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(54) **CONSTRAINED PROSTHETIC KNEE WITH ROTATING BEARING**

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(73) Assignee: **Zimmer, Inc.**, Warsaw, IN (US)

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A61F 2/38 (2006.01)

(52) **U.S. Cl.**
USPC **623/20.24**; 623/18.11; 623/20.15; 623/20.27; 623/20.28

(58) **Field of Classification Search**
USPC 623/20.15, 20.24, 20.25, 20.26, 20.27, 623/20.28, 20.29, 20.31, 20.33, 20.35
See application file for complete search history.

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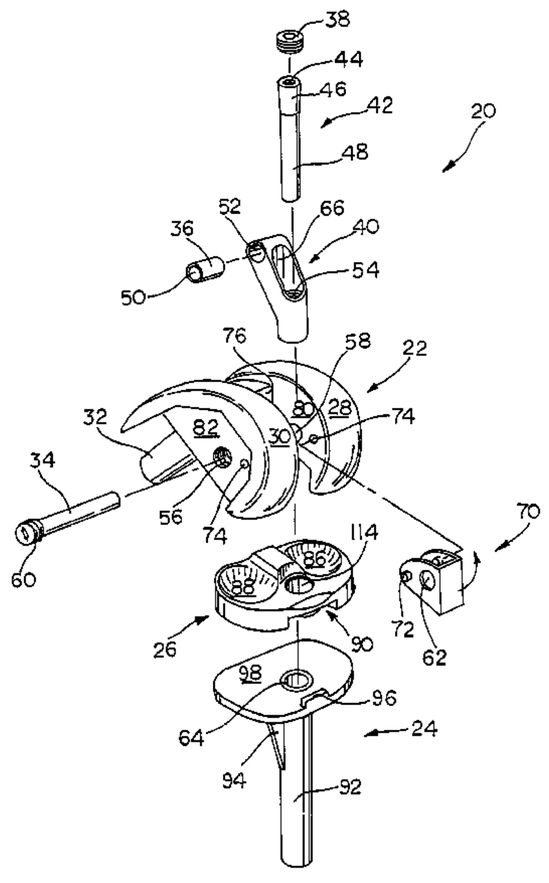
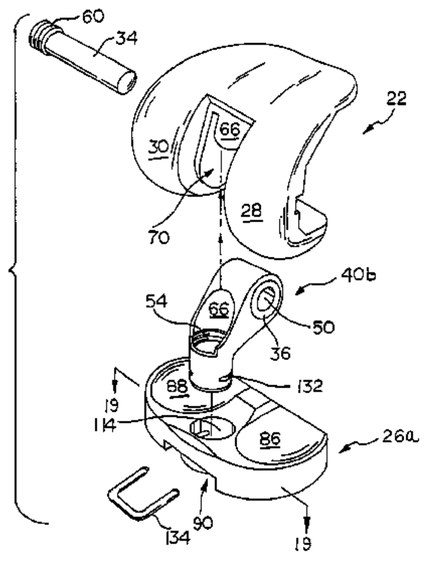
(57) **ABSTRACT**

A constrained prosthetic knee having a modular hinge post and a rotating bearing. A cannulated hinge post is rotatably connected to the femoral component of the knee prosthesis so that a hinge post extension may be anteriorly positioned through the hinge post and into the tibial component of the knee prosthesis, after positioning of the femoral component in the femur and the tibial component in the tibia. The hinge post is preassembled to the femoral component so that such assembly is not required during the implantation procedure. A meniscal component forming the rotating bearing of the knee prosthesis is packaged together with the hinge post extension so that the appropriate hinge post extension is readily available.

19 Claims, 9 Drawing Sheets





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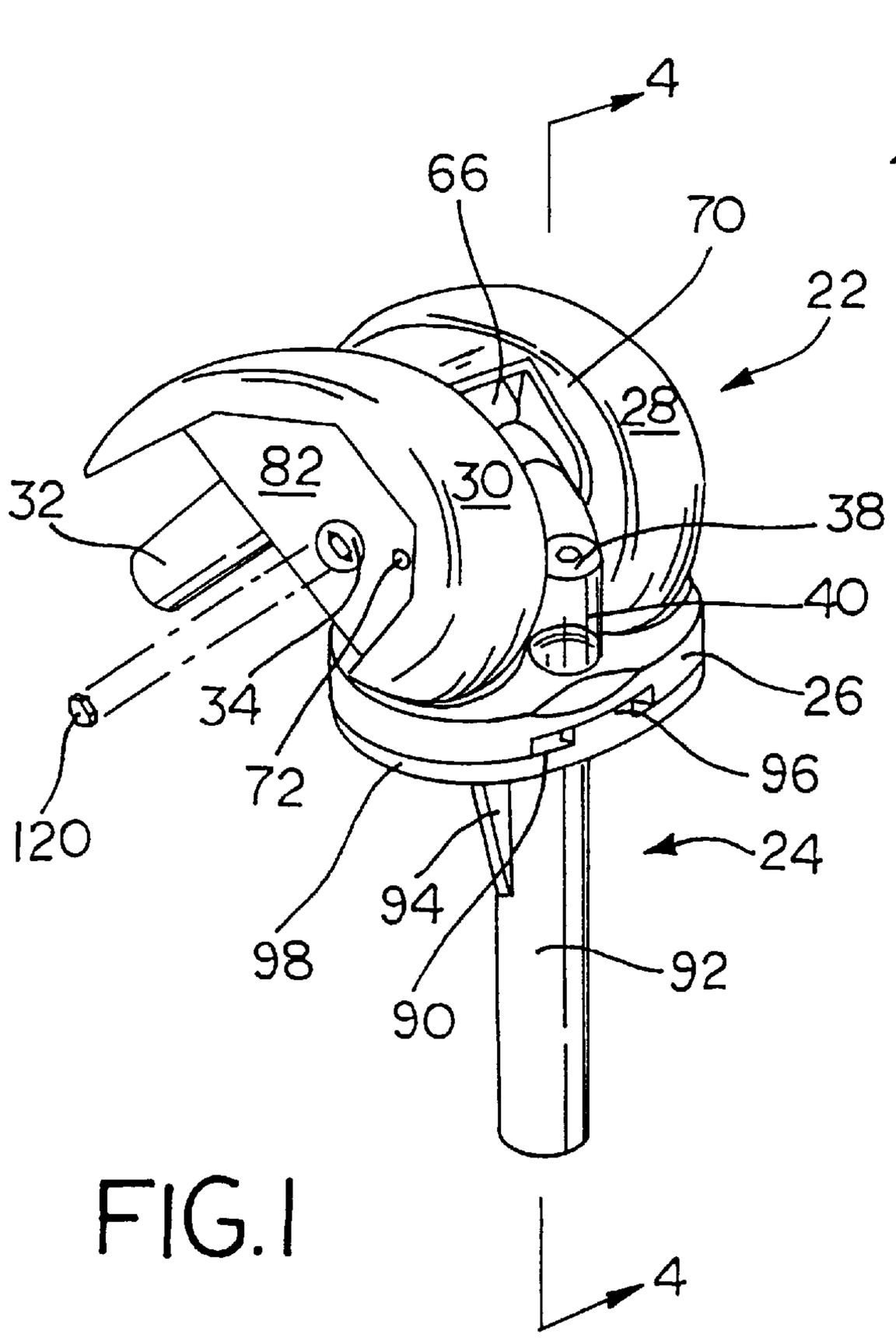

FIG.1

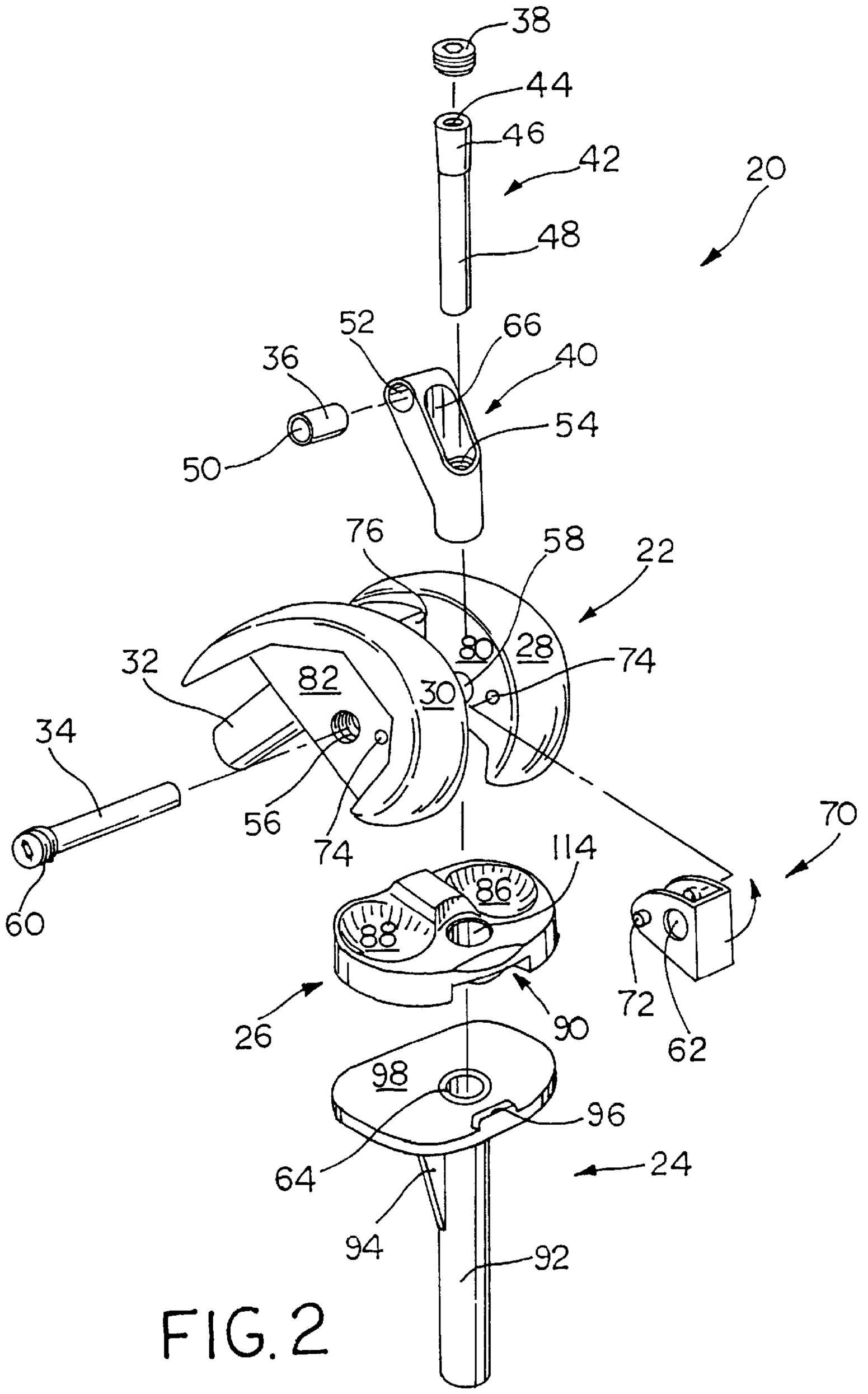
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FIG. 2

