United States Patent [19]

Swanson

[11] **3,875,594**

[45] **Apr. 8, 1975**

[54] **SURGICALLY IMPLANTABLE PROSTHETIC JOINT HAVING LOAD DISTRIBUTING FLEXIBLE HINGE**

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[73] Assignee: **Dow Corning Corporation,** Midland, Mich.

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[21] Appl. No.: **391,947**

[52] **U.S. Cl.** ..... **3/1;** 128/92 C

[51] **Int. Cl.** **A61f 1/24**

[58] **Field of Search** ..... 3/1; 128/92 C

[56] **References Cited**

UNITED STATES PATENTS

3,462,765	8/1969	Swanson	3/1
3,593,342	7/1971	Niebauer et al.	3/1
3,739,403	6/1973	Nicolle	3/1

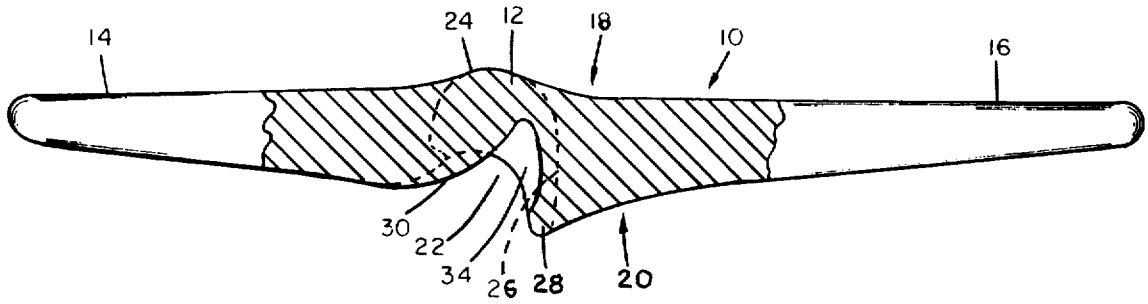
Primary Examiner—Ronald L. Frinks

Attorney, Agent, or Firm—Price, Heneveld, Huizenga & Cooper

[57] **ABSTRACT**

A one-piece surgically implantable prosthetic joint of molded silicone rubber. The prosthesis consists of enlarged midsection and a pair of oppositely projecting distal and proximal stem portions. The volar side of the midsection has a transverse channel extending across its width forming a flexible hinge. The side wall of the channel at the proximal stem side has a central depression formed therein to allow for the redistribution of compression forces and to accommodate displaced material from the reinforced base of the distal stem portion into the midsection on flexion movement.

