

[54] **PROSTHESIS FOR TOTAL
ARTHROPLASTY OF THE ELBOW JOINT**

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[58] Field of Search **3/1; 128/92 C, 92 CA, 92 R**

[56] **References Cited**

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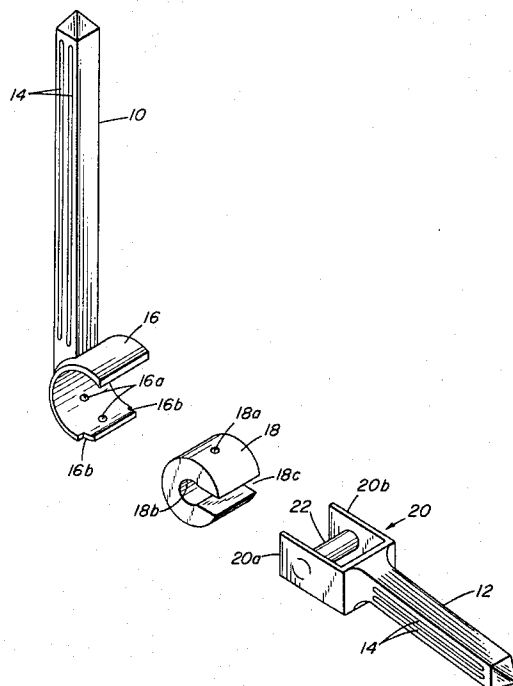
Attorney, Agent, or Firm—Spencer E. Olson

[57]

ABSTRACT

A prosthesis for total replacement arthroplasty of the elbow joint consists of a hinge joint having two intramedullary stems adapted for insertion into the medullary canals of the humerus and the ulna respectively, and which is articulated at the time of operation. The free end of one of the stems is formed with an integral partial cylinder within which is secured a cylindrical bearing member formed of ultra high density polyethylene having an axial bore for receiving a pivot pin carried on the free end of the other stem. A radial slot in the bearing member, of a width slightly less than the diameter of the pivot pin, allows the pin to be snapped into the bore of the bearing member to form the hinge joint.

9 Claims, 5 Drawing Figures



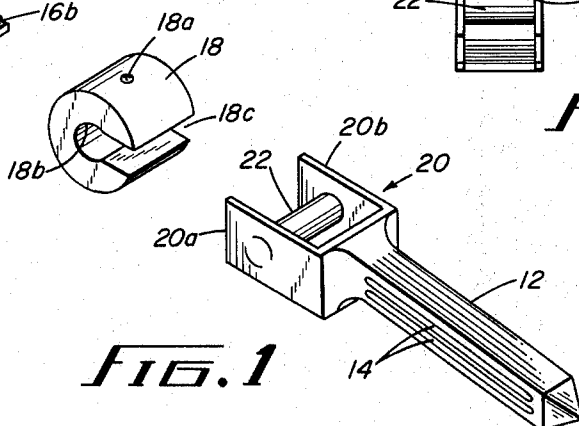
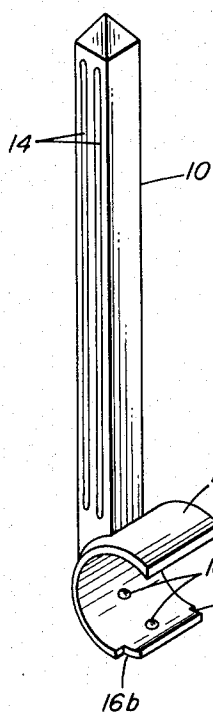


