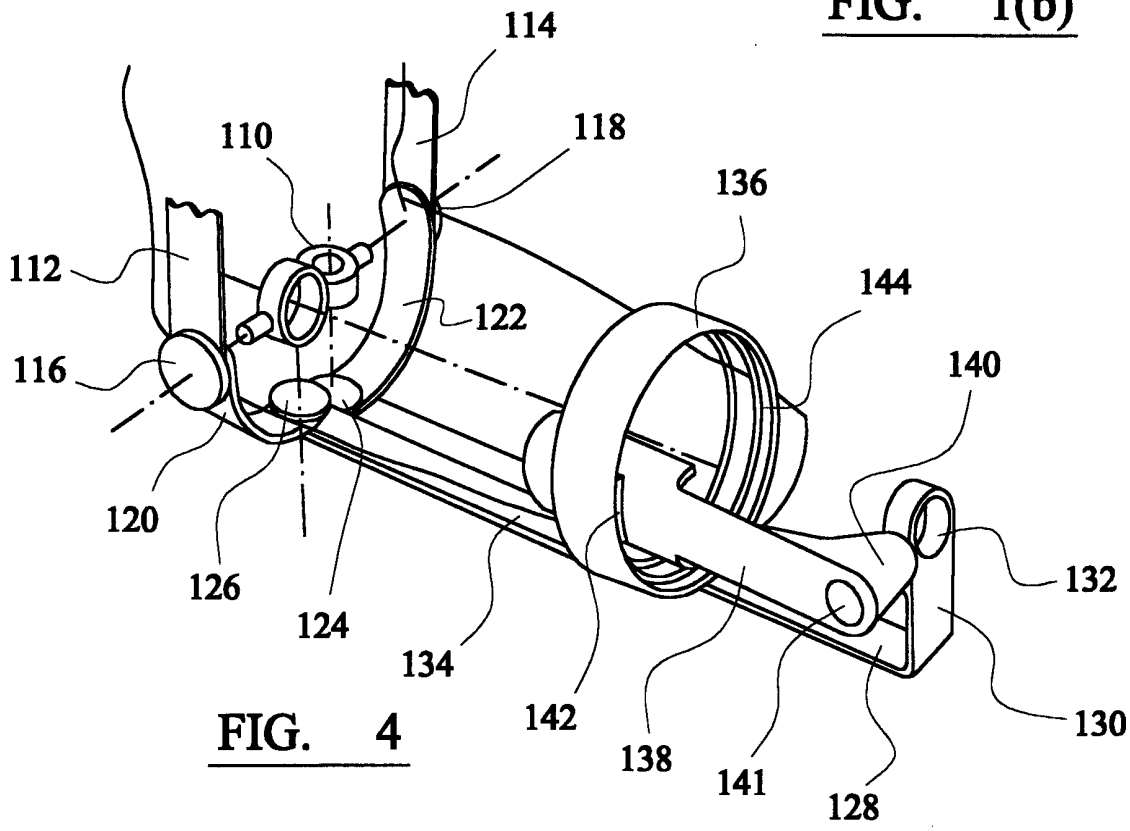

FIG. 4

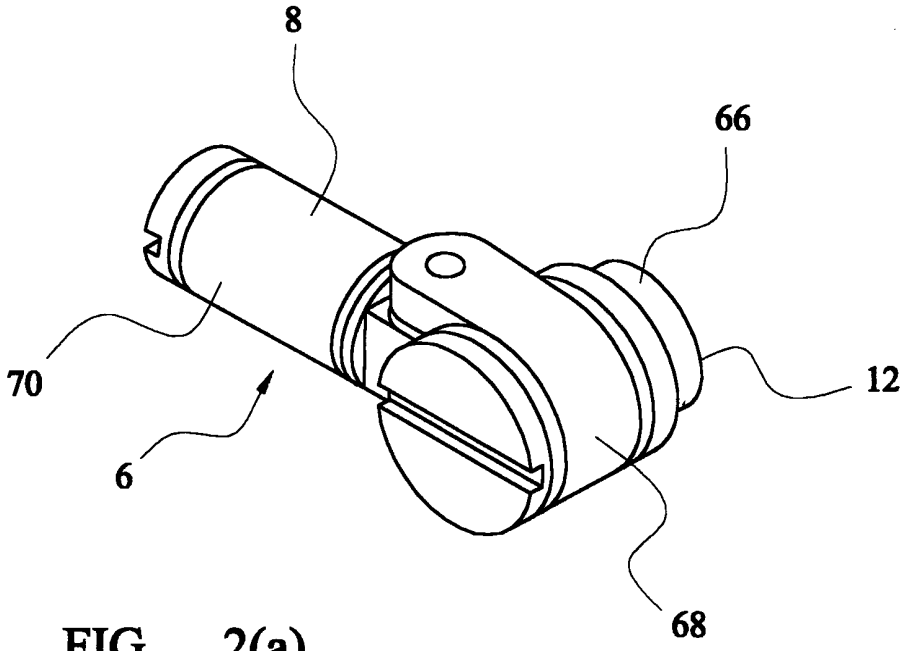
8
66
70
12
6
68

FIG. 2(a)