2 Claims, 7 Drawing Figures



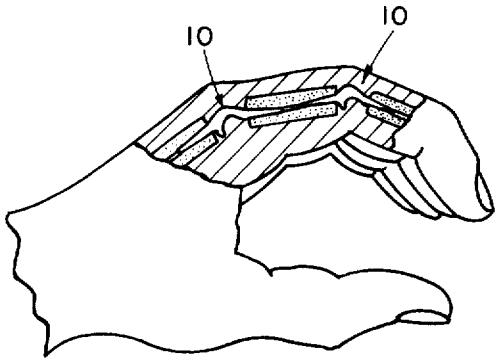


FIG 1

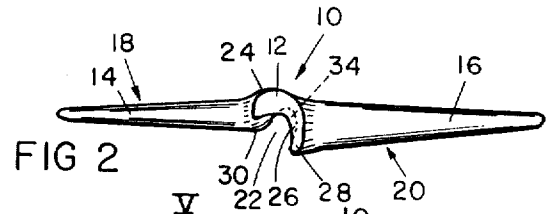


FIG 2

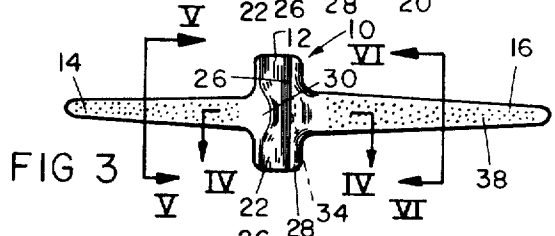


FIG 3

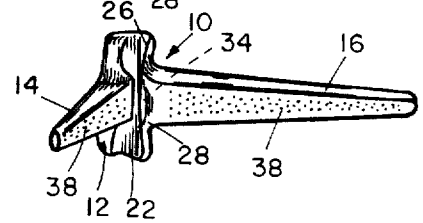


FIG 7

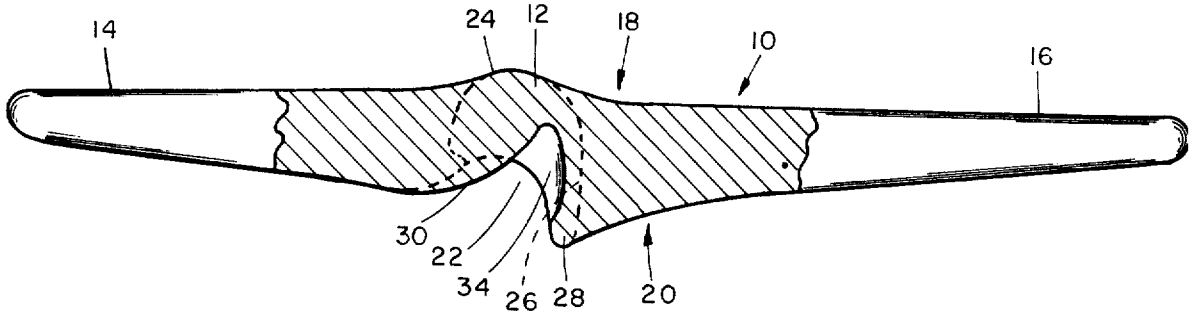


FIG 4

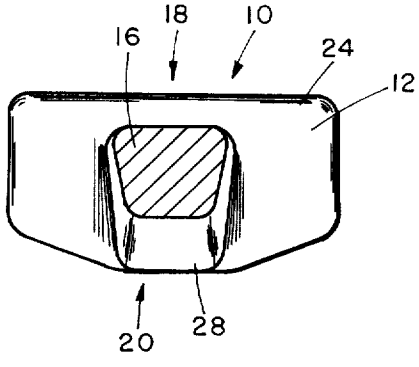


FIG 6

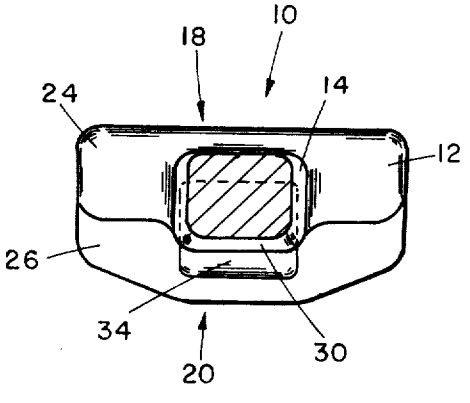


FIG 5

SURGICALLY IMPLANTABLE PROSTHETIC JOINT HAVING LOAD DISTRIBUTING FLEXIBLE HINGE

BACKGROUND OF THE INVENTION

The present invention relates to surgically implantable prosthetic devices for replacing skeletal joints. More particularly, the invention relates to such joint prosthesis having an improved flexible hinge formed therein.

The replacement of damaged or diseased joints in the human body has been known for some time. If the device used to replace the natural joint structures was to be movable in a manner similar to the natural joint it was once necessary to provide a multiple part structure of rigid clinically inert material. Generally, metals such as stainless steel alloys were used for this purpose. Such rigid structures, however, were subject to breakage and were difficult to implant and hold in place once implanted. Tissue growth commonly caused malfunction of the device, necessitating further surgery. Furthermore, while some metals are considered to be clinically inert, some risk of deterioration of the device with time continues to exist.

In Applicant's prior U.S. Pat. No. 3,462,765, issued Aug. 26, 1969, entitled SURGICALLY IMPLANTABLE PROSTHETIC JOINT, there is disclosed an improved surgically implantable joint prosthesis which is insofar as possible not subject to breakage or the effects of tissue growth or slight deterioration. The flexible, one-piece joint therein disclosed has received wide medical acclaim and improved markedly the prognosis for restruction patients. The instant invention is a subtle but extremely significant improvement thereover.

SUMMARY OF THE INVENTION

The present invention provides means for localizing the flexure at the midsection wherein a thickened reinforced portion of the distal end at the midsection is allowed to flex into a depression formed in the proximal middle area of the volar aspect of the midsection. Flexure can thus occur more easily as the thickened area moves into the depression during flexure. Accordingly, flexure loading is decreased while flexure life is increased without sacrificing strength and stability of the joint. The improved hinge further allows for redistribution of compression forces as the material is displaced during flexion to thereby maintain a natural joint alignment.

The many objects and advantages of the present invention will become readily apparent to those skilled in the art from a consideration of the following detailed description of the preferred embodiment when read in conjuction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial cross section of a human hand showing the implant of prosthetic joints of the present invention;

FIG. 2 is a side elevational view of the prosthesis of the invention;

FIG. 3 is a plan view of the joint as viewed from the volar side;

FIG. 4 is an enlarged partial cross-sectional view taken along the plane IV—IV of FIG. 3;

FIG. 5 is an enlarged cross-sectional view of the distal stem taken along the plane V—V of FIG. 3;

FIG. 6 is an enlarged cross-sectional view of the proximal end taken along the plane VI—VI of FIG. 3; and

FIG. 7 is a perspective view generally along the volar side showing the prosthetic joint in a flexed position.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, FIG. 1 illustrates the placement of the prosthesis of the invention for the knuckle and finger joints in a human hand. The natural joint is partially surgically removed and the intramedullary canals of the adjacent bone ends are prepared with a curette, broach, or drill to receive the stem portions of the prosthesis. The connective tissue, fascia and skin are replaced following implantation. Since the exact surgical procedure involved in the implanting of the joint forms no part of the present invention, it will not be described in detail.

