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(72) WHITE, PATRICK MICHEL, US
(71) WHITE, PATRICK MICHEL, US

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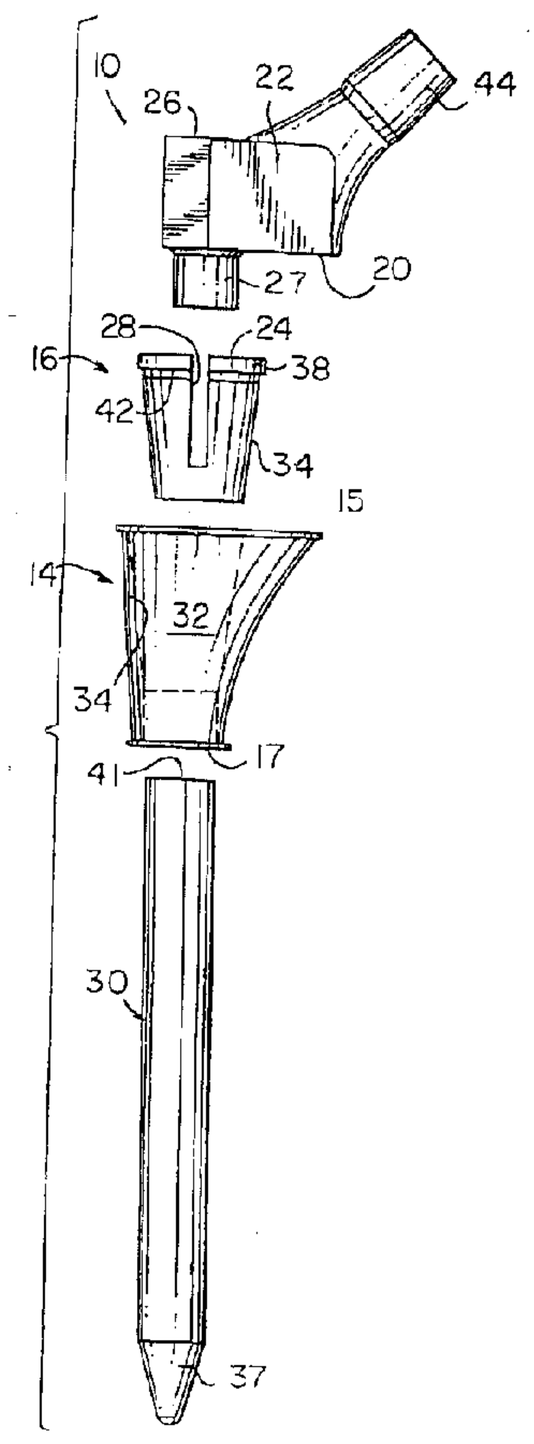
(54) **PROTHESE POURVUE D'UN CORPS CUNEIFORME**
(54) **PROSTHESIS HAVING WEDGE-SHAPED BODY**



(57) L'invention porte sur une prothèse (10) orthopédique modulaire pourvue d'un corps (14) ayant une section transversale triangulaire près d'une extrémité (20), ce qui permet aux angles de mordre ou d'inciser la cavité osseuse environnante pour obtenir une stabilité de rotation. Une tige (12), pouvant être de structure unitaire ou modulaire, et pourvue d'un col (22) proximal et d'un arbre (30) distal, se loge dans un trou traversant (18) du corps (14). Un manchon (16) de raccordement recevant la tige (12) passe à son tour dans le trou (18) du corps (14), puis est actionné pour se dilater radialement et bloquer la tige et le corps. L'invention porte également sur une hanche (10) modulaire préférée et sur des prothèses humérales (110).

(57) A modular orthopedic prosthesis (10) has a body (14) with a generally triangular cross section near one end (20), allowing its angular corners to bite or incise into the surrounding bone cavity for rotational stability. A stem (12), which may be either unitary or modular in structure, is received within a through-bore (18) of the body (14), having a proximal neck (22) and distal shaft (30). A connecting sleeve (16) receives the stem (12) and is, in turn, received within the bore (18) of the body (14), then actuated to radially expand to lock the stem and body together. Preferred modular hip (10) and humeral (110) prostheses are described.