FIG. 1

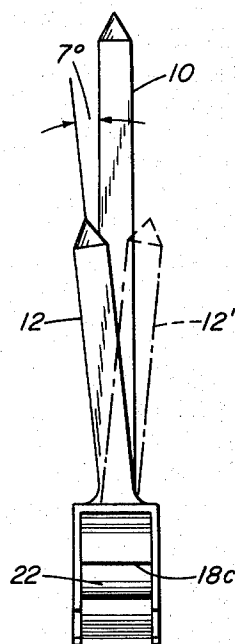


FIG. 3

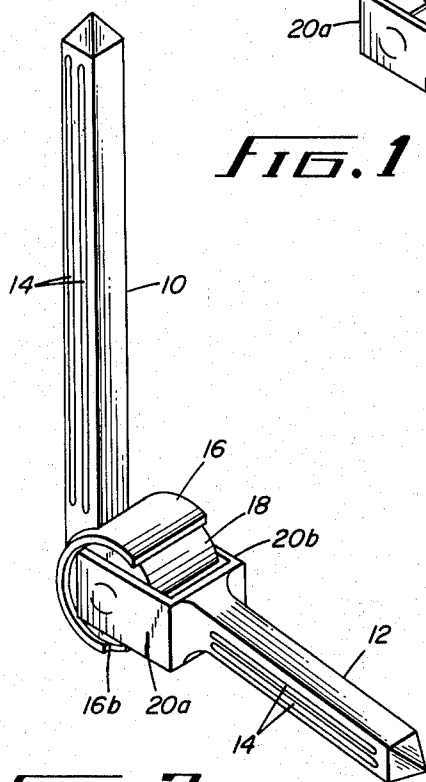


FIG. 4

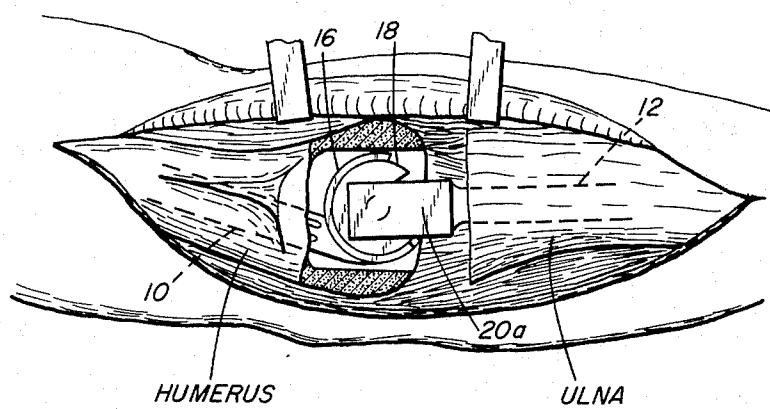


FIG. 5

PROSTHESIS FOR TOTAL ARTHROPLASTY OF THE ELBOW JOINT

BACKGROUND OF THE INVENTION

Research workers all over the world for many years have attempted a variety of methods of arthroplasty to lessen the disability for the patient suffering from rheumatoid arthritis of the elbow joint, or to replace elbow joints which are relatively immobile due to other causes such as shattering of the joint as by gunshot. The development of relatively nonreactive metallic implants has made it possible to successfully replace the elbow joint. To be successful, the arthroplasty must not only restore movement and abolish pain, but must also provide a stable fulcrum for the forearm.

Devices of various types have been developed in an attempt to satisfy these objectives, two of which are described in the following articles:

"Arthroplasty of the Elbow Joint Using A Vitallium Prosthesis," Constantin Chatzidakis, M.D., *International Surgery*, Vol. 53, No. 2, February, 1970.

"Total Replacement Arthroplasty of the Elbow Joint for Rheumatoid Arthritis," Roger Dee, *The Journal of Bone and Joint Surgery*, Vol. 54B, No. 1, February, 1972.

The prosthesis described in these articles consists essentially of a hinged joint cast in two sections from a chrome-nickel-cobalt alloy known as Vitallium (trademark of Howmedica, Inc., New York, N.Y.) which is articulated at operation by means of an axis pin. The prosthesis described by Roger Dee, which has enjoyed some acceptance in Europe, has a bifurcated member at the free end at one of the stems for receiving the free end of the other stem, the two members being pivotally joined and held together by a soft metal pin. One end of the pin is flared at manufacture and after the stems have been inserted in the medullary canals, the pin is inserted and retained by flaring the other end with a special G-clamp. Both stems are curved with their convexity posteriorly, and the stem of the ulnar component also has a curve which is convex laterally and follows the corresponding curve of the olecranon and proximal part of the ulnar shaft. Because of this, separate prostheses have to be made for the left and right elbows. Moreover, because of the large size of the hinge joint of the Dee prosthesis, it is necessary to completely resect the muscle attachments at the distal humerus, thus seriously weakening the muscles that extend the arm.

Insofar as applicant is aware, all prostheses of the kind here under consideration, including the just-described Dee device, employ a metal-to-metal hinge joint of dissimilar metals which has undesirably high friction which limits its action and, more significantly, results in abrasion of the contacting parts and release of metallic particles which are dispersed to the tissue surrounding the implant which often cause "giant cell" reaction. The abrasion also causes pitting of the mating parts which is aggravated by cathodic action that takes place due to the pin and stems being formed of different metals. Indeed, the bearing pin frequently deteriorates to a degree to require replacement which, of course, subjects the patient to another operation.