The joint includes an enlarged midsection **12** from which a pair of oppositely directed stem members **14** and **16** extend. For convenience, the shorter stem **14** will hereinafter be referred to as the distal stem or end, while the opposite, longer stem will be referred to as the proximal stem or end **16.** As shown in FIG. **2,** the upper surface of the prosthetic joint will be referred to as the dorsal surface and the lower surface **20** the volar surface. As will be apparent to those skilled in the art, the terms "distal", "proximal", "dorsal", and "volar" refer to the general orientation of the prosthetic joint when implanted in a human hand.

It will be realized that although hand joints are shown in the drawings for illustrative purposes, the present invention may be used to replace various other joints as well. Obviously, size, precise shape, and the angle at which the stem portions project from the enlarged midsection may be varied to adapt the device to the site at which the prosthesis is to be implanted.

Referring additionally to FIGS. **2–7,** the enlarged midsection **12** is provided with a transversely extending trough or channel **22** which serves to form the flexible hinge. Channel **22** opens from volar surface **20** and extends upwardly. A rounded, thickened, transverse section **24** is provided above channel **22** on the dorsal surface **18.**

The side wall **26** of trough **22** extends downwardly at the proximal side to form an integral intersection with proximal stem **16.** As shown in FIG. **6,** the proximal stem is generally rectangular in cross section tapering along its length outwardly form its thickest portion at the intersection with wall **26.** The volar surface of stem **16** flows outwardly forming a rounded volar interface **28** (FIG. **4**) at its intersection with wall **26** at volar surface **20.**

Distal stem **14** is similarly generally rectangular in cross section tapering slightly outwardly from its outer end to its thickened portion at the intersection with midsection **12.** The thickened portion **30** of the distal stem at the volar surface curves upwardly into the channel **22** opposite wall **26** to form the opposite boundary of the channel **22.** The distal stem is slightly offset or placed relatively dorsal to the proximal stem to give better control of the palmar displacing forces. The thickened curved portion **30** of the distal stem at the intersection with the midsection serves to localize flexion at the channel **22,** thus discouraging any tendency toward flexion at the stem-midsection interface.

A depression or recess **34** is provided in the volar, proximal middle area of wall **26** to accommodate the thickened portion **30** of the distal stem upon flexure. Flexion can thus occur more easily as the thickened area **30** moves into the depression **34.** The depression **34** also allows for the redistribution of compression forces during flexion to maintain joint alignment. The thickened portion **30** of the distal stem and its inherent cooperation with depression **34** in the central area of wall **26** decreases flex loading and actually increases flex life while still maintaining strength and stability of the joint. The dorsal and volar surfaces of the distal and proximal stems may be provided with irregularities as slightly raised dimples **38** for tissue ingrowth and to anchor the implant more securely in position.

Preferably, the implantable prosthetic joint of the invention is molded of flexible elastomeric, physiologically inert, material. CLEAN ROOM DOW CORNING Silicone Rubber Compound No. MDX 4-4515, available from the Dow Corning Corporation, Midland, Michigan, is one material selected to meet the requirements of the flexible joint implant. While the prosthetic device is described as being made of silicone rubber, it will be realized that other flexible, clinically inert materials having sufficient strength may be used.

Those skilled in the art will, of course, readily appreciate the many advantages of the present invention over that shown in the prior art. Those so skilled will also recognize that many modifications may be made and it is intended that the equivalent arrangements be covered unless the following claims by their wording expressly state otherwise.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows.

1. A surgically implantable prosthesis for replacing bone joints comprising: a one-piece body of flexible inert material, said body having an enlarged central midsection and a pair of outwardly directed stem portions; said stem portions corresponding generally to the dimension of the intramedullary canals of the bones adjacent said joint for implantation therein, said midsection extending laterally outwardly on both sides of said stem portions; a wall formed at the intersection of one of said stem portions and said midsection, said wall defining a longitudinal channel extending through said midsection and forming a hinge between said stem portions; the other of said stem portions having an area of thickened cross section at its intersection with said midsection; and a depression formed in said wall to accomodate displacement of said material upon bending movement of said one of said stem portions with respect to said other of said stem portions.

2. A flexible prosthetic joint for replacing bone joints comprising an elongated body having a distal stem and an oppositely directed proximal stem separated by an enlarged midsection formed of flexible inert material, said midsection extending transverse to said elongated body and having a recess formed along its transverse length opening from the volar side of said joint; said midsection having an area of thickened cross section forming a hinge at the dorsal surface of said body between said distal and proximal stems; said distal stem being tapered along its length and having an area of thickened cross section at its intersection with said midsection; and a wall surface of said recess at the proximal side thereof having a depression formed therein to accommodate said thickened area of said distal stem upon flexion of said hinge.

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