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Deyerle

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[54] **ACETABULAR CUP PROSTHESIS COMPONENT FOR TOTAL OR SUBTOTAL HIP PROSTHESIS SYSTEM**

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[51] **Int. Cl.²** **A61F 1/24**

[58] **Field of Search** ..... 3/1, 1.9–1.912; 128/92 C, 92 CA, 92 R

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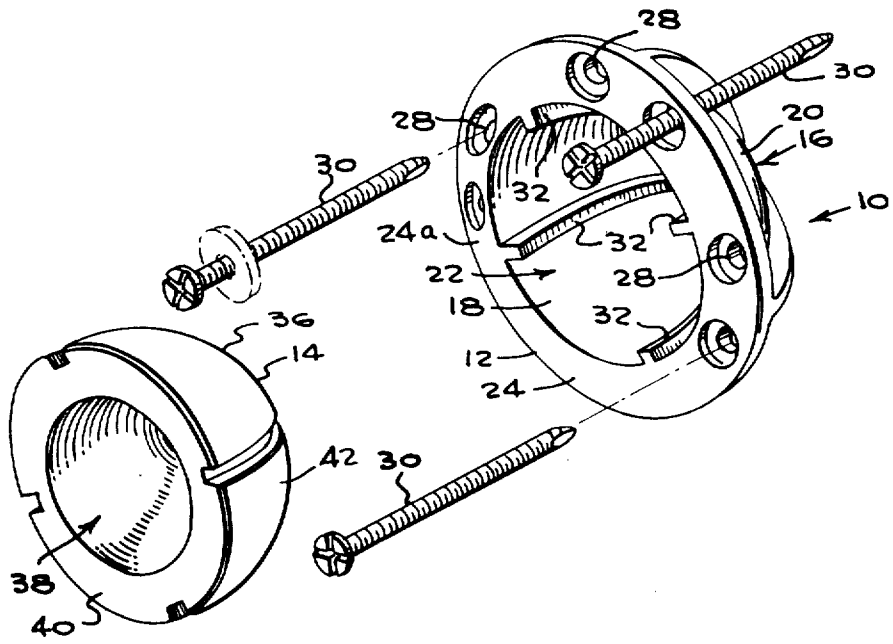
[57] **ABSTRACT**

An acetabular cup prosthesis assembly for total or subtotal hip replacement, including a metallic, unitary cup member having a dome portion defining a socket larger than the head of the femur or femoral prosthesis component to be accommodated, and including an integral flange rim to seat against the acetabulum and be secured thereto by screws. The cup has sharp edged fins to be seated in the acetabulum and restraining ribs on the interior surface of the socket. A replaceable plastic liner insert of hemispheric configuration interfits in the socket and has grooves shaped to provide a snap fit with the restraining ribs.