SUMMARY OF THE INVENTION

The primary object of the present invention is to provide an improved prosthesis for total replacement arthroplasty of the elbow joint which eliminates the above-outlined shortcomings of currently available prostheses of this type. A more specific object is to provide a total elbow prosthesis which is smaller than those currently available, is relatively simple and inexpensive to fabricate, and which is more easily articulated at operation than the prostheses now available.

These and other objects are accomplished in a prosthesis consisting of a hinge joint having two stems which are inserted into the medullary canals of the humerus and the ulna, respectively, and which, like the prior art devices, is articulated at the time of operation. The stems are formed of relatively nonreactive metal, preferably Vitallium, one end of one of which is formed with an integral partial hollow cylinder within which is secured a cylindrical bearing member formed of ultra high density polyethylene. The bearing member is retained within the partial cylinder by a plurality of protuberances or bosses formed on the inside wall of the cylinder which engage corresponding depressions in the outer surface of the polyethylene cylinder. The bearing member has an axial bore and a slot which extends radially from the bore to its outer surface, the slot having a width slightly smaller than the diameter of the bore. The other stem has a generally U-shaped member integrally joined to the free end thereof, the spacing between the legs of which being slightly greater than the length of the bearing and in which is supported a bearing pin having a diameter substantially equal to the diameter of the bore in the bearing member. The polyethylene is sufficiently resilient that the bearing pin can be readily forced through the slot in the bearing member to thereby articulate the joint, yet safely and reliably join the two stems together. Thus, the joint has a low-friction metal-to-polyethylene bearing which substantially eliminates the possibility of foreign particles being dispersed into the surrounding tissue and which is not subject to cathodic action. There are no protruding fastening means for the bearing member, and the bearing pin is also flush with the outer surfaces of the U-shaped member so as not to cause irritation of surrounding tissue.

Another important feature of the prosthesis is that the longitudinal axis of the ulnar stem (the one carrying the pivot pin) is at an angle of approximately 7° relative to a line perpendicular to the axis of the pin so as to correspond to the natural carrying angle of the arm. The stem and the integral U-shaped member being otherwise symmetrical it is thus possible to use the same ulnar stem for both the left and right arms simply by flipping the stem through 180 degrees prior to insertion in the bearing member. Thus, it is unnecessary to provide a different prosthesis for the left arm than for the right.

DESCRIPTION OF THE DRAWINGS

Other objects, features, and advantages of the invention, and a better understanding of its construction and operation will be had from the following detailed description, taken in conjunction with the accompanying drawings, in which:

FIG. 1 is an exploded isometric view of the prosthesis according to the invention;

FIG. 2 is an isometric view of the assembled prosthesis;

FIG. 3 is an elevation view of the prosthesis illustrating the angular relationship between the two stems;

FIG. 4 is an enlarged fragmentary cross-sectional view of one of the stems illustrating the construction of the bearing member; and

FIG. 5 is a lateral cutaway view of the human elbow showing the prosthesis in place.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The prosthesis according to the invention, which is shown substantially full size in the drawings, consists of two intramedullary stems, a humeral stem 10 for insertion into the medullary canal of the humerus, and a somewhat shorter ulnar stem 12 to be inserted in the ulna. Typically, the humeral stem is four inches long and the ulnar stem has an overall length of 2¾ inches. Both stems are preferably of square cross-section, typically one-quarter inch square, and slightly pointed at one end and are formed, as by casting, of a chrome-nickel-cobalt alloy known as Vitallium. At least two sides of both stems, preferably opposite sides as shown, are fluted with one or more grooves 14 to improve their bond with the acrylic cement employed to secure the stems in the intramedullary canals.

Integrally joined to one end of the humeral stem 10 is a partial cylinder 16, also formed of Vitallium, the longitudinal axis of which is perpendicular to the longitudinal axis of stem 10. The cylindrical member 16 is typically ½ inch long and ¾ inch in diameter, encompasses slightly more than a 180° arc, with the open side of the cylinder essentially straddling a plane containing the longitudinal axis of the cylinder and lying perpendicular to the longitudinal axis of the stem 10.