Abstract

Hygienic water-soluble cleansing paper which has a sufficient wet strength for cleansing human bodies or devices as well as a high solubility in water in a state being impregnated with practically useful cleansing agents with a high moisture content, imparts a good feel in using and can be produced at a high efficiency; and portable packaged water-soluble cleansing paper suitable for cleansing the body after evacuation when being out, preventing inflammation in menstruation and worsening of hemorrhoids, therapeutic uses, etc. The cleansing paper is obtained by interlocking fiber sheets made of a specific water-soluble fiber material with each other under a high-pressure water stream and then impregnating the obtained water-soluble nonwoven fabric with a specific aqueous cleanser. This paper can be enclosed in a steam-impermeable soft packaging material to give a packaged matter conveniently carried out or stored.

PROSTHESIS HAVING WEDGE-SHAPED BODY

TECHNICAL FIELD

This invention relates generally to orthopedic prostheses, particularly to those having a modular construction that is assembled from selected components and implanted during re-constructive arthroplastic surgery.

BACKGROUND

It is known that bone matter that is not stressed/loaded will atrophy and lose viability, a problem which currently persists in present orthopedic implants.

One approach others have taken is to provide a collar intended to correspond in shape and size to the prepared cavity of a proximal femur, ostensibly to offer rotatory stability to the implanted device. For example, *U.S. Patent No. 4,790,852 to Noiles* shows a modular hip prosthesis including a collar having a shape with a keyhole cross-section and terraces surrounding the outer surface perpendicular to the longitudinal axis of the collar. The collar has a tapered proximal-to-distal contour. However, the shape of the collar is instead dictated by the milling instrumentation used to prepare the proximal femoral cavity. According to the procedure, a surgeon resects the femoral head (ball) with an osteotome, thereby exposing the medial aspect of the cavity, then reams the intramedullary canal to make a space for the collar. The medial bone cavity is then milled to make it fit set criteria of the implant. *U.S. Patent No. 5,002,578 to Luman* also has transverse terraces and a supposed cavity conforming cross-section. However, such terraces, like those of the above Noiles '852 patent, do not counteract rotary motion of the prosthesis, but rather axial motion. *U.S. Patent No. 4,549,319 to Meyer* has an external geometric pattern of elongated projections spaced circumferentially on a hip prosthesis. *U.S. Patent No. 4,624,673 to Meyer* discusses a component for use in a prosthetic joint having a hollow tube with a closed end and an open end. The area of the external surface adjacent to the open end is at least twice the area of the external surface adjacent to the closed. A plurality of terraces, oriented orthogonal to a distal shaft, are on the external surface. A female part of self-

locking taper is provided to connect the components. *U.S. Patent No. 4,846,839 to Noiles* shows a modular hip with a collar having an oval cross-section and a terraced external surface, connecting with a stem. Products have been marketed generally based upon this approach, e.g., The SROM Hip, of Joint Medical Products, Inc.

The aforementioned patents seek to provide rotatory stability by circumferential contact between the prepared femoral cavity and an outer surface of a main body or collar member. This type of contact is actually tangential in nature. The use of an oval cross-sectional shape often does not allow the outer surface of the prosthesis collar to effectively engage the intact bone. In many cases, especially in revision patients, healthy bone can be problematic to uniformly contact, for example, in the lateral aspects of the proximal femur, where the greater trochanter is left largely undisturbed by the surgeon during a primary implantation. The lack of rotatory stability, needed for uniform stress on such healthy bone, can cause the intact tissue to weaken and possibly atrophy, unacceptably, at some point following the initial implantation of the prosthesis.

Others, including some of the above approaches, have further sought to achieve prosthesis-cavity conformance while providing various modular constructions and ways of connecting the components of the prosthesis.