16 Claims, 7 Drawing Figures



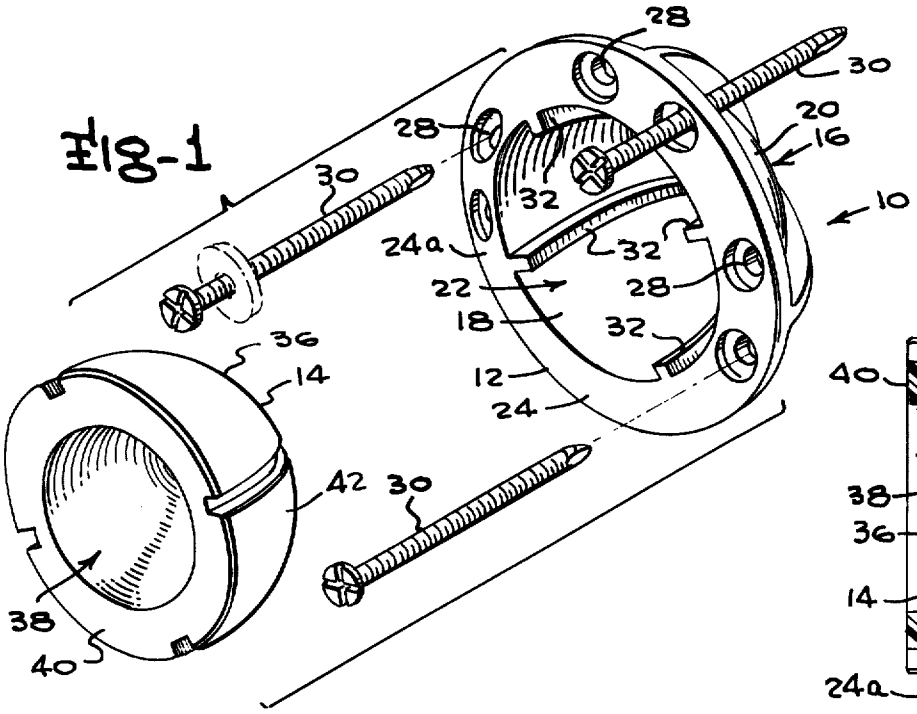


Fig-1

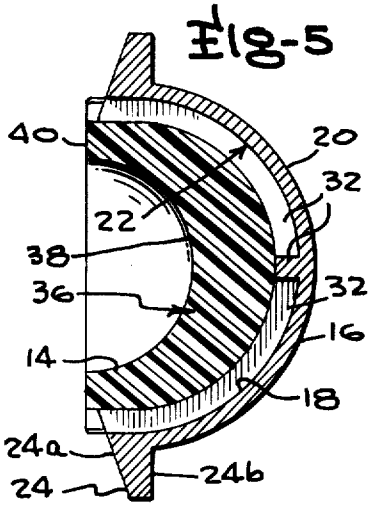


Fig-5

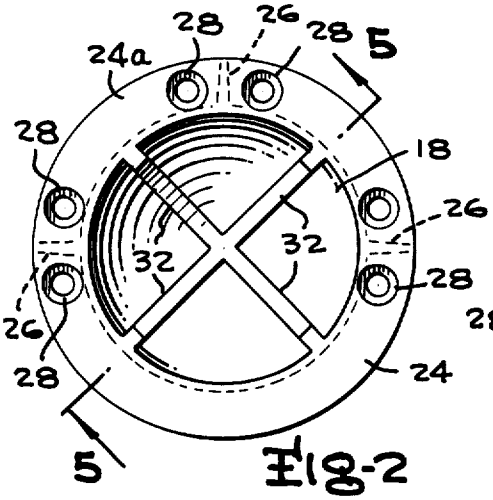


Fig-2

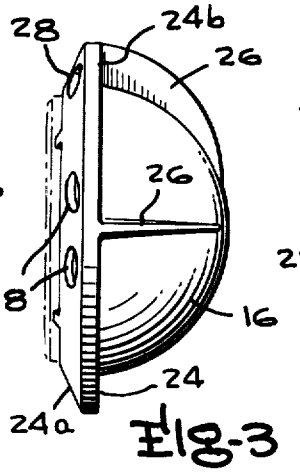


Fig-3

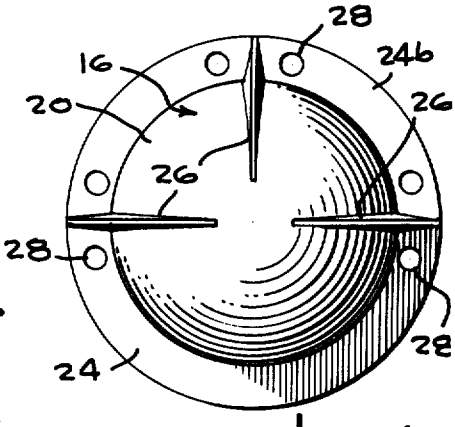


Fig-4

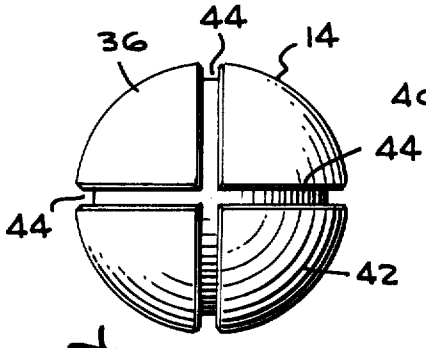


Fig-6

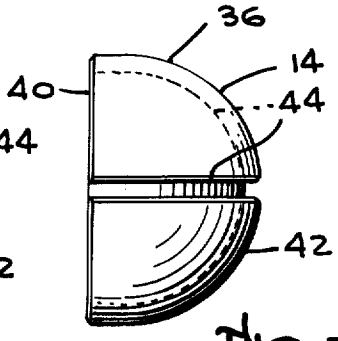


Fig-7

ACETABULAR CUP PROSTHESIS COMPONENT FOR TOTAL OR SUBTOTAL HIP PROSTHESIS SYSTEM

BACKGROUND AND OBJECTS OF THE INVENTION

The present invention relates in general to prosthetic devices for use in total and subtotal hip replacements, and more particularly to an acetabular cup assembly which may be implanted on the acetabulum to correct hip problems, usable with or without a femoral prosthesis component.