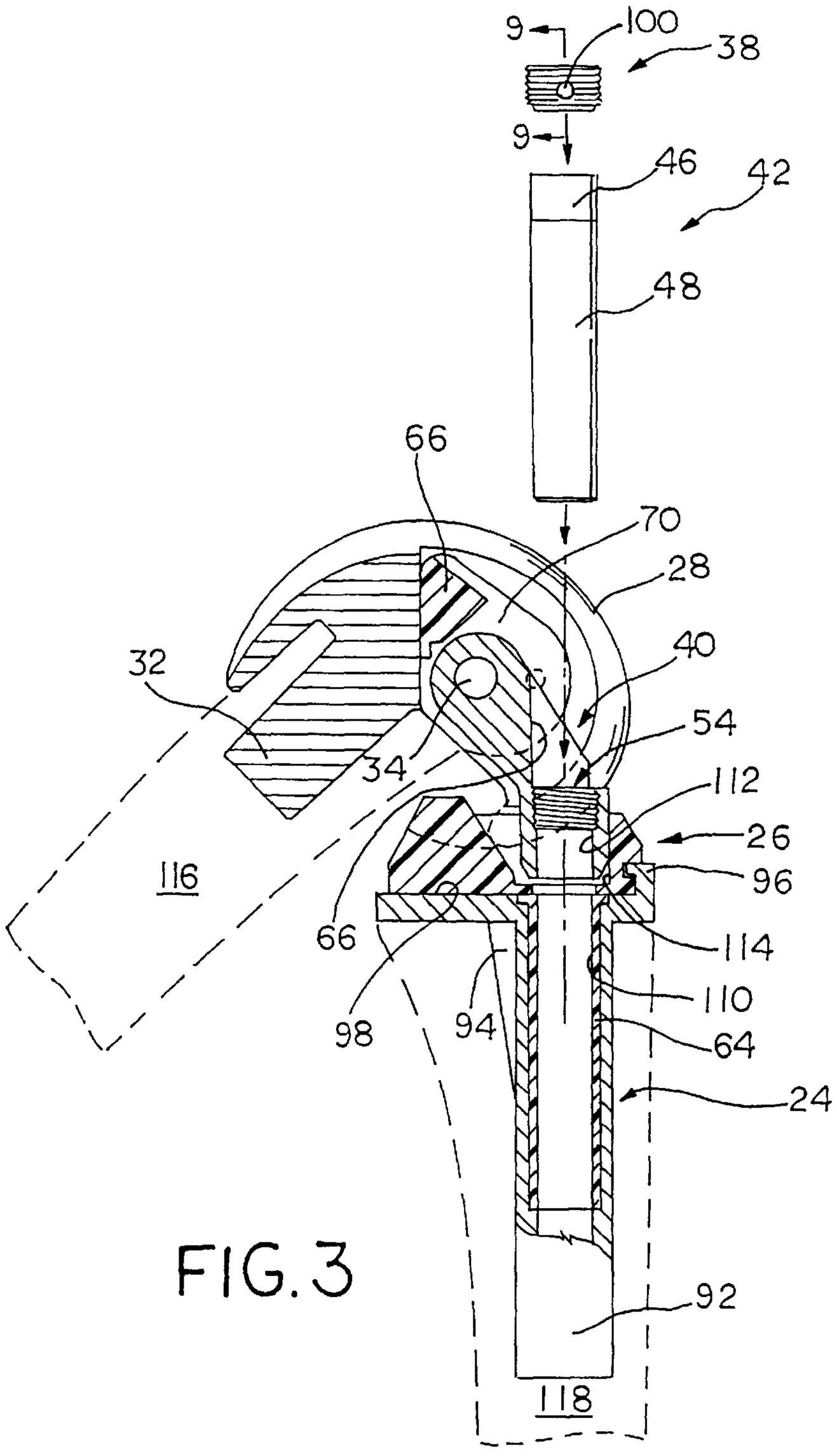
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FIG. 3

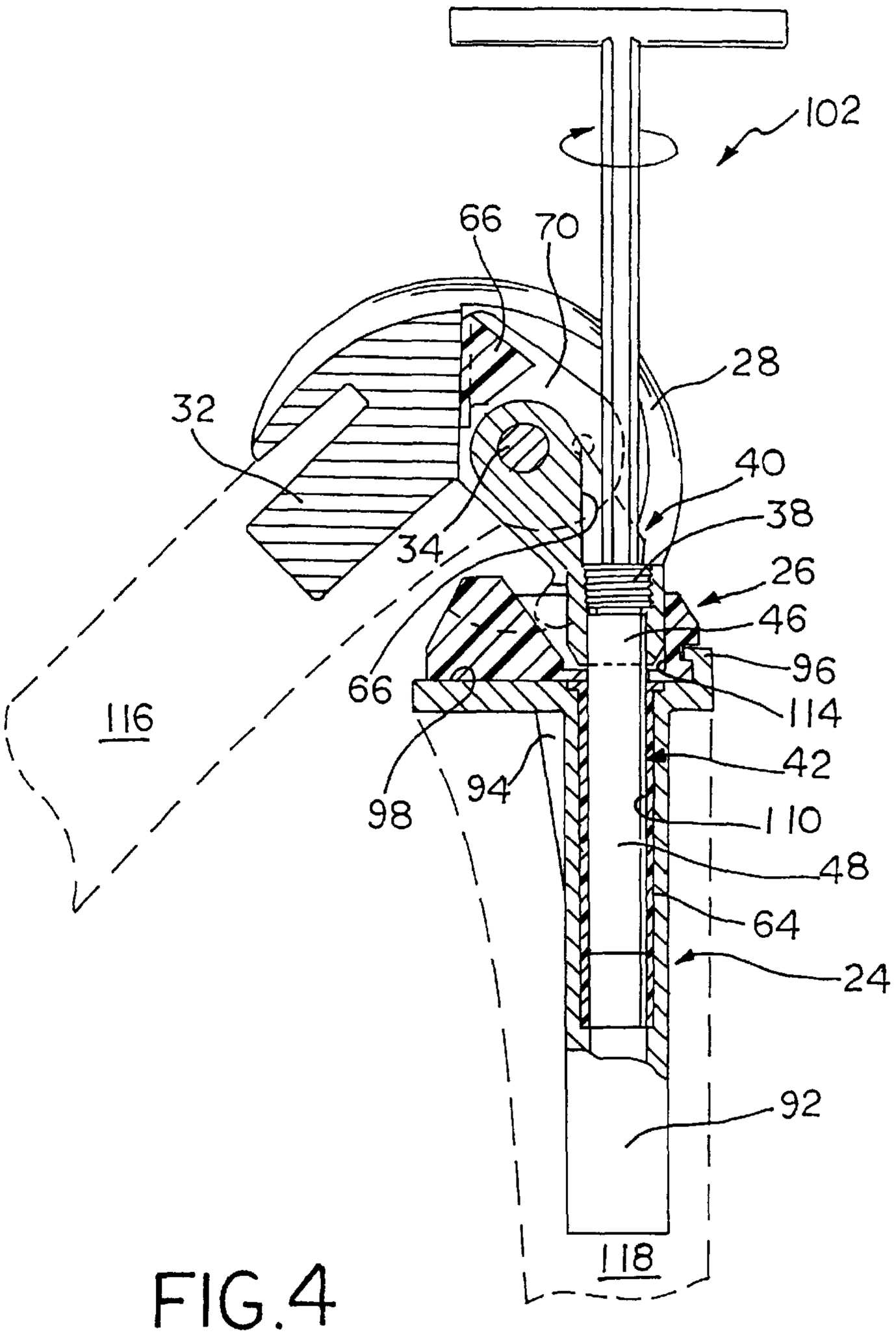
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FIG.4