For example, related *U.S. Patent Nos. 5,370,706 and 5,080,685 to* Bolesky show a body member having a neck with a base defining a neck basal plane. A body member includes an upwardly and inwardly directed portion and a tapered longitudinal bore. A tapered connector engages a head member with the upwardly and inwardly directed portion. A problem experienced with this particular design is its limited strength, due to the location of the interconnecting components. Thus, the point of connection of the shaft must bear a load that is often too great, without being able to distribute that force. In *U.S. Patent No. 4,878,917 to Kranz, et al.*, there is shown a modular implant with a tensioning connector rod structurally designed to break when loaded a selected amount. *U. S. Patent No. 5,201,882 to Paxson* discloses indicia for selecting the desired ante-version of a modular hip stem that is connected via tapered fittings to a unitary neck/body member, but the neck is not independently adjustable relative to the body. U.S. Patent No. 5,725,592, issued to the

present Inventor, describes a modular hip prosthesis having a distal stem component that connects with a body component and a neck component both having tapered through-bores.

Various implant systems have also been proposed for reconstruction of the humerus. *U.S. Patent No. 5,489,309 to Lackey, et al.*, entitled, AModular Humeral Component System@, discloses a kit of interchangeable elements each having a variety of sizes said to fit a particular desired patient. A head is assembled proximally to a body by standard tapered connection, the body being affixed to one or more elongated stem portions by conical fittings having hexagonal ends said to prevent anti-rotation. As noted, the stems may further include distal extensions to accommodate the length of the intramedullary canal of the humerus. In U.S. Patent No. 5,702,486 to Craig, et al., another modular humeral prosthesis is described, wherein a unitary humeral stem is assembled to a head by a tapered connection, including a distal extension that can be screwed-in to the stem to fit the given length of a patient=s intramedullary canal. It should be noted that these systems rely upon heretofore conventional means for connecting the several components of the prosthesis.

There is still a need for a modular prosthesis having independently adjustable components, and for a connector mechanism allowing the surgeon to visibly adjust them. Also, a prosthesis is needed, having an adjustable body with a geometry that incisively engages healthy bone, then securely locks with a stem component inter-operatively. The prior patents do not show a body shape capable of adjustably engaging healthy bone tissue in such a manner.

Other prior unitary implants have had various shapes, but the distal shaft and main body portions of these were not independently adjustable components, allowing surgeons to inter-operatively achieve optimal engagement of the body with healthy bone tissue.

Moreover, a need exists for a prosthesis that allows the surgeon to independently adjust the implant and realize the aim of engaging intact bone, as well, for an implant geometry that incises the intact bone and stresses it.

There is a further need for a modular implant that is infinitely adjustable, rotationally and axially, using a relatively simple array of components, allowing a surgeon flexibility while reducing the cost of carrying a large inventory of sizes. Such a need also exists while continuously delivering desired benefits, via the implant geometry, to a patient's intact bone. A modular implant design is called for, whose components can be readily assembled intra-operatively and securely locked together by the surgeon to achieve these purposes.

SUMMARY OF THE INVENTION

According to the invention, there is provided a modular orthopedic prosthesis including a stem having one end with an elongated portion and another, longitudinally opposed end with a first means presenting a joint motion surface. The prosthesis has a body including a bore defining at least a first axis and having a polygonal cross-section with at least two angular corners adapted to bite or incise into the bone cavity of a patient to prevent rotation of the implanted prosthesis relative to the bone. Means are provided for connecting and locking the stem and body together in a fixed position.

In a preferred embodiment of this invention, the body has a first end with a generally triangular cross-section in the region of the first end and a generally round cross-section in the region of its second end, presenting a multi-axial wedge shape.

According to the invention, in another of its aspects, a modular orthopedic prosthesis is provided. The prosthesis comprises a stem component having one end with an elongated portion and another, longitudinally opposed end with a first means presenting a joint motion surface. A body component includes a bore defining at least a first axis. A radially expansible sleeve has opposed ends, one end received within the bore and the other end projecting outwardly from the bore, the sleeve adjustably connecting the stem and body together and locking them in a fixed position.

In a preferred embodiment of this invention, the joint motion surface is adjustably spaced from the body.

In one or more further preferred embodiments of this invention, a modular hip prosthesis is provided and, in one or more still further preferred embodiments, a humeral prosthesis is provided.

An advantage of the present invention is inventory and manufacturing cost savings, since its modularity allows for economy in manufacturing, as any number of well-known stem types may be selected, and also reduces the inventory of pieces needed on-hand for each surgical procedure.