Heretofore, total hip prosthesis surgery has been performed wherein a cup is fitted in the acetabulum and a head or femoral prosthesis member, which comprises a stem or shank portion and an artificial head, is fixed to the femur to provide a prosthetic hip joint. Also, to relieve certain conditions, particularly in young patients where there is no immediate need for amputating the head of the femur and substituting a femoral prosthesis member, subtotal hip replacement surgery such as a cup arthorplasty may be performed where a cup is implanted in the acetabulum or cupshaped socket in the pelvis. In either case, the acetabulum cup or cup prosthesis component provides a socket for receiving the head of the femur or the head of the femur prosthesis component.

Heretofore, metal acetabulum cups have been employed, for example, for protrusio-acetabuli and in rheumatoid arthritic cases, or in performing total hip prosthesis surgery, wherein the cup provides a metal surfaced socket for receiving the head of the femur or the head of the femoral prosthesis component, providing either a bone to metal or a metal to metal contact in the hip socket. While methyl methacrylate bone cement has been previously used for fixation of the acetabular cup used in the prior art in the recipient pelvis, this bone cement may present a serious hazard to the patient, as pointed out in the recent article by Edith R. Kedes, M.D., et al entitled "Inoperative Deaths Associated With Acrylic Bone Cement", Journal American Medical Association, Vol. **222**, No. **5**, pp. **575–577**, Oct. **30, 1972.** Furthermore, improved acetabular cup fixation means is desired, as methyl methacrylate is notorious for its brittleness and lack of resistance to shear. Also, if it becomes necessary to replace the acetabular cup prosthesis at any time in the future, fixation with methyl methacrylate may require badly chopping the recipient pelvis attempting to remove the methyl methacrylate.

I have found it desirable to provide a rimmed acetabular cup which may be securely fixed in the recipient pelvis by the use of screws extending through flanged portions of the rimmed cup into the acetabulum to securely fix the metal cup in position. The flanged rimmed cup gives many options in the selection of the proper treatment in a specific hip problem. In a young patient where it is thought that a cup arthroplasty may give the patient six to ten years of good function and postpone the need for a total hip, the rimmed cup can be implanted. The femur head can be reshaped and used in that situation until such time as the head and neck are absorbed. At that time a total hip can then be inserted in the exact same position as the rimmed cup with less surgery and no stock is lost by the use of the rimmed cup for the cup arthroplasty. The cup should be place between **30°** and **45°** verticle and **10°** forward facing to provide stability for the cup arthroplasty and later stability for the total hip.

Furthermore, I have found it desirable to provide a replaceable plastic liner for the concave socket formed by the acetabular cup prosthesis, formed of a high density monomer plastic insert that may be removed at seven to ten years or at any time that sufficient wear occurs and replaced without removing the acetabular cup from the pelvis. The concave socket portion of the acetabular cup prosthesis is specially formed to receive and support the plastic liner or insert, and to facilitate its removal and replacement when required. A further advantage of the metal encased plastic liner is that this avoids the slight but definite tendency of a high density monomer to stretch or drape, since the metal encasement formed by the body of the acetabular cup will give a more symmetrical support than would methyl methacrylate cement in which plastic acetabular cups have been heretofore embedded to fix it in the acetabulum.

An object of the present invention, therefore, is the provision of a novel flanged rimmed acetabular cup prosthesis formed of a metal body defining a socket for reception of the head of the femur or a femoral prosthesis component, which is fixed to the acetabulum by screws extending into the recipient pelvis without use of methyl methacrylate bone cement and which has a replaceable plastic liner or insert which can be removed and replaced from the acetabular cup without removing either the femoral component or the metallic component of the acetabular cup. Even if methyl methacrylate or any other substance were used as a filler, my flanged rimmed cup would still stabilize and prevent movement of the cup.