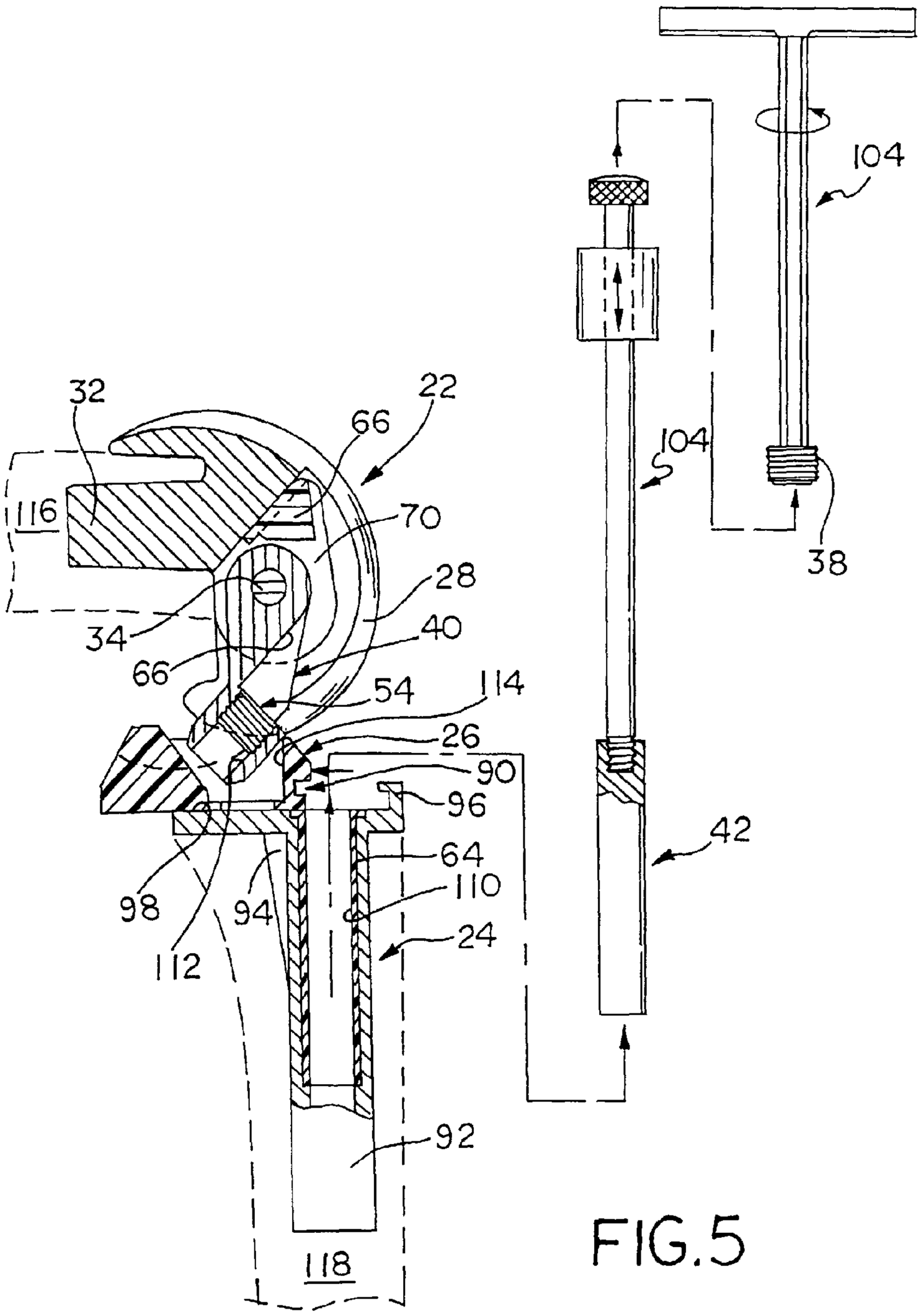
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FIG.5