Another advantage of the invention is enhanced clinical benefits, as the wedge shape offers enhanced rotatory stability of the prosthesis in use, particularly with revision surgery patients.

A further advantage of the invention is in providing a connector mechanism that is highly secure once fixed in place, meanwhile providing the surgeon inter-operative flexibility to axially and rotationally adjust the stem independently of the body.

A still further advantage of the invention gives a surgeon the capability to rotationally "dial" the body in order to have its triangular corners contact and "bite into" or incise as much available healthy bone as possible. By evenly loading/stressing such intact bone, wherever found by the surgeon, particularly in revision patients, it is possible to avoid potential eventual atrophy of the bone tissue.

Other objects and advantages will become apparent to those skilled in the art by reference to the following Description and Drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a modular hip prosthesis of the invention, fully assembled and implanted in a proximal femur, with the bone longitudinally cut away;

FIG. 2 is an external side view of the body component of the present invention, taken from an anterior-posterior aspect;

FIG. 2A is a cross-section of the proximal portion of the body of **FIG. 2**, taken substantially along the lines **2A-2A**;

FIG. 2B is a cross-section of the proximal portion of the body of **FIG. 2**, taken substantially along the lines **2B-2B**;

FIG. 2C is a cross-section of the proximal portion of the body of **FIG. 2**, taken substantially along the lines **2C-2C**;

FIG. 3 is an external side view of the sleeve component of the present invention, taken from either an anterior-posterior or medial-lateral aspect;

FIG. 3A is a longitudinal section of the body of **FIG. 3**, taken substantially along the lines **3A-3A**;

FIG. 3B is an external top view of the proximal portion of the sleeve of **FIG. 3**;

FIG. 4 is a partially exploded perspective view of the invention, showing the sleeve partially seated in the bore of the body, prior to insertion of the stem;

FIG. 5A is a cross-section taken through the proximal femur of a representative cadaver bone;

FIG. 5B is a cross-section of the proximal portion of the body of the invention, implanted in the cadaver bone of FIG. 5A, further showing also the cross-section of a representative prior art implant for comparison purposes.

FIG. 6 is an exploded perspective view of the stem, body and sleeve of the invention, shown prior to assembly, wherein the stem has a modular shaft construction with separate neck protrusion and distal shaft components;

FIG. 7 is an exploded perspective view of the prosthesis of FIG. 6, showing the distal shaft component of the modular stem being connected to the body with another independent sleeve;

FIG. 8 is an exploded perspective view of the prosthesis of the invention showing a unitary stem with a tapered connection region, a sleeve with a cylindrical outer surface and a tapered internal bore, and a body with a linear through-bore;

FIG. 9 is a top view of the body component having a generally triangular shape with two sharp corners and a tapered bore;

FIG. 10 is a top view of the body component having a generally polygonal shape, i.e., hemi-hexagonal, with sharp corners, and a tapered bore;

FIG. 11 is an external view of the body of a prosthesis of the invention with a medial osteotomy plane;

FIG. 12 is a top view of the body component of FIG. 11;

FIG. 13 is a sectional view, taken substantially along lines 13-13 of FIG. 12;

FIG. 14 is a perspective view of a modular humeral prosthesis of the invention;

FIG. 15 is an exploded perspective view of the stem, body and sleeve of a humeral prosthesis of the invention, shown prior to assembly, wherein the stem has a modular construction with separate neck and distal shaft components: and

FIG. 16 is an exploded perspective view of a humeral prosthesis of the invention, showing a unitary stem, a sleeve and a body.

DETAILED DESCRIPTION

According to the invention, as shown in FIGS. 1-13, there is provided a modular prosthesis assembly, generally shown at 10, including a stem component, generally shown at 12, a body component, generally shown at 14, and means in the form of a sleeve, generally shown at 16, for affixing the stem and body together. In FIGS. 1, 4, and 8 the stem 12 is a unitary member, however, as shown in FIGS. 6-7, the stem can be in a modular form. In FIGS. 1, 4, 6 and 8, the prosthesis 10 comprises a single sleeve, however, as shown in FIG. 7, the prosthesis can include a pair of sleeves 16 in conjunction with a modular stem. Nevertheless, a single sleeve is preferred. In FIGS. 1, 2, 2-C, 4, and 6-13, the body has a first or proximal end 15 and a second, longitudinally opposed or distal end 17. The body 14 functions as a wedge generally in the anterior-posterior and medial-lateral plane, as well as the proximal-distal plane, as will be herein elucidated.