Other objects, advantages and capabilities of the present invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings illustrating the preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE FIGURES

FIG. **1** is an exploded perspective view of an acetabular cup prosthesis assembly embodying the present invention;

FIG. **2** is a front or bottom view of the cup component of the assembly;

FIG. **3** is a side elevation of the cup component;

FIG. **4** is a rear or top view of the cup component;

FIG. **5** is a section view through the cup and insert components of the assembly, taken from the section plane of line **5—5** of FIG. **2**;

FIG. **6** is a rear or top view of the insert or liner of the assembly; and

FIG. **7** is a side elevation of the insert.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The acetabular cup prosthesis component assembly of the present invention is indicated generally by the reference character **10** and comprises a rimmed metal acetabular cup **12** illustrated best in FIGS. **1** and **2**, and a replaceable high density plastic liner or insert **14** removably assembled with the rimmed metal acetabular cup. The rimmed metal cup component **12** is a solid unitary, integral cast structure comprising a dome shaped body portion **16** forming a socket for reception of the head of the femur or the head of the femoral

prosthesis component, such, for example, as that described and illustrated in my earlier U.S. patent application Ser. No. **183,418,** now U.S. Pat. No. **3,814,089,** the dome shaped body **16** having an interior concave, generally spherical surface **18** and an exterior convex, generally spherical surface **20** both formed about a common center. The metal cup **12** forms a generally spherical socket **22** for reception of the head of the femur or of the femoral prosthesis, surrounded or bounded at the entrance opening to the socket **22** by an annular rim or rim flange **24** which in the preferred embodiment has an incident or lower surface **24***a* facing towards the femur or femoral prosthesis component which lies in an upwardly flaring or upwardly diverging truncated conical path as will be apparent from FIG. **3.** The upper or posterior surface **24***b* of the annular rim portion **24,** relative to the femur, may lie in a plane perpendicular to the center line or axis of the dome portion intercepting the zenith of the dome, or it may also be in an upwardly and outwardly diverging conical path, as desired. In the preferred form herein illustrated, three reinforcing flanges or webs are provided at positions faced **90°** apart extending from the exterior convex spherical surface **20** of the dome portion **16** to the outer edge of the rim portion **24,** having a truncated crescent shaped lateral profile, forming reinforcing web flanges **26** strengthening the dome portion and further fixing the position of the rim portions relative thereto. Also in the illustrated embodiment, three pairs of holes **28** are provided in the rim at positions spaced circumferentially approximately **90°** apart, for reception of fixation screws **30** to be inserted in the drill holes in the acetabulum to fix the cup **12** in position.

The interior concave spherical surface **18** of the dome portion **16** is interrupted by a plurality of inwardly projecting arcuate lugs or ridges **32,** of rectangular cross section, which in the illustrated embodiment are in cruciate or cruciform configuration alined with a pair of diametric bisectors of the dome disposed at right angles to each other and forming meridian rib segments extending from the socket entrance to an intersection at the zenith of surface **18.**

The replaceable plastic liner or insert **14,** best shown in FIGS. **5** and **6,** is also a generally dome shaped body **36** having a spherically concave inner surface **38** whose center of revolution is in the plane of the lower or anterior face **40** of the insert, and includes a spherically convex outer surface **42** having its center of revolution spaced upwardly or posteriorly of the plane of the incident or anterior surface **40,** as will be apparent from inspection of FIG. **7.** The spherically convex outer surface **42** is shaped and sized to conform to the interior concave spherical surface **18** of the dome shaped body portion **16** of the cup, and is provided with arcuate slots or kerfs **44,** of cruciate configuration in the illustrated embodiment, conforming in configuration precisely to the cruciate lugs or ridges **32** of the cup, and having, if desired, a slight **45°** chamfer or bevel formation along all of the exterior edges of the slots. The insert or liner **14** is made of an ultra high molecular weight polyethylene or similar high density plastic material or other suitable material and is designed to be received by a snap fit in the socket **22** formed by the dome portion **16** of the cup **12.**

To prepare the acetabulum and install the acetabular cup assembly of the present invention, the acetabulum is exposed by known surgical procedures, and the approximate location of the acetabular cup prosthesis site and the position to be assumed by the cup is preferably determined by using a Kuntschner nail, for example, a **10** or **12** mm. nail which is held parallel with the anterior iliac crests and a **45°** angle flag is slipped on to form a guide for placing the cup. The cup is to be placed between **45°** and **30°.** A **30°** angle flag is also tested and by trial insertion of the cup prosthesis, the amount of reaming necessary can be determined. In some cases of large acetobuli or protrusio-acetabuli it is only necessary to remove the cartilage lining of the acetabuli with little reaming of the bone.