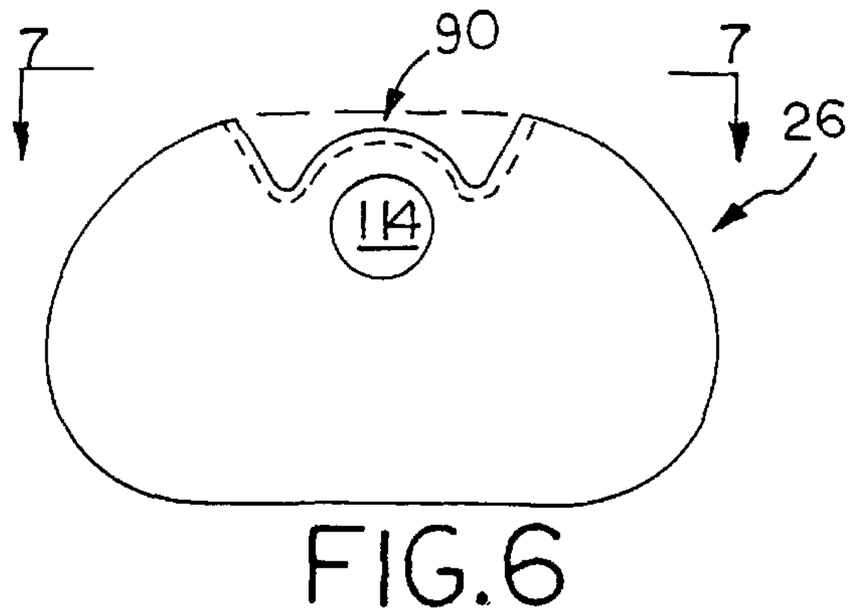

FIG.6

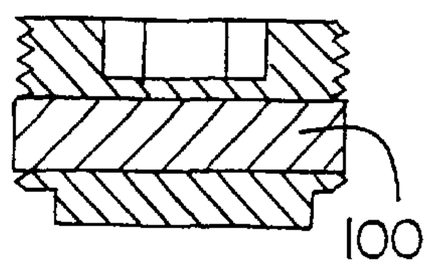

FIG.9

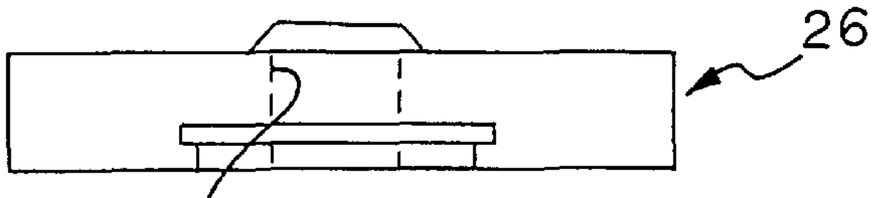

FIG. 7

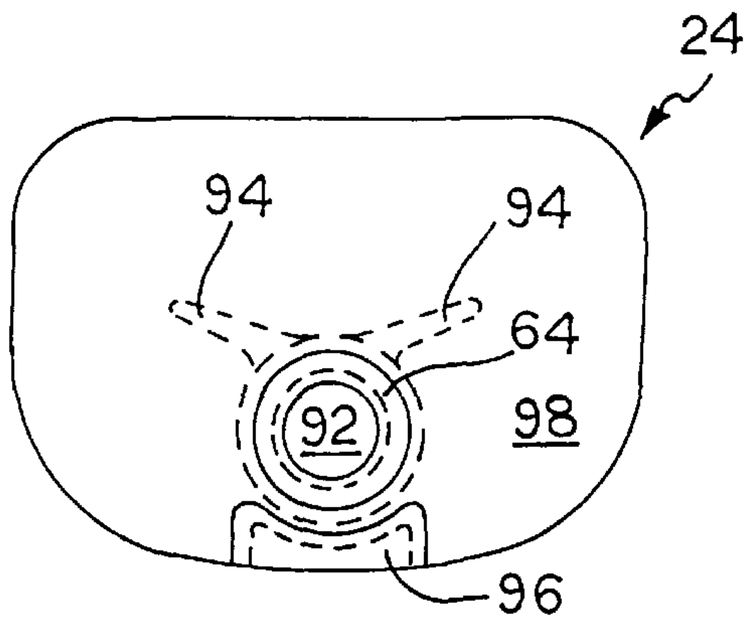

FIG.8

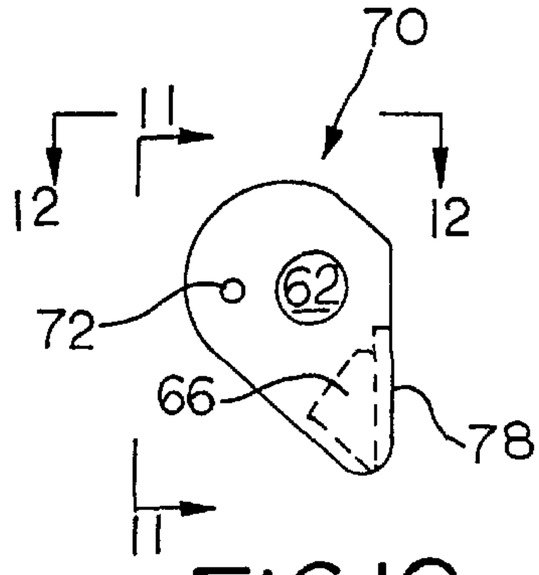

FIG.10

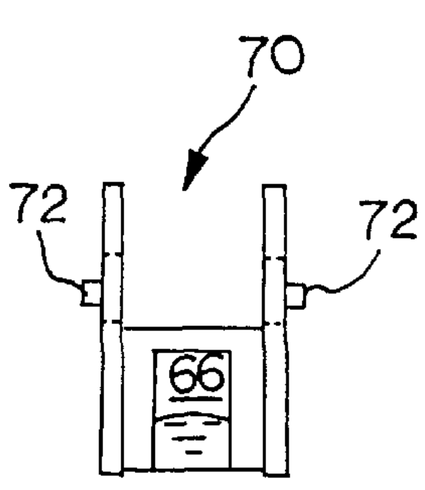

FIG.11

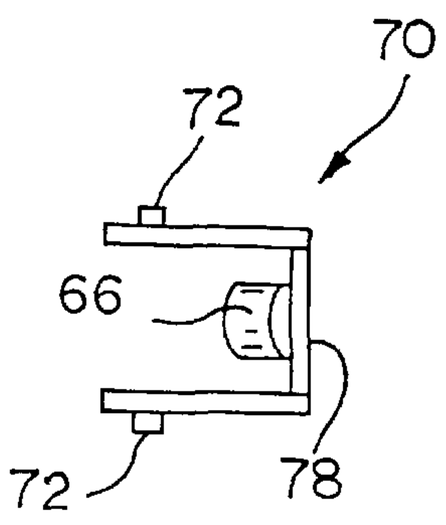

FIG.12

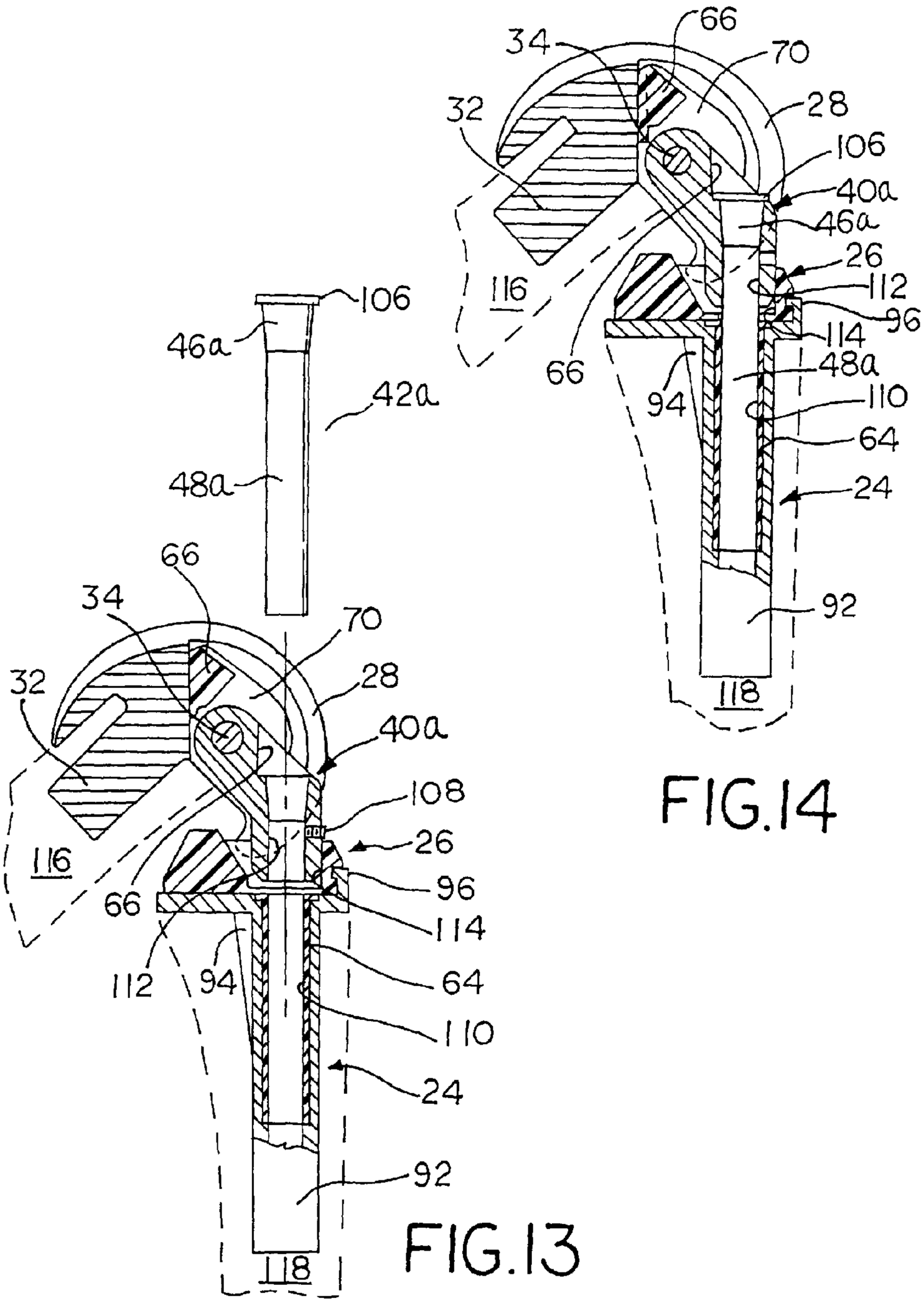
66
34
70
32
28
106
40a
46a
26
112
96
114
48a
110
64
24
92
116
118
94
108