The body 14 has a bore 18 with a first axis A extending between the proximal 15 and distal 17 ends, through which stem 12 is received, once the stem has been passed through sleeve 16. The assembled stem 12 and sleeve 16 are seated in bore 18 and, as they are urged into the bore fully, the sleeve radially compresses to pressure-lock the stem and body together in a fixed relative position.

The present invention employs a distinctive geometry and connection technology that variably locks together the three fundamental components 12, 14 and 16 of the prosthetic hip 10 into a fixed configuration. In surgery, the proximal femoral bone cavity is prepared by reaming and then a finish broaching operation, thereby creating the desired cavity in the bone. In FIG. 4, the sleeve 16 is placed in the bore 18 (phantom) through a

first end **15** of body **14** but left proud, i.e., not fully seated in the bore. Then stem **12** is passed through the sleeve **16** until the desired neck height is achieved for restoring the tension of the total articulated joint. Indicia could be added to allow visual recognition of the height adjustment by the surgeon. Once the proper height is achieved, an axial force is applied to the top **24** of sleeve **16**, locking it against the bore **18**. In a preferred embodiment, axial force can be applied to the top **26** of neck **22** and transmitted indirectly, through the bottom **20** of neck **22**, to top **24** of sleeve **16**. The components are actuated and locked together in this manner as shown by **FIGS. 1** and **4**, in the case of a unitary stem **12**, and similarly in the case of a modular assembly. As shown in **FIGS. 6-7**, modular neck **22** has a protrusion **27** extending distally from bottom **20** of the neck for connecting with sleeve **16**. Protrusion **27** may be either straight or tapered, depending upon the geometry of its interconnecting member.

The sleeve 16 will now be more particularly described. Preferably, sleeve **16** is radially flexible by means of a preferred split collet **28**, as shown in **FIGS. 3** and **3A-3B**, to lock the components together. The preferred split collet **28** can be made from titanium, stainless steel or cobalt-chromium alloys. Sleeve **16** has bottom **25** received within bore **18**. The same locking function is performed by sleeve **16** in the embodiments of **FIGS. 6-8** that show a modular distal shaft **30**. Alternatively, a solid construction could be employed for the sleeve (not shown), using a super-elastic material that is inherently radially flexible under controlled temperature conditions, e.g., a nickel-titanium alloy such as nitinol. Sleeve **16** has an outer surface **31** that engages bore **18**.

The body **14** will now be more particularly described. As shown is **FIG. 2A**, taken through the region of first or proximal end **15** of body **14**, the body has an outer surface **32** with a "generally polygonal" cross-sectional shape, although the polygon is preferably a triangle. Such a shape affords non-tangential contact with the intact bone, in a plane perpendicular to the longitudinal axis of the bone. Together with the tapered contour in the proximal-distal plane, body 14 functions as a three-dimensional wedge. By the term "generally polygonal", it is meant that one or more of the sides of the polygon could be either linear or slightly bowed, in a concave or convex manner. However, substantially linear sides are preferred. The degree to which the sides may be bowed should not defeat

the function of the angular corners 34 shown in FIGS. 1, 2. 2A, 2C and 4-10, as well as in FIGS. 11-12 that will be described below.