Before the acetabulum is reamed, one is careful to leave between a quarter and a half inch of the lateral cartilagenous margin of the acetabulum intact, and to assist in this marks this portion with an osteotome. In some cases there is no cartilage in which case the hard bone is left intact. Using an osteotome and a gauge, the medial wall and the medial two-thirds of the acetabulum are denuded of all cartilage down to bleeding bone with an osteotome before any reaming. This tends to displace the cup as far medially as possible and still maintain sufficient medial wall support to avoid fracture into the pelvis. Again, the angle to be assumed by the cup is checked with the **45°** measurement flag inserted on the Kuntschner nail held alined with the anterior iliac crests, and a cup reamer of the exact size of the exterior convex spherical surface **20** of the dome is applied to ream the dome shaped socket in the acetabulum to receive the cup body **12.** The cup prosthesis is preferably disposed so that it is faced downwardly between **30°** and **45°** with forward facing of **10°** which is the normal forward facing of the average acetabulum. After the acetabulum is reamed with the dome shaped cup reamer to a point where the edge of the reamer is about one-eighth inch under the rim of the acetabulum, a rim reamer is then inserted, which has a smooth **1-7/8** inches dome the exact size of the outer surface **20** of the cup, and having reamer teeth on an annular portion outwardly surrounding the smooth dome shaped portion. This rim reamer does not ream anywhere except in the rim region, and is employed to ream a recess the exact size to receive the annular rim portion **24** of the cup prosthesis.

After the rim reamer has been used, the cup prosthesis **12** is reinserted with the three reinforcing flanges or webs **26** positioned anterior and posterior and absent on the medial side. Using a nylon insertim impactor having a **15/8** inch nylon domeshaped head for impacting the metal cup, the cup prosthesis **12** is tamped lightly to mark a place within the acetabulum for the three flanges **26.** Frequently a cutting is required for the superior and inferior flange, and occasionally for the lateral flange. The lateral flange is not usually sunk into the edge of the acetabulum.

Throughout the reaming procedure, the lateral one-half or one-fourth inch cartilage rim or hard bone is still left in place, tending to force the cutting medially as the reamer will not cut as well on the cartilage as on the denuded bone. This also preserves a good lateral lip displacing the cup medially. The cup is firmly seated, with the impactor, using several hammer blows, after the sites for the three reinforcing flanges or webs **26** have been cut as required, to firmly seat the cup in the acetabulum, drill holes are then drilled in the acetabulum to receive the mounting screws, and two or three chrome cobalt molibidum screws or screws of other ac-

ceptable material are inserted into the drill holes. These screws have an average length of 1-¼ inches. All of the anterior and lateral holes are carefully checked for depth by a depth gauge as well as palpating with the finger within the pelvis, as extreme caution must be taken to avoid penetrating the pelvis in the region of the sciatic notch. The two or three fixation screws **30** through selected ones of the holes **28** serve the purpose of maintaining the position of the cup after it has been well impacted. After **8** to **10** weeks, the rim and flanges provide the main stabilizing effect. The advantage of screws not being over **2** inches long is that the plasticity of the pelvis is much greater than the plasticity of the metal and or acrylic which may be buried in it, thus minimizing the length of dissimilar material relative to longer screw lengths and reducing the potential motion between them.

In one satisfactory example, the rimmed metal acetabular cup had a maximum diameter of about **2.43** inches at the outer periphery of the rim **24,** the dome shaped portion **16** had a height from the posterior or upper surface **24***b* of the rim to the zenith or peak of the dome of about **0.837** inch, the distance from the zenith of the dome to the plane of the entrance to the socket was about **1.085** inches, and the thickness of the rim at its outer periphery was about **0.090** inch. The interior concave spherical surface **18** of the socket **22** was sized to exactly conform to and accept the exterior surface **42** of the insert **14,** which in a preferred embodiment had a spherical radius of about **0.875** inch. The radius of the inner spherical surface **38** of the insert in the preferred embodiment was about **0.55** inch, or a diameter of about **1.105,** and the radium of the bottom of the kerfs or slots **44** was about **0.77** inch.