As best seen in FIGS. 1 and 4, a plurality of protuberances or bosses 16a are formed on the inner wall of partial cylinder 16 which, in cooperation with the arcuate shape of the cylinder, serve to retain a cylindrical bearing member 18 within the cylinder. The bearing member 18 is preferably formed of ultra high density polyethylene and has a like plurality of depressions 18a formed in the outer surface thereof at locations to be engaged by the bosses 16a when it is inserted in the partial cylinder. The bearing member is dimensioned to be received in the partial cylinder 16 with a press fit and is sufficiently elastic as to be pressed into either end of cylinder 16, over the bosses 16a, until it is centered within the cylinder with the bosses engaging the depressions in the plastic member. The bearing member has an axial bore 18b and is formed with a slot 18c which extends radially from the bore to the outer surface. As best seen in FIG. 4, the width of the slot 18c is slightly smaller, typically 1½ mm., than the diameter of the bore 18b. The bore 18b is slightly truncated, being of slightly larger diameter at its ends than at the midpoint, for reasons to be discussed below.

The stem 12 has integrally joined to end thereof, as by casting, a U-shaped member 20 the arms 20a and 20b of which are spaced apart a distance slightly greater than the length of bearing member 18 and have a height dimension somewhat less than the diameter of the bearing member, typically 7/16 inch. The length of the arms is approximately equal to the diameter of the bearing member and there is supported therebetween, at a point essentially midway of the height dimension

of the arms and approximately ¼ inch in from their free ends, a bearing pin 22 having a diameter approximately 1½ mm larger than the width of slot 18c and approximately equal to the midpoint diameter of the truncated bore 18b to allow it to be "snapped" through the slot. The slight truncation of bore 18b allows a slight amount of "toggle" between the pin and bore in the lateral plane, and is designed to allow movement of pin 22 through an angle of approximately ±3° relative to bearing member 18 to compensate for deviation in individual patients from the average carrying angle of 7° incorporated in the design of the prosthesis. Moreover, the non-rigid joint minimizes the chance of breakage of the bearing member or pin in the event the patient should fall on the elbow. The pin 22, also formed of Vitallium, is secured in openings in the arms 20a and 20b, preferably by electrowelding, and the ends ground smooth and flush with the outer walls of the arms, as by centerless grinding, to remove any source of irritation to surrounding tissue.

As shown in FIGS. 1 and 2, cylinder 16 is slightly longer than bearing member 18 and has cutouts 16b at the lower front edge thereof which serve as stops for the arms 20a and 20b when the stem 12 is at an angle of about 180° relative to stem 10, thereby to prevent motion of the forearm beyond its normal fully extended position. Because in the average human the center line of the humerus makes an angle of about 7° with the center line of the ulna (the one of two bones of the forearm that articulate), the stem 12 is formed such that its longitudinal axis makes an angle of approximately 7° with the longitudinal axis of stem 10 when the joint is articulated. Although evident in FIGS. 1 and 2, this feature is best seen in the elevation view of FIG. 3 where it is seen that the axis of stem 12 is at an angle of 7° relative to the longitudinal axis of stem 10. This angle is outward from the body with the consequence that stem 12 must be on one side or the other of stem 10 depending upon whether the implant is in the left or the right arm. By virtue of the symmetrical location of pin 22 in the U-shaped member 20, it is possible to accommodate either the left or right arm with the same device by inserting stem 12 in the orientation shown in FIG. 1 and in solid line in FIG. 3 for one arm and simply flipping the stem 12 through an angle of 180° from the position shown in FIG. 1 when the implant is to be made in the other arm. In the latter case, shown in dot-dash lines in FIG. 3, the 7° angle is at the opposite side of the center line of stem 10.

Without going into the full details of the operation procedure, the manner in which the prosthesis is inserted will now be generally described with reference to FIG. 5. Good access to the medial and lateral aspects of the elbow is provided by a curved postero-radial incision and by raising full thickness flaps. Depending on the nature of the damage to the osseous structures, the proximal ulna is cut away and a slot is cut in the distal humerus having a width sufficient to accommodate the pivot joint of the prosthesis. By virtue of the ability to accommodate the present relatively small prosthesis in the slot in the humerus, the amount of bone that need be removed from the ulna is such that the triceps insertion is never completely destroyed, that is, the muscle that extends the arm is not appreciably weakened by the operation. The medullary cavities are reamed out to the necessary depth to receive the stems 12 and 14 and the proximal portions shaped as needed using a