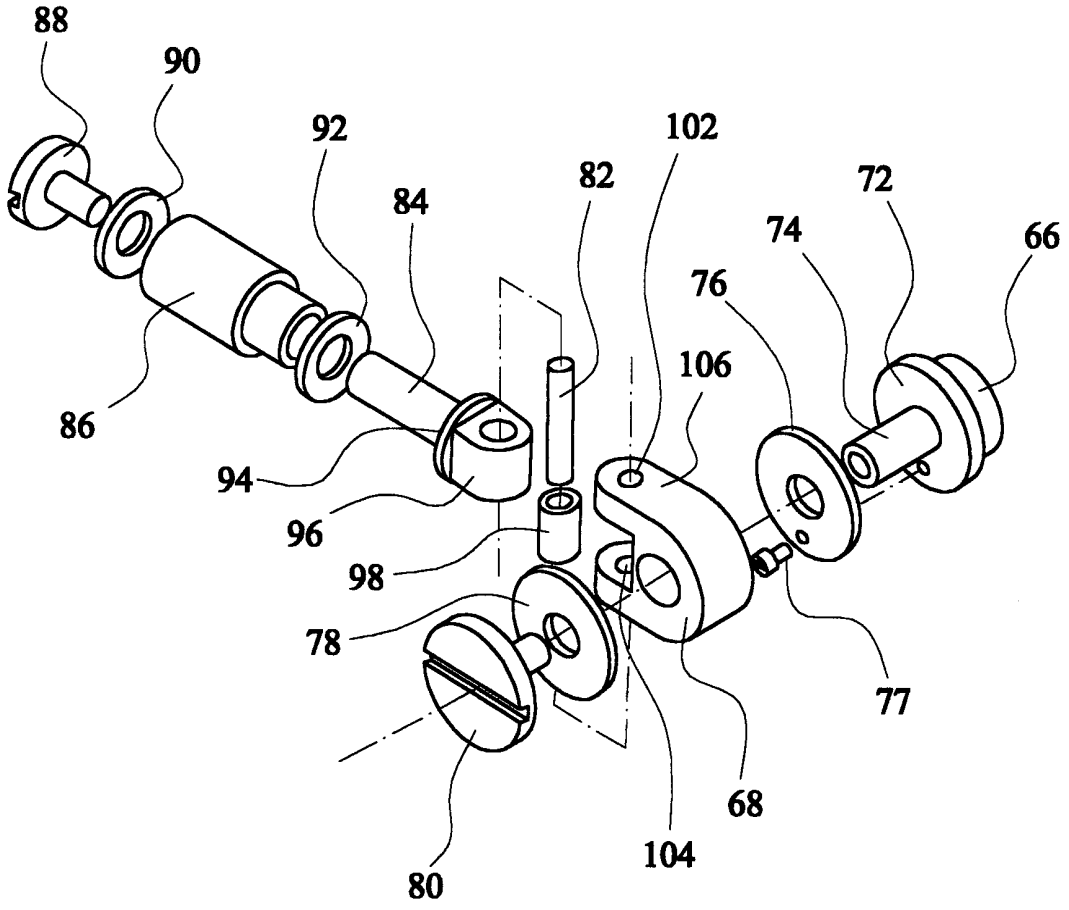
88
90
92
102
82
72
84
74
66
76
106
86
94
96
98
78
77
68
104
80

FIG. 2(b)