The centroid (not shown) of the proximal polygonal cross-sectional shape of body 14 need not coincide with axis A of bore 18. Likewise, the centroid (not shown) of the distal cross-section (FIG. 2B) which could be polygonal or preferably round, need not coincide with the axis A of bore 18, although such coincidence is preferred. Neither of the first 15 and second 17 ends of body 14 need be perpendicular to the axis A of bore 18, yet, it is preferred that ends 15, 17 are perpendicular to axis A. As shown in FIGS. 11-13, body 14 has a planar osteotomy surface 35, oriented at a selected angle relative to axis A, such that the distance between the axis A and the edge of the outer surface 32 increases in a direction from the first end of the body toward the second end of the body. The planar surface 35 generally corresponds to the location of an osteotomy cut. Either of the surfaces 15 or 35 could optionally carry a collar member (not shown) that is meant to rest on the end of the bone, where clinically indicated, to help prevent linear subsidence of the body component axially into the bone cavity. As to the function of the cross-sectional shape, however, the body geometry shown in FIGS. 11-13 has the same function as in the other embodiments previously discussed. That is, the corners 34 incise into the bone to provide rotatory stability to the implanted prosthesis 10, while effectively loading the bone.

Reference is now made to the three views of sleeve 16 shown in FIG. 3. An outer surface 31 of sleeve 16 contacts bore 18 and creates a lock between stem 12 and body 14, while an inner bore 36 of the sleeve creates a lock between stem 12 and the body, when axial force is applied to the assembled components. Sleeve 16 is radially flexible about axis A of bore 18, by means of collet 28. As with the first 15 and second 17 ends of body 14, the opposed top 24 and bottom 25 of sleeve 16 need not lie in planes that are parallel to one another, although such is preferred. As shown in of FIG. 3A, sleeve 16 may have either a straight or tapered bore 36. Similarly, the outer surface 31 of sleeve 16 could be tapered or straight. The sleeve may have bore 36 of different diameters correspond to the different outer diameters of the stem 12, respectively. The thickness of the wall defined between the inner diameter of the bore 36 and outer diameter to the surface 31 may be varied to accommodate different corresponding diameter sizes of the stem.

Although a single through-bore **18** is preferred, separate bores (not shown) could be used to receive each of the distal shaft and neck components, as in the case of a modular stem construction contemplated by **FIGS. 6-7**. In a modular construction, shaft **30** has a free end or distal tip **37** that is received within the medullary canal of the femur, in the case of hip prosthesis **10**.

In the top and external views of **FIG. 3**, top **24** of sleeve **16** has an optional upper shoulder **38** that is spaced from surface **15** of body **14**. In **FIG. 8** an embodiment is shown wherein the optional shoulder **38** stops the sleeve **16** from falling through the bore **18** in body **14** which is necessary since the bore **18** and outer surface **31** of sleeve **16** are both straight rather than tapered. When the stem **12** is passed through the sleeve **16** the taper connection region **40** adjacent the bottom **20** of neck **22** spreads the collet **28** of sleeve **16** and locks the components together. Shoulder **38** has an underside **42** that abuts the outer periphery of bore **18** and stops the sleeve **16** from falling through the bore **18**. Alternatively instead of the shoulder **38** limiting axial motion of the sleeve relative to the bore, the bore could have a counter-sunk inlet (not shown) that would abut the bottom **25** of sleeve **16** and arrest its downward motion in the bore. The leg length could be adjusted by using different height shoulders **38**.

Referring to **FIGS. 1, 4, 6** and **7-8**, neck **22** carries a joint motion surface via tapered connector **44** to which a ball (not shown) may be attached having the acetabular fit needed to ensure proper articulation and total joint tension. Distal shaft **30** could be coated, fluted, slotted or the like. The connection region **40**, although shown with a tapered diameter in **FIG. 8**, as well as in a unitary stem **12** or modular neck **22** and shaft **30** configuration, can also have a straight diameter in the other embodiments described. Region **40** is adjacent a fixed or proximal end **41** of modular shaft component **30** (**FIGS. 6-7**), which is longitudinally opposed from distal tip **37**. End **41** is received within sleeve **16**.

Reference is now made to **FIG. 5**, showing the preferred triangular proximal cross-sections of the invention versus a representative prior art collar (oval and keyhole shapes) in an actual cadaver bone. Superimposed on the prior keyhole shape is the triangular cross-section of the invention. By contrast, the prior art relies upon circumferential and, ultimately

tangential contact with the bone and does not present a multi-axial wedged shape that reaches out and incises into intact bone in the lateral regions of the proximal femoral cavity, as does the present design. This structural difference results in a crucial functional distinction.