FIG.14

FIG.13

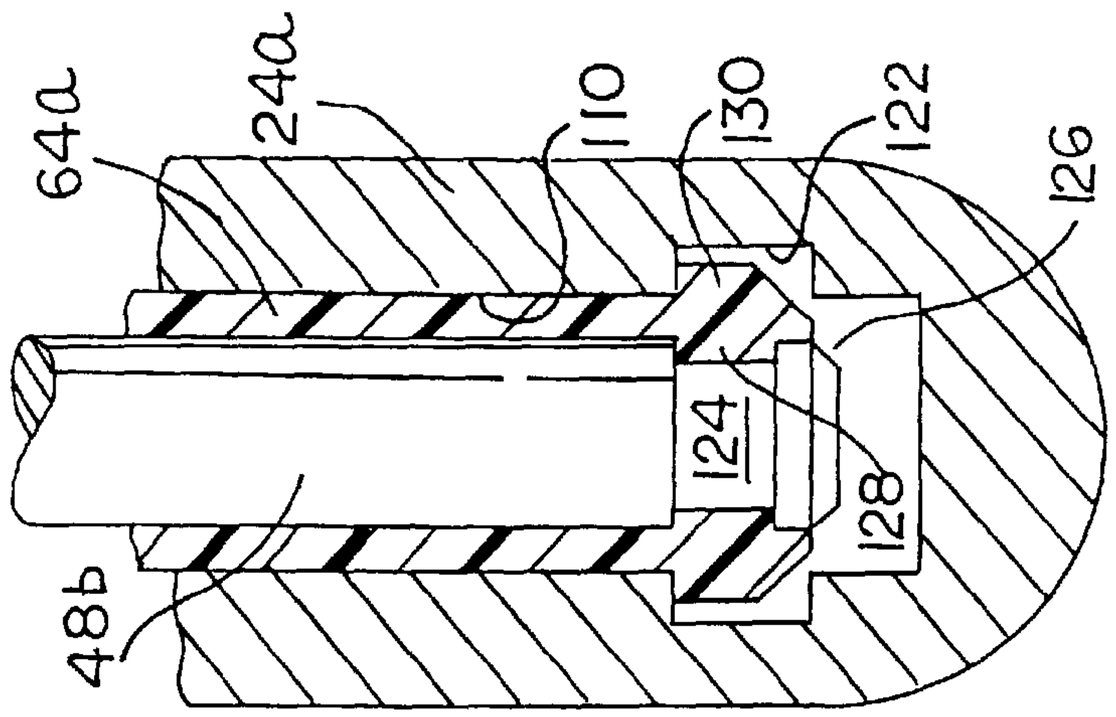

FIG. 17

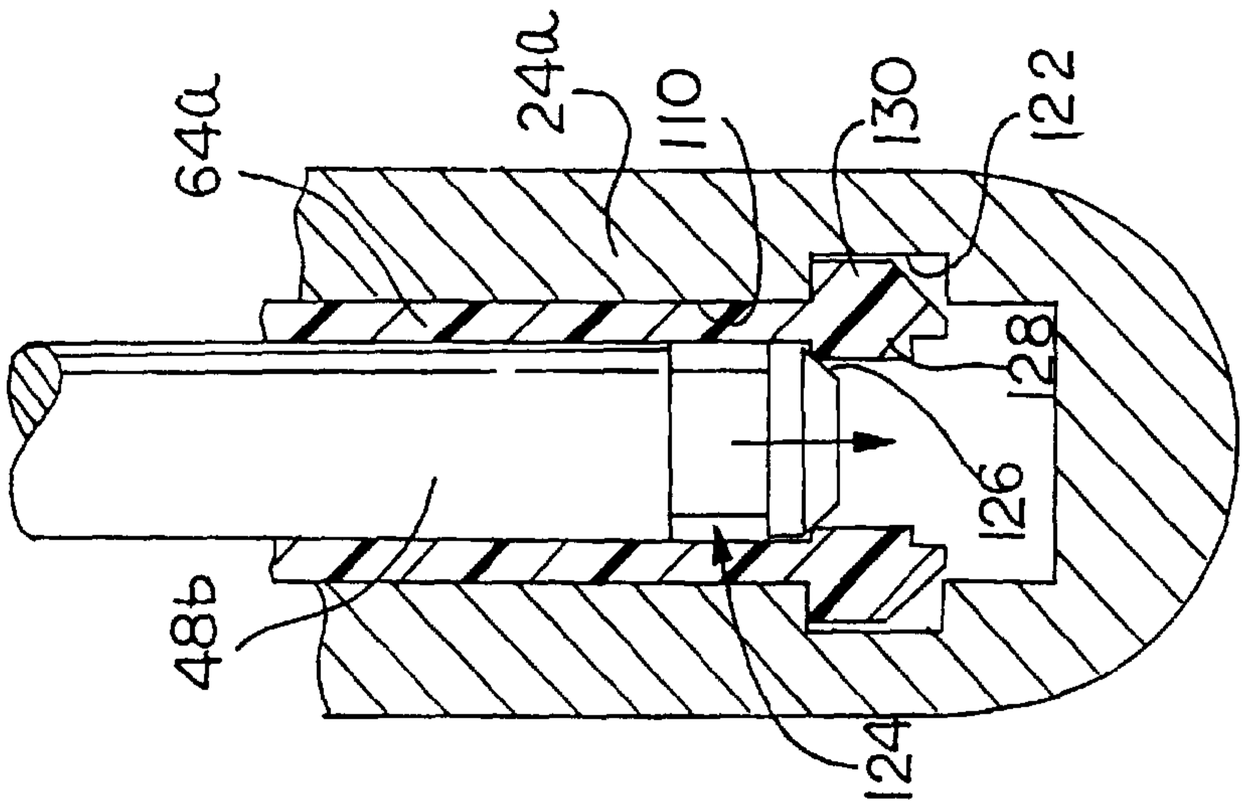

FIG. 16

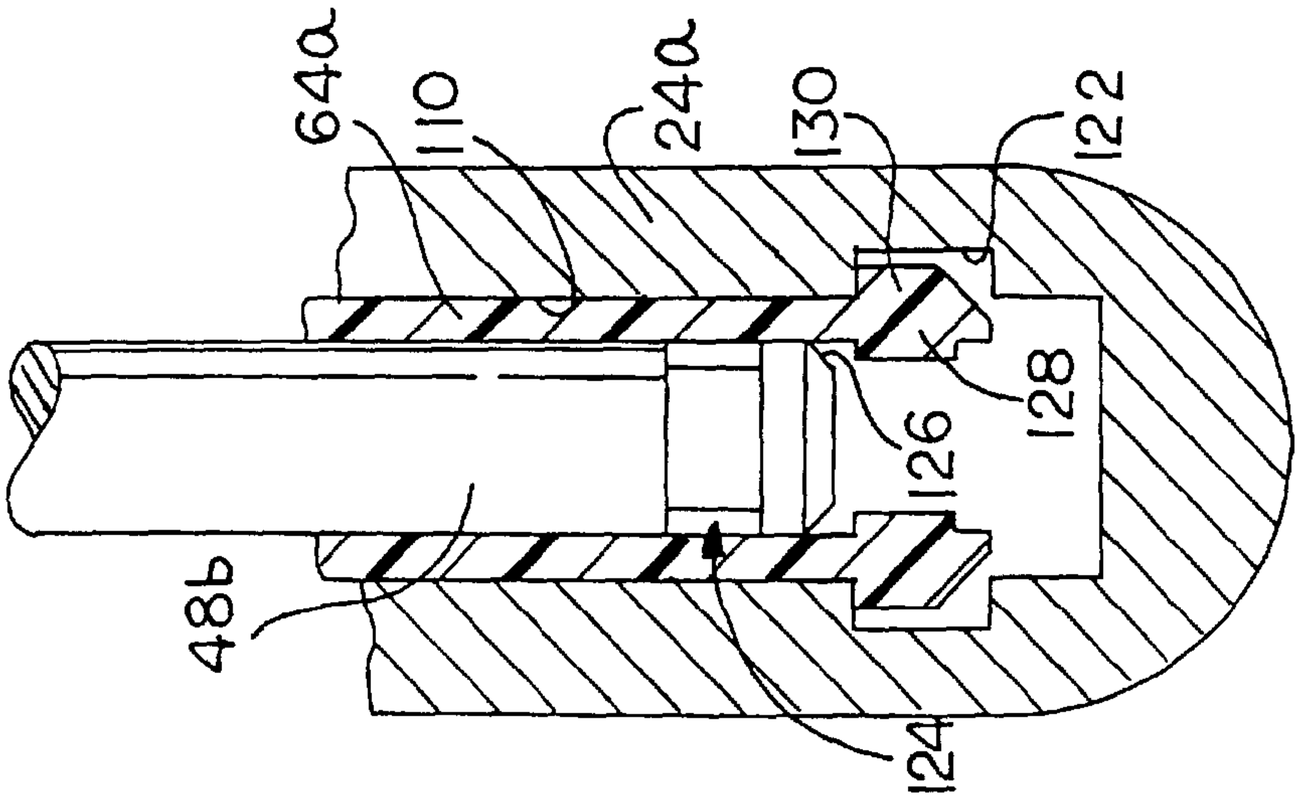

FIG. 15

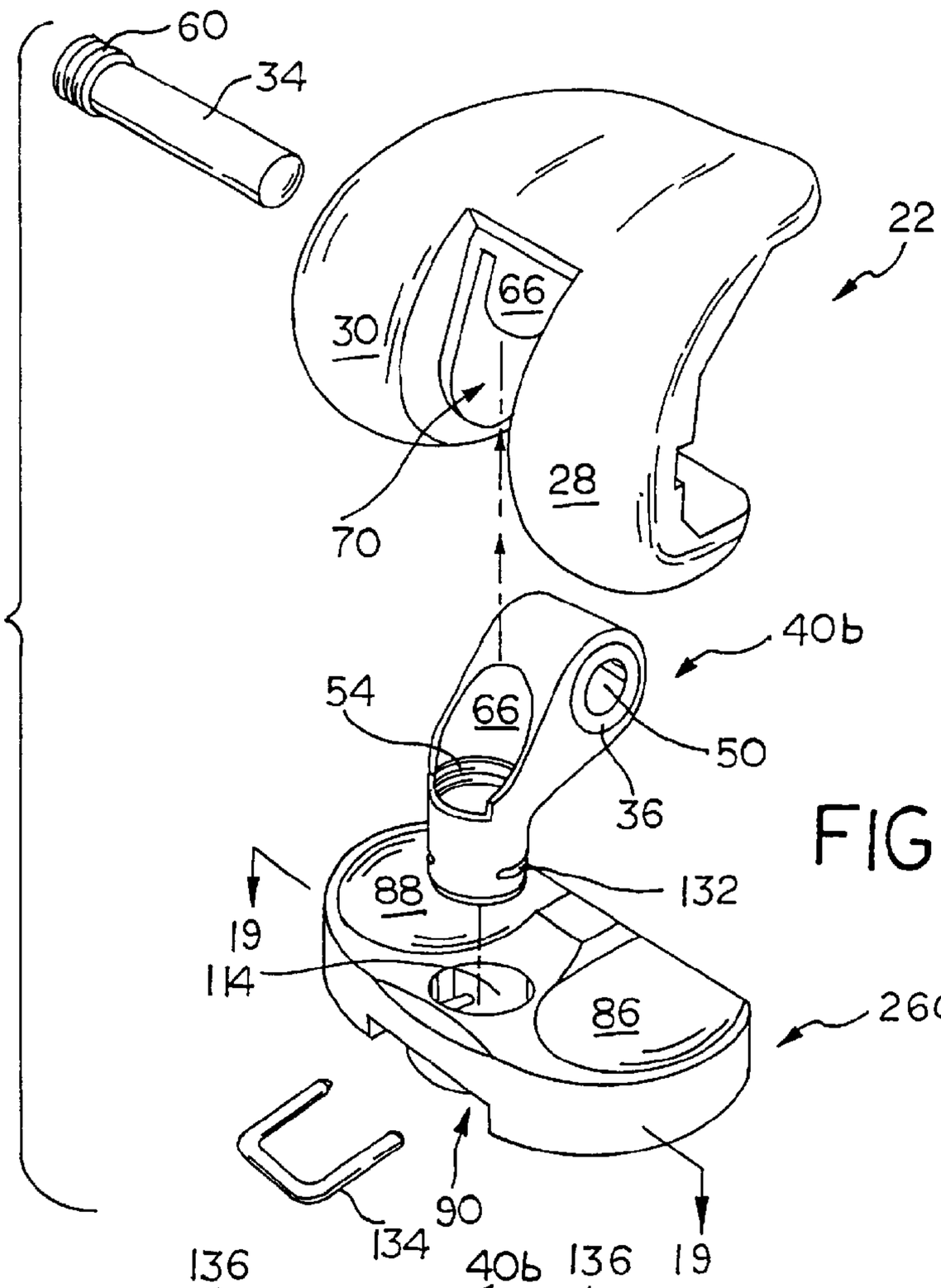

FIG 18

FIG.19

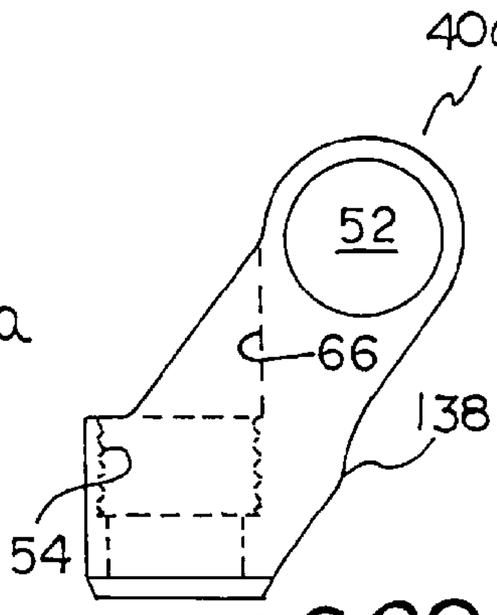

FIG.20

CONSTRAINED PROSTHETIC KNEE WITH ROTATING BEARING

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

CROSS-REFERENCED TO RELATED APPLICATIONS

This is a continuation of application Ser. No. 09/771,061, filed Jan. 29, 2001, now U.S. Pat. No. 6,485,519.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to prosthetic joints, and, more particularly to a constrained prosthetic knee having a modular hinge post and a rotating bearing.

2. Description of the Related Art

Generally, the knee is formed by the pair of condyles at the distal portion of the femur, the lower surfaces of which bear upon the correspondingly shaped proximal surface plateau of the tibia. The femur and tibia are connected by means of ligaments such as, the posterior cruciate ligament, the lateral collateral ligament, the medial collateral ligament, and the anterior cruciate ligament. These ligaments provide stability to the joint formed by the femur and tibia (i.e., the knee).

In a broad sense, prosthetic knee joints can be considered either constrained or unconstrained. For the purposes of this discussion, constrained prosthetic knees include femoral and tibial prosthetic components which are mechanically linked or constrained to each other by a hinge structure. An unconstrained prosthetic knee includes femoral and tibial components which are not mechanically linked. An unconstrained knee utilizes the patient's existing ligaments to provide joint stability. With this in mind, constrained prosthetic knees have particular applicability to cases in which a patient has experienced ligament loss and/or the existing ligaments do not provide adequate support and stability to the knee.

Tibial components of a prosthetic knee can be formed as a one-piece configuration in which the tibial tray forms the meniscal component of the prosthetic knee. Various other prosthetic knees utilize a modular meniscal component separate from the tibial component. Devices utilizing modular meniscal components include those in which the meniscal component (i.e., tibial bearing surface) is fixed to the tibial tray portion of the tibial component and is incapable of movement relative thereto. Alternative devices utilize a modular meniscal component capable of movement relative to the tibial tray. Devices in which relative rotational movement occurs between the meniscal component and the tibial component are typically referred to as rotating bearing knees. Rotating bearing knees thus allow movement between the bearing (i.e., meniscal component) and the tibial tray, as well as movement between the femoral component and the tibial bearing.

Constrained knees of the prior art include constructions in which a hinge post extension is first positioned within a tibial component (with an end protruding therefrom) and is thereafter connected to the femoral component by positioning the hinge post (rotatably attached to the femoral component) over the top of the protruding end of the hinge post extension and thereafter connecting the hinge post extension to the hinge post, e.g., by threading the hinge post extension into the hinge post. After making this connection, the meniscal component is thereafter slid into position between the femoral component and the tibial component. Meniscal components utilized with these prior art prosthetic knees were fixed to the tibial component.

The present invention is directed to a constrained knee prosthesis with a rotating bearing. The knee prosthesis of the present invention is structured to facilitate implantation thereof. The present invention is further directed to a prosthetic knee implant set having a plurality of matched modular hinge post and meniscal component pairs.