With the removable plastic liner **14** in the dome portion of the cup **12,** the cup assembly accepts a **28** mm. head on a femur prosthesis component. The liner **14** is held in position by the cruciate lugs or ridges **32** that are snapped immovably into position in the conforming kerfs or slots **44** in the insert when the insert is installed in the cup using a nylon impactor having a **28** mm. nylon head. The initial cup when installed in the acetabulum is usually installed in one piece with the liner already inserted. This offers the option of replacement of the liner after any period of time when wear becomes significant. To replace the liner, the hip is merely dislocated and using an oscillating saw and osteotome, two cross cuts are made along the diametric planes of the ribs into the remaining liner to cut the liner into four pieces for ease of removal from the cup **12** without having to cut through the full thickness of the liner portions intervening between the rib segments. A removable new plastic liner of similar construction and configuration may then be inserted with a nylon impacter.

If desired, an annular washer may be alined with one of the screw holes **28** in the annular rim overlying the outer surface thereof through which one of the fixation screws is inserted, the washer being of sufficient diameter so that an edge portion thereof outwardly overlaps the edge of the flat lower face **40** of the insert to bear tightly against the face **40** and provide added insurance against motion. The real fixation of the plastic liner, however, is secured by the self locking cruciate conformation of the cup and plastic liner. The liner will not move in the metal cup due to the fact that the friction at the periphery will be greater than the friction in the center portion with the **28** mm. prosthesis head.

Of course, if there is any difficulty in removing the liner from the cup, by removing the fixation screws in the holes **28** of the annular rim **24,** the entire cup can be removed and replaced with a new plastic liner. It is highly advantageous to be able to offer the patient the option of a new liner, which is made available by the construction of the present invention, when the liner of the existing installation becomes either mechanically unstable or causes symptoms from debris or products from the wearing of the plastic in the head and socket region. By the construction of the invention, the old liner can be replaced by a new liner to avoid these difficulties without the necessity of replacing the entire hip and without the necessity of massive surgery to extricate cups which have been seated and fixed with methyl methacrylate as sometimes practiced in the prior art.

What is claimed is:

1. An acetabular cup prosthesis assembly to be fixed on the acetabulum of a patient in connection with total or sub-total hip prosthesis surgery, comprising an integral unitary metal cup prosthesis component and a replaceable liner insert, the cup prosthesis component having a dome portion extending in a hemispherical path from a proximal end plane of the prosthesis formed of a substantially hemispherical metal wall having a convex spherical outer surface and a concave spherical inner surface defining a generally hemispherical cup socket having an entrance opening at said proximal end plane and having a diameter of predetermined greater size than the head of an associated femur or femoral prosthesis component to be located in said cup socket, said cup prosthesis component also including an annular rim flange extending radially outwardly from the end of said hemispherical metal wall at said proximal end plane defining an integral annular ring portion encircling said entrance opening to abut against surface portions of a recipient acetabulum and be secured thereto to locate and aid in supporting the cup prosthesis thereon, said dome portion including rotation and tilting resisting and liner retaining rib formations protruding radially inwardly from said spherical inner surface, said rib formations being formed of a pair of semicurclar ribs spanning the cup socket along meridians disposed in a pair of diametric planes intersecting at the zenith of the inner surface of said wall defining patterns of meridian rib segments extending from the entrance opening to the zenith intersection to present surfaces to the liner resisting tilting and rotation thereof in the socket and for frictionally retaining the liner seated in the socket, and the replaceable liner insert being formed of an integral molded body of plastic material of generally hemispherical configuration interfitted in said cup socket having an outer spherical surface conforming closely to the size and complementing the configuration of the inner spherical surface and meridian rib segments of the dome portion to restrain the liner insert in said cup socket by tight frictional interengagement therewith, and said liner insert having a concave spherical inner surface defining a liner socket of a diameter corresponding to the heads of the femur or femoral prosthesis to be located therein.

2. An acetabular cup prosthesis assembly as defined in claim **1,** wherein said diametric planes of the semicircular meridian ribs are located at right angles to each

other whereby said meridian rib segments define a cruciate pattern.

3. An acetabular cup prosthesis assembly as defined in claim 2, wherein said meridian rib segments are continuous uninterrupted ribs of uniform height and thickness throughout their extent from said entrance opening to the zenith of the inner surface of said wall, the ribs thereby defining diametric planes along which the liner may be cut, subdividing the liner into four quadrants for ease of removal from the socket without having to cut through the full thickness of the liner portions intervening between rib segments.

4. An acetabular cup prosthesis assembly as defined in claim 1, wherein fin formations of truncated crescent configuration in profile are located in quadrature relation about the outer surface of the hemispherical wall with the truncated end edges of the fin formations integrally joined to said annular rim flange and extending outwardly from said wall to the outer periphery of said annular rim flange, the outer edges of the fin formations extending along outwardly convex arcs and merging into said convex spherical outer surface of said wall adjacent the zenith thereof.