In **FIGS. 9-10**, two preferred polygonal shapes are shown for body **14**, taken cross-sectionally in the region of first end **15** adjacent neck **22**. In **FIG. 12**, body **14** has a generally triangular cross-section, with at least two corners **34** on its outer surface **32**, whereas, in **FIG. 13** there is shown another polygonal shape, i.e., partially hexagonal, which presents such corners **34**. The necessity for biting into intact bone, in the case of hip arthroplasty, is most important in the lateral aspect of the femoral cavity, which is less exposed than the medial aspect. This is because the femoral head is resected, exposing the entire proximal medial cavity to the surgeon. This is not so laterally, hence the geometry of the body of the present invention which can reach out and bite into the lateral intact bone. An oval shape does not do this. Bore **18** of body **14** has a tapered portion **46** adjacent the top or proximal end **15**, for mating engagement with either sleeve **16** or a tapered stem.

Although the invention has been described with reference to a prosthesis **10** designed for hip arthroplasty, it must be understood that this invention may be used in other types of arthroplasty, e.g., a shoulder joint, with certain particular adaptations as will be described with reference to **FIGS. 14-16** below.

Referring to **FIGS. 14-16**, a modular humeral prosthesis is generally shown at **110**, including a stem component, generally shown at **112**, a body component, generally shown at **114**, and a sleeve component, generally shown at **116**. Stem **112** has a proximal neck **122** and an elongated distal shaft **130** with tip **137** for implantation in the intramedullary canal of a patient. Neck **122** has a first means, in the form of tapered male connector **144**, presenting a joint motion surface on which a humeral head component, generally shown at **139**, is attached by a mating female connector on the underside (not shown) of the head. Body component **114** includes a bore (not shown) defining at least a first axis. Radially expansible sleeve **116** has opposed ends **124**, **125**, one end **125** received within the bore of body **114** with the other end **124** projecting outwardly from the bore. The sleeve **116** adjustably connects stem **112** and body **114** together, radially expanding and locking them

in a fixed position when the sleeve is actuated. Body **114** has external surface **132** that contacts the intact bone of the patient. Humeral head **139** is received within the glenoid cavity (not shown) of a patient. This is analogous to the manner in which a ball (not shown) having a desired size would be assembled, i.e., to the proximal connector **44** on stem **12** of hip **10** (**FIGS. 1, 6 and 8**), for receipt within the acetabulum of a patient.

The different variations, by which the above-referenced preferred modular system of **FIGS. 14, 15 and 16** are constructed and assembled according to the invention, generally follow the scheme shown in **FIGS. 1, 6 and 8**, respectively. The bore of sleeve **116** may have either a cylindrical or tapered structure, depending upon the desired geometry of body **114** or stem **112**, respectively. Likewise, the outer surface **131** of sleeve **116** could be tapered or cylindrical, depending upon the desired geometry of body **114** or stem **112**, respectively. Neither of these various alternative combinations of geometry (tapered and cylindrical) will be described in detail here, nor will their associated structures and function be further mentioned, as those skilled in the art will appreciate them by careful resort to **FIGS. 1-13**. In either case, sleeve **116** is provided with collets **128** that radially expand, upon assembly, to lock body **114** and stem **112** together in fixed position, as depicted in **FIG. 14.**

The stem component **112** of humeral prosthesis **110** will now be described, with reference to **FIGS. 14-16**. Platform **133** is preferably disposed at an angle of generally about 30 degrees, depending upon the patient=s anatomy, with respect to the longitudinal axis of distal shaft **130**. This angle is generally equal to the angle between the axis of the of the patient=s humeral head and the patient=s humeral intramedullary canal, that is, the hollow interior of the proximal humerus or humeral shaft. When prosthesis **110** is implanted in a patient, platform **133** acts to prevent subsidence of the implant in the intramedullary canal, and to distribute anatomical loads on the proximal humerus. Neck **122** has a lateral fin **135** extending outwardly therefrom in which suture holes (not shown) may be provided. Tapered male connector **144** projects medially and proximally from neck **122** and mates with a female connector (not shown) located within the underside (not shown) of humeral head component **139** when the prosthesis is fully assembled. Stem **112** may comprise a unitary or modular structure, as shown in **FIGS. 15 and 16**, respectively. The modular stem **112** of **FIG. 15** functions similarly to the unitary stem **112** of **FIG. 16**, with respect to the

manner in which the stem is locked together with body **114** and sleeve **116** in fixed position. In FIG. 15, stem further comprises a separate distal shaft 130 and a proximal protrusion 127 which components are assembled as in the preferred hip embodiment shown in FIG. 6.