SUMMARY OF THE INVENTION

The present invention provides an improved constrained knee prosthesis having a cannulated hinge post facilitating implantation of the knee prosthesis in a relatively minimally invasive procedure. The prosthetic knee implant set of the current invention includes a separately packaged femoral component, a separately packaged tibial component, and a third package containing a hinge post extension and the meniscal component. Packaging the individual components of a knee prosthesis in this fashion insures that the appropriate hinge post extension is readily available. A bearing box is interposed between the hinge post and the femoral component. The bearing box includes a hyperextension stop which cooperates with the hinge post to prevent hyperextension of the knee prosthesis. Various structures are utilized to prevent the disengagement of the constrained knee prosthesis of the present invention.

A prosthetic knee constructed in accordance with the present invention includes a femoral component having a pair of condyler surfaces and a hinge post rotatably connected to the femoral component between the condyler surfaces. The hinge post is cannulated and accommodates insertion of a hinge post extension shaft therein. The hinge post and hinge post extension include cooperating locking tapers for locking the hinge post extension to the hinge post. Additionally, the hinge post includes internal threads so that a set screw may be threaded therein to further hold the hinge post extension in place. The tibial component includes a hinge post extension aperture into which the hinge post is seated. The meniscal component similarly includes an aperture to accommodate the hinge post and hinge post extension. The meniscal component of the current invention is free to rotate about the hinge post during flexion and extension of the knee joint.

Having a cannulated hinge post through which a hinge post extension may be anteriorly positioned and secured advantageously allows for a relatively minimally invasive knee replacement procedure.

The present invention advantageously provides a constrained prosthetic knee having a rotating bearing flush with the condyler surfaces of the femoral component.

Another advantage of the present invention is the packaging of the prosthesis components and specifically the packaging of the appropriate hinge post extension together with a meniscal component.

BRIEF DESCRIPTION OF THE DRAWINGS

The above-mentioned and other features and advantages of this invention, and the manner of attaining of them, will become more apparent and the invention itself will be better understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings, wherein:

FIG. **1** is a perspective view of an assembled knee prosthesis in accordance with the present invention;

FIG. **2** is an exploded view thereof;

FIG. **3** is a cutaway, exploded view illustrating assembly of the knee prosthesis of the current invention including the anterior positioning of the hinge post extension into the hinge post;

FIG. **4** is a cutaway view illustrating securement of the hinge plug (i.e., set screw) in the hinge post to facilitate locking of the hinge post extension therein;

FIG. **5** is a cutaway, exploded view illustrating removal of the hinge post extension;

FIG. **6** is a bottom elevational view of the meniscal component of the present invention;

FIG. **7** is a front elevational view thereof;

FIG. **8** is a top elevational view of a tibial component in accordance with the present invention;

FIG. **9** is a sectional view of a hinge plug in accordance with the present invention;

FIG. **10** is a side elevational view of a bearing box in accordance with the present invention;

FIG. **11** is a front elevational view thereof;

FIG. **12** is a top elevational view thereof;

FIG. **13** is a cutaway, exploded view of an alternative embodiment of the knee prosthesis of the present invention;

FIG. **14** is a cutaway view of an assembled knee prosthesis in accordance with the embodiment illustrated in FIG. **13**;

FIG. **15** is a fragmentary, cutaway view of an alternative embodiment of the hinge post extension and tibial bushing of the present invention;

FIG. **16** is a fragmentary, cutaway view of the embodiment of FIG. **15** illustrating insertion of the hinge post extension into the tibial bushing;

FIG. **17** is a fragmentary, cutaway view of the embodiment of FIG. **15** illustrating the hinge post extension fully inserted into the tibial bushing;

FIG. **18** is an exploded view of an alternative embodiment of the knee prosthesis of the current invention;

FIG. **19** is a sectional view of a meniscal component in accordance with an alternative embodiment of the present invention; and

FIG. **20** is an elevational view of a hinge post in accordance with an alternative embodiment of the present invention.

Corresponding reference characters indicate corresponding parts throughout the several views. Although the drawings represent embodiments of the invention, the drawings are not necessarily to scale and certain features may be exaggerated to better illustrate and explain the invention. The exemplifications set out herein illustrate embodiments of the invention, in alternative forms, and such exemplifications are not to be construed as limiting the scope of the invention in any manner.

DETAILED DESCRIPTION

Referring now to the drawings and particularly to FIG. **2**, knee prosthesis **20** in accordance with the present invention is illustrated. Knee prosthesis **20** generally includes femoral component **22**, tibial component **24**, and meniscal component **26**. Hinge post **40** is rotatably connected to femoral component **22** and includes elongate hinge post extension aperture **112** (FIGS. **3-6**, **13**, and **14**). Elongate aperture **112** accommodates placement of hinge post extension **42** therein. Hinge post extension **42** thereafter traverses hinge post aperture **114** in meniscal component **26** and hinge post extension aperture **110** (FIGS. **3-6**, **13** and **14**) in tibial component **24**. Elongate hinge post extension aperture **112** of hinge post **40** advantageously allows for anterior placement of hinge post extension **42** during surgical implantation of knee prosthesis **20** of the present invention.

As illustrated in FIG. **2**, hinge post extension **42** includes locking taper **46** and cylindrical extension **48**. Hinge post extension aperture **112** includes a mating locking taper to cooperate with locking taper **46** and lock hinge post extension **42** to hinge post **40**. After positioning of hinge post extension **42** through apertures **112**, **114**, and **110**, hinge plug **38** may be threaded into hinge plug threads **54** in elongate aperture **112** of hinge post **40** (FIG. **4**). Hinge plug **38** abuts the end of hinge post extension **42** and thereby facilitates locking of morse taper **46** in elongate aperture **112**. In one exemplary embodiment, locking taper **46** comprises a two degree locking taper. When prosthetic knee **20** is assembled as illustrated in FIG. **1**, condyler bearing surfaces **28**, **30** abut bearing surfaces **86**, **88** (see, e.g., FIG. **2**) in meniscal component **26**.

Hinge post extension **42** is typically formed as a one-piece construction of an inert metal such as, e.g., a cobalt-chromium alloy. Hinge post extension **42** may, however, be constructed of other bio-compatible metals or alloys, such as titanium. Throughout this document reference will be made to various components formed of a cobalt-chromium alloy. Any such component may also be constructed of other bio-compatible metals or alloys such as titanium, as is well-known. As illustrated in FIG. **4**, hinge plug wrench **102** is utilized to thread hinge plug **38** into hinge plug threads **54** of hinge post **40**. As illustrated in FIG. **9**, hinge plug **38** includes locking material **100** to provide a locking connection between hinge plug **38** and hinge plug threads **54** in hinge post **40**. Hinge plug **38** is, in one exemplary embodiment formed of a cobalt-chromium alloy. Locking material **100** comprises any suitable biocompatible polymer such as, e.g., ultra-high molecular weight polyethylene (UHMWPE).

As illustrated, e.g., in FIG. **2**, femoral component **22** includes condyler bearing surfaces **28**, **30** with bearing box wall **76** positioned therebetween. Femoral component **22** further includes external side walls **82**, only one of which can be seen in FIG. **2**. Condyler bearing surfaces **28**, **30** are smooth and highly polished, generally spheroidally shaped and extend outwardly from external side walls **82**, as is well known in the industry. Femoral component **22** further includes modular femoral stem **32** for insertion into femur **116** (FIGS. **3-5**, **13**, and **14**), as is known in the art. Femoral component **22** further includes internal side walls **80**, only one of which is illustrated in FIG. **2**. Internal side walls **80** are substantially perpendicular to bearing box wall **76** and extend outwardly therefrom. Femoral component **22** is typically formed as a one-piece construction of an inert metal such as, e.g., a cobalt-chromium alloy.

Bearing box **70** is designed for placement between condyler bearing surfaces **28**, **30** of femoral component **22** as illustrated, e.g., in FIG. **1**. Bearing box **70** is further illustrated in FIGS. **10-12** and includes affixing protrusions **72**, hinge pin aperture **62**, hyperextension stop **66**, and anti-rotation surface **78**. As illustrated in FIG. **2**, femoral component **22** includes affixing protrusion apertures **74** sized to receive affixing protrusions **72**. FIG. **1** illustrates bearing box **70** operably positioned on femoral component **22**, with anti-rotation surface **78** flush with bearing box wall **76** of femoral component **22**, and affixing protrusions **72** received in affixing protrusion apertures **74**. The abutting relationship of anti-rotation surface **78** with bearing box wall **76** discourages rotation of bearing box **70** about the longitudinal axis of affixing protrusions **72**. When bearing box **70** is positioned on femoral component **22**, hinge pin apertures **62** of bearing box **70** align with threaded hinge pin aperture **56** and hinge pin aperture **58**

of femoral component **22**. Bearing box **70** can be formed of any suitable plastic, such as, e.g., UHMWPE.

Hinge post **40** is rotatably connected to femoral component **22** via hinge pin **34**. Hinge post **40** is placed between opposing walls of bearing box **70** and is positioned so that hinge pin aperture **52** is aligned with apertures **56**, **58**, and **62**. The opposing walls of bearing box **70** thus act as a bearing surface between hinge post **40** and internal side walls **80** of femoral component **22**. Prior to placement of hinge post **40** between opposing walls of bearing box **70**, hinge pin sleeve **36** is operably positioned within hinge pin aperture **52** of hinge post **40**. Hinge post **40** is formed from a cobalt-chromium alloy, while hinge pin sleeve **36** is formed from a suitable plastic, such as, e.g., UHMWPE. Hinge pin sleeve **36** acts as a bearing between hinge pin aperture **52** of hinge post **40** and hinge pin **34**. Accordingly, hinge pin sleeve **36** includes hinge pin aperture **50** sized to accommodate hinge pin **34**. After positioning of hinge post **40** between the opposing walls of bearing box **70**, hinge pin **34** is positioned through apertures **56**, **62**, **50**, and **58**. Hinge pin threads **60** are thereafter threadedly engaged in the threads of threaded hinge pin aperture **56** until the head of hinge pin **34** is flush with external side wall **82**.