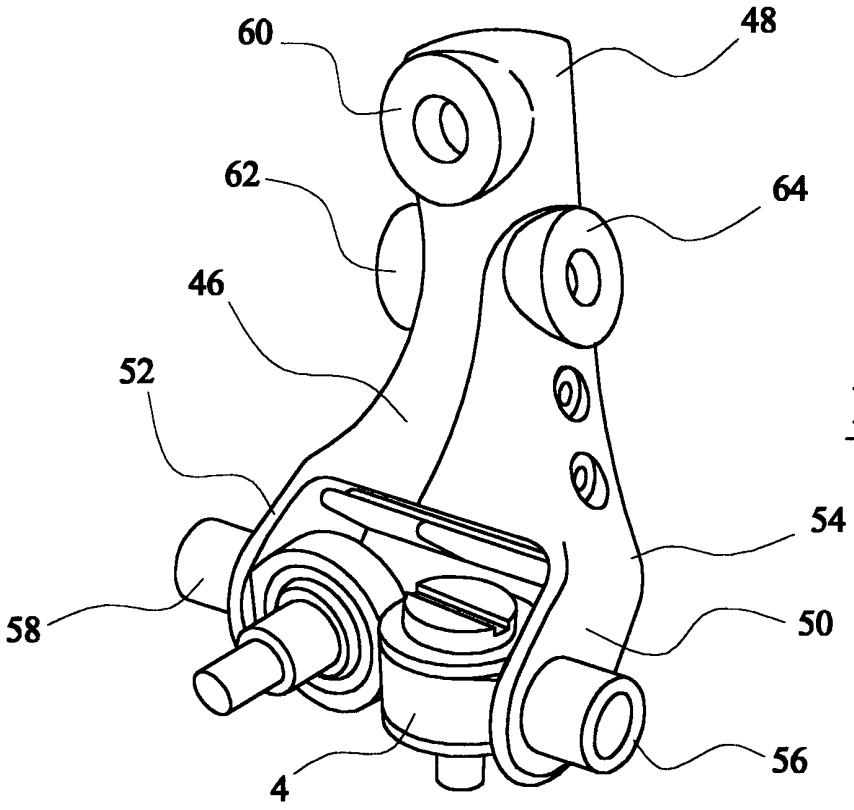

FIG. 3(a)

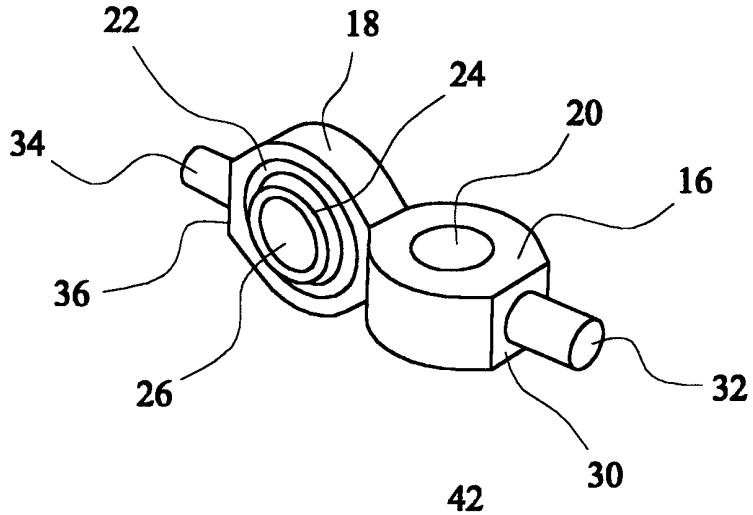

FIG. 3(b)

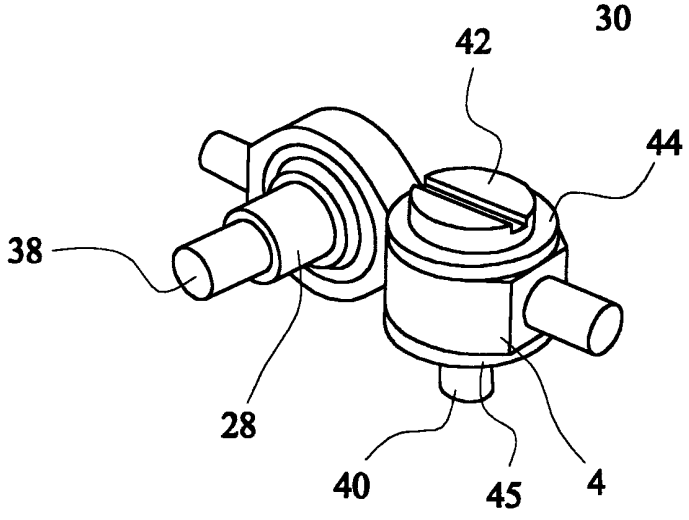

FIG. 3(c)