rasp. The ulnar stem is then cemented into position with acrylic cement, for example, and after a trial reduction, the humeral stem is also cemented into place. Alternatively, in cases where the ligamentous structure is so tight as to preclude pulling apart of the components of the elbow, the cement is initially put into both cavities and both stems introduced simultaneously, with the pin 22 engaging the outer extremity of the slot 18c. The joint is articulated by snapping the pin 22 through slot 18c into the bore 18b of the bearing member. Articulation can be accomplished with relatively little force, and thus minimal trauma to the patient, and requires no special tools. Similarly, in the unlikely event that the prosthesis need ever be repaired or removed, special tools are not required to disengage the pin from the bearing member.

It will be apparent from the foregoing that applicant has provided a total elbow prosthesis which by reason of its small size permits improvement in the surgical procedure, is free of external protuberances that could cause irritation of surrounding tissue, has low friction, does not have metal-to-metal contacts which can cause dispersion of reactive metal particles or result in deleterious cathodic action, and which can be readily articulated without the need for special tools. While there is disclosed what is now considered to be a preferred embodiment, many modifications and variations therein will be readily apparent to those skilled in the art. Accordingly, all such variations and modifications are included within the intended scope of invention as defined by the following claims.

I claim:

1. Prosthesis for total replacement of the elbow joint of humans comprising,

first and second elongated stems formed of a metal alloy which is essentially nonreactive with body tissue,

said first stem having a U-shaped member integrally joined to and extending from one end thereof,

a pivot pin secured to and extending between the arms of said U-shaped member,

said second stem having a bearing member integrally joined to one end thereof, said bearing member including a cylindrical non-metallic member having an axial bore of substantially the same diameter as said pivot pin for supporting said pivot pin to form a hinge joint, said non-metallic member having a slot extending radially from the bore to the outer surface thereof and having a width sufficiently smaller than the diameter of said pivot pin that said pin is normally retained in the bore yet allows the pivot pin to be forced through the slot to permit articulation of the hinge joint after insertion of said items in their respective intramedullary canals.

2. Prosthesis in accordance with claim 1, wherein said bearing member comprises a hollow partial cylinder formed of the same material and integrally joined

to said second stem with its longitudinal axis perpendicular to the longitudinal axis of the stem, and

wherein said cylindrical member is formed of high density polyethylene and is secured within said partial cylinder with the bore coaxial with the axis of the cylinder and with said slot lying in a plane which includes the axis of the cylinder and is substantially perpendicular to the longitudinal axis of said second stem.

3. Prosthesis in accordance with claim 2, wherein the longitudinal axis of said first stem is offset approximately 7° from an imaginary plane including the longitudinal axis of said second stem and perpendicularly bisecting said pivot pin.

4. Prosthesis in accordance with claim 3, wherein the bore in said cylindrical member is truncated so as to have a slightly larger diameter at its extremities than at its midpoint for allowing lateral toggle action of the hinge joint.

5. Prosthesis in accordance with claim 3, wherein said first stem is shorter than said second stem.

6. Prosthesis in accordance with claim 3, wherein said stems are of square cross-section.

7. Prosthesis in accordance with claim 2, wherein said hollow partial cylinder has an inner diameter to receive said cylindrical member with a press fit and encompasses an arc of at least 180° and has a plurality of bosses protruding from the inner wall thereof each engaging a respective one of a corresponding number of depressions formed in the outer surface of said cylindrical member for securing said cylindrical member within said partial cylinder.

8. Prosthesis in accordance with claim 2, wherein said partial cylinder is formed with stops for engaging the arms of said U-shaped member to limit the included angle between the two stems to approximately 180°.

9. In a prosthesis consisting of a hinge joint having a pivot pin and a bearing member pivotally engaging the pivot pin, an improved bearing member comprising, a hollow partial cylinder formed of a metal alloy which is essentially nonreactive with body tissue, and which encompasses an arc of at least 180°, and

a cylindrical member formed of high density polyethylene and having an axial bore and an outer diameter substantially equal to the inner diameter of said partial cylinder secured within said partial cylinder,

said partial cylinder having a plurality of bosses protruding from the inner wall thereof and distributed over its arcuate length each engaging a respective one of a corresponding number of similarly distributed depressions formed in the outer surface of said cylindrical member for preventing axial movement of the cylindrical member relative to the partial cylinder.

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