As illustrated in FIG. **1**, hinge pin plug **120** is positioned within the hexagonal indentation of hinge pin **34** after installation of hinge pin **34** as described above. When positioned within the hexagonal indentation of hinge pin **34**, hinge pin plug **120** is flush with the head of hinge pin **34**. In use, hinge pin plug **120** substantially prohibits the entry of foreign materials into the hexagonal indentation of hinge pin **34**. For example, hinge pin plug **120** substantially prohibits bone growth into the hexagonal indentation of hinge pin **34**, as well as prohibiting positioning of bone cement therein. The above-described connection of hinge post **40** to femoral component **22** is performed prior to implantation of femoral component **22**. Femoral component **22** is packaged and sold with bearing box **70**, hinge post **40**, hinge pin sleeve **36**, hinge pin **34**, and hinge pin plug **120** preassembled as described above, with the assembly preferably occurring in the manufacturing environment.

Pre-assembly of hinge post **40** to femoral component **22** eliminates a number of meticulous assembly steps (many of which were performed during implantation) which were required with constrained knees of the prior art. Furthermore, the assembly of hinge post **40** and femoral component **22** as described above facilitates replacement of various portions of knee prosthesis **20**. Specifically, the threaded connection of hinge pin **34** to femoral component **22** allows for removal and replacement of various components of knee prosthesis including, e.g., bearing box **70**, hinge pin sleeve **36**, and hinge post **40**.

In use, femoral bone stock may abut external side walls **82** of femoral component **22** and extend to the underside of condyler bearing surfaces **28**, **30**. To remove hinge pin **34**, a hole saw is utilized to remove a relatively small portion of femoral bone stock to provide access to hinge pin **34**. Advantageously, femoral component **22** does not require extensive removal of femoral bone stock for implantation thereof (since bone stock can extend to the underside of condylar bearing surfaces **28**, **30**), and, furthermore, does not require removal of femoral component **22** to effect replacement of, e.g., hinge post **40**, bearing box **70**, or hinge pin sleeve **36**. Upon accessing hinge pin **34** (e.g., utilizing a hole saw as described above), hinge pin plug **120** is removed, e.g., with a scalpel and forceps to provide access to the hexagonal indentation of hinge pin **34** so that a hexagonal wrench may be inserted therein to unthread hinge pin **34** from femoral component **22**.

Knee prosthesis **20** includes a pair of hyperextension stop mechanisms. The first hyperextension stop comprises a portion of condylar bearing surfaces **28**, **30** of increased radius of curvature as compared to the remaining condylar bearing surface. At three degrees of hyperextension this portion of increased radius of curvature will contact meniscal component **26** and act to retard further hyperextension. If hyperextension continues, the area of increased radius of curvature will cause femoral component **22** to lift away from meniscal component **26**. The second hyperextension stop mechanism functions at four degrees of hyperextension to prohibit further hyperextension of knee prosthesis **20**. The second hyperextension stop mechanism comprises hyperextension stop surface **66** of hinge post **40** and hyperextension stop **68** of bearing box **70**. Hyperextension stop surface **66** comprises the concave back wall of cannulated hinge post **40** as illustrated, e.g., in FIGS. **2** and **3**. Hyperextension stop **68** of bearing box **70** comprises a protrusion extending from the back wall of bearing box **70** opposite anti-rotation surface **78**. Hyperextension stop **68** includes a convex outer surface as illustrated, e.g., in FIG. **12**. Hyperextension stop surface **66** of hinge post **40** cooperates with hyperextension stop **68** of bearing box **70** to provide a hyperextension stop for knee prosthesis **20**. Concave hyperextension stop surface **66** becomes flush with the convex outer surface of hyperextension stop **68** of bearing box **70** at four degrees of hyperextension to prevent further hyperextension of knee prosthesis **20**.

Tibial component **24** is depicted in FIGS. **1-5**, **8**, **13**, and **14**. As illustrated, e.g., in FIG. **2**, tibial component **24** includes tibial tray **98** connected to tibial stem **92**. Stabilizing ribs **94** stabilize tibial tray **98** relative to tibial stem **92** and impede rotation of tibial component **24** in tibia **118** (see, e.g., FIG. **3**). In one exemplary embodiment, tibial component **24** is formed from a cobalt-chromium alloy. Tibial component **24** further includes tibial bushing **64** positioned within hinge post extension aperture **110**. Tibial bushing **64** is formed of plastic, such as, e.g., UHMWPE and provides a bearing surface between hinge post extension **42** and hinge post extension aperture **110** of tibial component **24**. As described above, meniscal component **26** comprises a rotating bearing, and, thus, hinge post extension **42** will rotate relative to tibial component **24**. Tibial bushing **64** facilitates this rotation of hinge post extension **42**.

Tibial component **24** further includes rotation protrusion **96**. As illustrated, e.g., in FIG. **3**, rotation protrusion **96** protrudes upwardly from tibial tray **98** of tibial component **24** and further extends in a plane substantially parallel to tibial tray **98**. Rotation protrusion **96** cooperates with cutout **90** of meniscal component **26** to guide rotation of meniscal component **26** about hinge post extension **42**, as further described hereinbelow.

One embodiment of meniscal component **26** is illustrated in FIGS. **1-7**, **13**, and **14**. Meniscal component **26** is formed from a suitable plastic such as, e.g., UHMWPE and provides a rotating bearing surface between femoral component **22** and tibial component **24**. Meniscal component **26** includes bearing surfaces **86**, **88** which contact condylar bearing surfaces **28**, **30** of femoral component **22** during movement of knee prosthesis **20**. As described above, meniscal component **26** further includes hinge post aperture **114** accommodating passage of hinge post **40** and, consequently, hinge post extension **42** therethrough. Meniscal component **26** is operable to rotate about the longitudinal axis of hinge post extension **42** to form a rotating bearing.

Meniscal components of varying heights may be constructed in accordance with the present invention. In one advantageous aspect of the present invention, meniscal component **26** is packaged for sale and use together with hinge

post extension **42** to facilitate component choice and, in one embodiment, to ensure proper extension of hinge post extension **42** into tibial component **24**. The extension of hinge post extension **42** into tibial component **24** functions to prevent separation of knee prosthesis **20** after implantation thereof. As is known in the art, the femoral component of a knee prosthesis may, in some situations, move relative to and away from the tibial component in a direction parallel to the longitudinal axis of the hinge post extension. With this in mind, hinge post extension **42** is made to be of sufficient length to be retained within tibial component **24** even in situations in which femoral component **22** moves as described immediately supra. In one exemplary embodiment, hinge post extension **42** extends four centimeters into hinge post extension aperture **110** in tibial component **24**.

Meniscal component **26** includes cutout **90** which cooperates with rotation protrusion **96** of tibial component **24** to guide rotation of meniscal component **26** and to resist lifting of meniscal component **26** from tibial tray **98** of tibial component **24**. As illustrated, e.g., in FIG. **3**, cutout **90** accommodates the portion (i.e., lip) of rotation protrusion **96** extending in a plane substantially parallel to the plane containing tibial tray **98**, with a portion (i.e., lip) of meniscal component **26** being positioned between rotation protrusion **96** and tibial tray **98** in a direction substantially perpendicular to the plane containing tibial tray **98**. This configuration functions to discourage displacement of meniscal component **26** away from tibial tray **98** in a direction parallel to the longitudinal axis of hinge post extension **42**. Furthermore, rotation protrusion **96** acts against the back of cutout **90** to limit rotation of meniscal component **26** about the longitudinal axis of hinge post extension **42**.

As illustrated in FIG. **5**, meniscal component **26** may be slid out from between tibial component **24** and femoral component **22** when the hinge post extension **42** has been removed from knee prosthesis **20**. As illustrated, hinge post aperture **114** is sized to allow rotation of hinge post **40** so that meniscal component **26** may be slid out from its position between femoral component **22** and tibial component **24**. This configuration allows for replacement of an implanted meniscal component **26** without requiring removal of hinge post **40**. FIG. **5** illustrates removal of hinge post extension **42** to accommodate replacement of meniscal component **26**. As illustrated, hinge plug wrench **102** engages hinge plug **38** for removal thereof. After removal of hinge plug **38**, slap hammer **104** is threadedly engaged with threaded aperture **44** in hinge post extension **42**. Slap hammer **104** may then be utilized to unlock the engagement of locking taper **46** in elongate hinge post extension aperture **112** so that hinge post extension **42** may be removed.

FIGS. **13** and **14** illustrate an alternative embodiment of the knee prosthesis of the current invention. This alternative embodiment utilizes hinge post extension **42**a having locking taper **46**a, cylindrical extension **48**a, and flange **106**. In this embodiment, a locking instrument may be utilized to apply force atop hinge post extension **42**a so that locking taper **46**a is seated in elongate hinge post extension aperture **112** and locked therein. Flange **106** may be utilized to facilitate removal of hinge post extension **42**a. As illustrated in FIG. **13**, set screw **108** may be utilized as a secondary lock for hinge post extension **42**a. In all other respects, the knee prosthesis illustrated in FIGS. **13** and **14** is constructed as described above with respect to the first embodiment of the knee prosthesis in accordance with the present invention.

FIGS. **15**, **16** and **17** illustrate an alternative embodiment of the hinge post extension and tibial bushing of the present invention. In this embodiment, tibial component **24**a includes annular tibial bushing expansion groove **122** formed in hinge post extension aperture **110**. Tibial bushing **64**a includes retaining flange **130** positioned within annular tibial bushing expansion groove **122**. FIG. **15** illustrates insertion of cylindrical extension **48**b of the hinge post extension into tibial bushing **64**a positioned within tibial component **24**a. As cylindrical extension **48**b proceeds into tibial bushing **64**a, bevel **126** contacts annular locking protrusion **128** of tibial bushing **64**a and causes outward movement of retaining flange **130** to allow cylindrical extension **48**b to proceed to its seated position as illustrated in FIG. **17**. Annular tibial bushing expansion groove **122** is sized to allow radial expansion of retaining flange **130** to accommodate placement of cylindrical extension **48**b within tibial bushing **64**a. In the fully seated position (FIG. **17**) cylindrical extension **48**b is locked in place by the engagement of annular locking protrusion **128** in annular locking groove **124**. Furthermore, retaining flange **130** cooperates with annular tibial bushing expansion groove **122** to prohibit axial displacement of tibial bushing **64**a and, consequently, cylindrical extension **48**b. In this embodiment, the femoral component is retained in abutting relationship to the meniscal component and lift off of the femoral component is substantially prohibited. Tibial bushing **64**a is, in one exemplary embodiment, formed of UHMWPE

FIGS. **18** and **19** illustrate another alternative embodiment of the knee prosthesis of the current invention. In this embodiment, locking clip **134** is utilized to retain the position of hinge post **40**b within hinge post aperture **114** of meniscal component **26**a. Hinge post **40**b is rotatably attached to femoral component **22** utilizing hinge pin **34** as described above. In this embodiment, hinge post **40**b includes locking clip grooves **132**, and meniscal component **26**a includes locking clip apertures **136**. Upon positioning of hinge post **40**b within hinge post aperture **114**, locking clip **134** is positioned as illustrated in FIG. **19** with each prong of locking clip **134** being inserted into locking clip apertures **136** of meniscal component **26**a. As illustrated in FIG. **19**, locking clip **134** engages locking clip grooves **132** to retain hinge post **40**b within hinge post aperture **114** of meniscal component **26**a. In this embodiment, lift off of femoral component **22** is prohibited by the engagement of hinge post **40**b with meniscal component **26**a. This embodiment of the knee prosthesis of the current invention may further utilize a meniscal component cutout together with a rotation protrusion on the tibial component to resist lifting of the meniscal component from the tibial tray as described above.