5. An acetabular cup prosthesis assembly as defined in claim 1 wherein said meridian rib segments are continuous uninterrupted ribs of uniform rectangular cross section throughout and of uniform height and thickness throughout their extent from said entrance opening to the zenith of the inner surface of said wall, the ribs thereby defining diametric planes along which the liner may be cut, subdividing the liner into four quadrants for ease of removal from the socket without having to cut through the full thickness of the liner portions intervening between said rib segments and said outer spherical surface of said liner insert having grooves therein of uniform rectangular cross section closely conforming to the cross section and configuration of said meridian rib segments to receive the latter in tightly interfitted relation therein.

6. An acetabular cup prosthesis assembly as defined in claim 1, wherein said dome portion includes a plurality of circumferentially spaced, outwardly extending fin formations projecting from the outer concave surface thereof and having sharp outer edges extending in diametric planes of the hemisphere defined by said metal wall to be forced into the bone structure of the acetabulum at plural locations surrounding the dome portion.

7. An acetabular cup prosthesis assembly as defined in claim 1, wherein the outer spherical surface of said liner insert includes grooves formed therein precisely conforming to said inwardly extending elongated ribs on the inner surface of said wall and shaped to provide a snap fit therewith frictionally restraining the insert in the cup socket.

8. An acetabular cup prosthesis assembly as defined in claim 2, wherein the outer spherical surface of said liner insert includes grooves formed therein precisely conforming to said inwardly extending elongated ribs on the inner surface of said wall and shaped to provide a snap fit therewith frictionally restraining the insert in the cup socket.

9. An acetabular cup prosthesis assembly as defined in claim 3, wherein the outer spherical surface of said liner insert includes grooves fomred therein precisely conforming to said inwardly extending elongated ribs on the inner surface of said wall and shaped to provide a snap fit therewith frictionally restraining the insert in the cup socket.

10. An acetabular cup prosthesis assembly as defined in claim 1, wherein said liner insert has an incident annular planar face spaced outwardly a slight distance from said proximal end plane surrounding an entrance opening for said liner socket, said spherical inner surface of said insert having its center in the plane of said planar face and said outer spherical surface of said insert having its center spaced toward the zenith of said cup socket from said planar face.

11. An acetabular cup prosthesis assembly as defined in claim 3, wherein said liner insert has an incident annular planar face spaced outwardly a slight distance from said proximal end plane surrounding an entrance opening for said liner socket, and the spherical inner surface of said insert having its center in the plane of said planar face and said outer spherical surface of said insert having its center spaced toward the zenith of said cup socket from said planar face.

12. An acetabular cup prosthesis assembly as defined in claim 4, wherein said liner insert has an incident annular planar face spaced outwardly a slight distance from said proximal end plane surrounding an entrance opening for said liner socket, said spherical inner surface of said insert having its center in the plane of said planar face and said outer spherical surface of said insert having its center spaced toward the zenith of said cup socket from said planar face.

13. An acetabular cup prosthesis assembly as defined in claim 7, wherein said liner insert has an incident annular planar face spaced outwardly a slight distance from said proximal end plane surrounding an entrance opening for said inner socket, said spherical liner surface of said insert having its center in the plane of said planar face and said outer spherical surface of said insert having its center speced toward the zenith of said cup socket from said planar face.

14. An acetabular cup prosthesis assembly as defined in claim 1, wherein said cup prosthesis has a plurality of screw holes solely located in said annular rim flange in a circumferential path spaced radially outwardly from the periphery of said liner for receiving fixation screws to extend into the recipient acetabulum of the patient for fixation of the cup prosthesis component thereon.

15. An acetabular cup prosthesis assembly as defined in claim 3, wherein said cup prosthesis has a plurality of screw holes solely located in said annular rim flange in a circumferential path spaced radially outwardly from the periphery of said liner for receiving fixation screws to extend into the recipient acetabulum of the patient for fixation of the cup prosthesis component thereon.

16. An acetabular cup prosthesis assembly as defined in claim 7, wherein said cup prosthesis has a plurality of screw holes solely located in said annular rim flange in a circumferential path spaced radially outwardly from the periphery of said liner for receiving fixation screws to extend into the recipient acetabulum of the patient for fixation of the cup prosthesis component thereon.

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