FIG. **20** illustrates a further alternative embodiment of the hinge post of the present invention. Hinge post **40**c illustrated in FIG. **20** includes reinforcing material **138** to strengthen hinge post **40**c.

While this invention has been described as having exemplary designs, the present invention may be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains.

What is claimed is:

[1. A prosthetic femoral component, comprising:

a femoral component body;

a hinge post having a longitudinal axis, said hinge post rotatably connected to said femoral component body, said hinge post rotatable relative to said femoral component body bout an axis of rotation, said hinge post

including an elongate aperture, along said longitudinal axis aid elongate aperture transverse to said axis of rotation.]

2. [The prosthetic femoral component of claim **1**, further comprising:] *A prosthetic knee assembly, comprising:*

a femoral component body that includes a first internal side wall opposing a second internal side wall;

a hinge pin having a longitudinal hinge pin axis;

a hinge post positioned between the first internal side wall and the second internal side wall of the femoral component body and having a longitudinal hinge post axis, said hinge pin fixed to said femoral component body and passing through a hinge pin aperture in said hinge post for rotatably, hingedly connecting said hinge post to said femoral component body so that rotation of said hinge post relative to said femoral component body is defined about the longitudinal hinge pin axis, said hinge post including an elongate hinge post extension aperture along said longitudinal hinge post axis, said elongate hinge post extension aperture transverse to said longitudinal hinge pin axis; and

a hinge post extension *removeably locked to said hinge post*, said elongate *hinge post extension* aperture of said hinge post sized for placement of said hinge post extension therein, whereby said hinge post extension traverses a first end of said elongate *hinge post extension* aperture of said hinge post and protrudes from a second end of said elongate *hinge post extension* aperture of said hinge post.

3. The prosthetic [femoral component] *knee assembly* of claim **2**, [further comprising:

securing means for securing said hinge post extension to said hinge post] *further comprising a tibial component into which the hinge post extension can be received, wherein, when the femoral component is attached to a femur and the tibial component is attached to a tibia opposite the femur, said hinge post extension can be separated from said hinge post to allow rotation of said hinge post about said longitudinal hinge pin axis without having to rotate the femur or tibia about said longitudinal hinge pin axis*.

4. The prosthetic [femoral component] *knee assembly* of claim [**3**, wherein said securing means comprises:

a male taper positioned on said hinge post extension; and

a female taper positioned in said elongate aperture, said male taper engageable in said female taper to secure said hinge post extension to said hinge post] *2 including cooperating locking tapers removeably locking the hinge post extension to the hinge post*.

5. The prosthetic [femoral component] *knee assembly* of claim [**1**] *2*, further comprising:

a bearing box connected to said femoral component body, said bearing box interposed between said hinge post and said femoral component body, said bearing box including a hyperextension stop, said hinge post including a hyperextension stop surface, said hyperextension stop contacting said hyperextension stop surface to prevent further hyperextension of the [prosthetic] femoral component body beyond a predetermined point of hyperextension.

6. The prosthetic [femoral component] *knee assembly* of claim **5**, *wherein* said predetermined point of hyperextension comprises four degrees of hyperextension of the [prosthetic knee] *femoral component* body.

7. The prosthetic [femoral component] *knee assembly* of claim **5**, wherein said hyperextension stop comprises a convex protrusion.

8. The prosthetic [femoral component] *knee assembly* of claim **5**, wherein said hinge post includes an internal wall, said hyperextension stop surface comprising said internal wall of said hinge post.

[**9**. A prosthetic femoral component, comprising:

a femoral component body;

a hinge post rotatably connected to said femoral component body; and

a bearing box connected to said femoral component body, said bearing box interposed between said hinge post and said femoral component body, said bearing box including a hyperextension stop, said hinge post including a hyperextension stop surface, said hyperextension stop contacting said hyperextension stop surface to prevent further hyperextension of the prosthetic femoral component body beyond a predetermined point of hyperextension.]

10. [The prosthetic femoral component of claim **9**, further comprising:] *A prosthetic knee assembly, comprising:*

a femoral component body;

a hinge post rotatably connected to said femoral component body about a rotational axis;

a bearing box connected to said femoral component body, said bearing box interposed between said hinge post and said femoral component body, said bearing box including a hyperextension stop, said hinge post including a hyperextension stop surface, said hyperextension stop contacting said hyperextension stop surface to prevent further hyperextension of the prosthetic femoral component body beyond a predetermined point of hyperextension; and

a hinge post extension *having a longitudinal axis and being removeably locked to said hinge post*, an elongate aperture of said hinge post sized for placement of said hinge post extension therein, whereby said hinge post extension traverses a first end of said elongate aperture of said post and protrudes from a second end of said elongate aperture of said hinge post, *wherein the longitudinal axis of said hinge post extension is non-intersecting with said rotational axis*.

11. The prosthetic [femoral component] *knee assembly* of claim **10**, further comprising:

securing means for securing said hinge post extension to said hinge post.

12. The prosthetic [femoral component] *knee assembly* of claim **11**, wherein said securing means comprises:

a male taper positioned on said hinge post extension; and

a female taper positioned in said elongate aperture, said male taper engageable in said female taper to secure said hinge post extension to said hinge post.

13. The prosthetic [femoral component] *knee assembly* of claim [**9**] *10*, wherein said predetermined point of hyperextension comprises four degrees of hyperextension of the [prosthetic] femoral component body.

14. The prosthetic [femoral component] *knee assembly* of claim [**9**] *10*, wherein said hyperextension stop comprises a convex protrusion.

15. The prosthetic [femoral component] *knee assembly* of claim [**9**] *10*, wherein said hinge post includes an internal wall, said hyperextension stop surface comprising said internal wall of said hinge post.

16. A prosthetic knee, comprising:

a femoral component;

a tibial component;

a meniscal component positioned between said femoral component and said tibial component, said femoral component including a condylar bearing surface, said

meniscal component including a cooperative bearing surface facing said condylar bearing surface of said femoral component *for contacting said condylar bearing surface*, said femoral component rotatably connected to said tibial component;

a hinge pin having a longitudinal hinge pin axis;

a hinge post rotatably connected to said femoral component *which includes said hinge pin passing through a hinge pin aperture in said hinge post for rotatably, hingedly connecting said hinge post to said femoral component so that rotation of said hinge post relative to said femoral component is defined about the longitudinal hinge pin axis*, said meniscal component including **[**an**]** *a hinge post* aperture *with a longitudinal hinge post aperture axis that is non-intersecting with said longitudinal hinge pin axis*, said hinge post positioned within said *hinge post* aperture; and

a locking clip, said meniscal component including a locking clip aperture, said hinge post including a locking clip groove, said locking clip traversing said locking clip aperture and engaging said locking clip groove to retain said hinge post within said hinge post aperture.

[17. A prosthetic knee, comprising:

a femoral component;

a tibial component;

a meniscal component positioned between said femoral component and said tibial component, said femoral component including a condylar bearing surface, said meniscal component including a cooperative bearing surface facing said condylar bearing surface of said femoral component, said femoral component rotatably connected to said tibial component;

a hinge post extension, said hinge post extension rotatably connected to said femoral component, said hinge post extension including an annular groove; and

a tibial bushing including an annular locking protrusion and a retaining flange, said tibial component having a tibial bushing expansion groove, said retaining flange positioned in said tibial bushing expansion groove, said annular locking protrusion engaged in said annular groove.**]**

18. A prosthetic knee, comprising:

a femoral component having a hinge post rotatably connected thereto *about a rotational axis*;

a tibial component;

a meniscal component positioned between said femoral component and said tibial component, said femoral component including a condylar bearing surface, said meniscal component including a cooperative bearing surface facing said condylar bearing surface of said femoral component *for contacting said condylar bearing surface*, said meniscal component including **[**an**]** *a hinge post* aperture *having a longitudinal axis that is non-intersecting with said rotational axis*, whereby said hinge post is positioned within said *hinge post* aperture when the prosthetic knee is operably assembled; and

a locking clip, said meniscal component including a locking clip aperture, said hinge post including a locking clip groove, said locking clip traversing said locking clip aperture and engaging said locking *clip* groove to retain said hinge post within said hinge post aperture.

19. The prosthetic femoral component of claim 2, wherein said first end of said elongate aperture of said hinge post is positioned closer to said hinge pin than said second end of said elongate aperture so that said hinge post extension protrudes from said second end of said elongate aperture of said hinge post in a direction away from said hinge pin.

20. The prosthetic femoral component of claim 10, wherein said first end of said elongate aperture of said hinge post is positioned closer to said femoral component body than said second end of said elongate aperture of said hinge post so that said hinge post extension protrudes from said second end of said elongate aperture of said hinge post in a direction away from said femoral component body.

21. The prosthetic femoral component of claim 2, wherein said hinge pin includes a hexagonal indentation on a first end thereof, said first end being flush with said femoral component, said prosthetic femoral component further comprising a hinge pin plug positioned within said hexagonal indentation and being flush with said first end of said hinge pin.

22. The prosthetic femoral component of claim 2, wherein said longitudinal hinge post axis is non-intersecting with said longitudinal hinge pin axis.

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