Sleeve **116** with radially expanding collets **128** is of substantially the same structure and performs the same function as the sleeve **16** with collets 28 described above in relation to **FIGS. 1-13**.

Body **114** preferably has a polygonal shape, more preferably has a generally triangular proximal cross-section. The structure and advantages of this geometry are as described with respect to one or more embodiments of the preferred body **14** of hip prosthesis **10** shown in **FIGS. 1-13**.

The above Description should not be construed as limiting but rather is given for purposes of illustrating the invention. Obviously, persons skilled in the art could make various modifications to the embodiments shown, without departing from the scope of the present invention, as claimed in those claims appended to this Specification.

CLAIMS:

1. A modular orthopedic prosthesis comprising:

a stem having one end with an elongated portion and another, longitudinally opposed end with a first means presenting a joint motion surface;

a body including a bore defining at least a first axis and having a generally polygonal cross-section with at least two angular corners adapted to bite into the bone cavity of a patient to prevent rotation of the implanted prosthesis relative to the bone; and

means for connecting the stem and body together in a fixed position.

2. The prosthesis of Claim 1 wherein the body has a generally triangular cross-section.

3. The prosthesis of Claim 1 wherein the body has a single through-bore.

4. The prosthesis of Claim 1, the body having first and second ends longitudinally opposed from one another along the first axis, the first end being adjacent the first means and the second end being adjacent the elongated portion, the body having a generally polygonal cross-section in the region of the first end of the body.

5. The prosthesis of Claim 1, the body having a planar osteotomy surface oriented at a selected angle relative to the first axis, such that the distance between the axis and the edge of the surface increases in a direction from the from the first end of the body toward the second end of the body.

6. The prosthesis of Claim 4, the body having a generally circular cross-section in the region of the second end of the body.

7. The prosthesis of Claim 1, the first means further comprising a neck operatively connected to the body in the region of the first end.

8. The prosthesis of Claim 1, the elongated portion further comprising a shaft having a free end with a tip and a fixed end opposite the tip wherein the bore of the body is adapted to receive the fixed end for assembly with the body.

9. The prosthesis of Claim 1 wherein the stem further comprises a neck, carrying the joint motion surface, and a shaft opposite the neck, the shaft being adapted for receipt within the medullary canal of a bone, the stem passing through the bore and being attached to the body in a fixed position along the first axis.

10. The prosthesis of Claim 1, wherein the neck and shaft each comprise separate modular articulating components of the stem.

11. The prosthesis of Claim 10, the stem further comprising a neck attached to the body along the first axis.

12. The prosthesis of Claim 10 wherein the elongated portion is attached to the body along the first axis.

13. The prostheses of Claim 1 wherein the sleeve comprises a super-elastic material.

14. The prostheses of Claim 13 wherein the super-elastic material is nitinol.

15. The prosthesis of Claim 1 wherein the bore of the body and an outer surface of the sleeve have mating tapers which, when seated together, activate the stem and body to lock together in fixed relative position.

16. The prosthesis of Claim 1, the sleeve having an inner bore that is tapered and the stem having at least one corresponding outer surface that is tapered wherein the mating tapers, when engaged, activate the stem and body to lock together in fixed relative position.

17. A modular orthopedic prosthesis comprising:

a stem component having one end with an elongated portion and another, longitudinally opposed end with a first means presenting a joint motion surface;

a body component including a bore defining at least a first axis; and

a radially expansible sleeve having opposed ends, one end received within the bore and the other end projecting outwardly from the bore, the sleeve connecting the stem and body together in a fixed position.

18. The prosthesis of Claim 17 wherein the body has a polygonal cross-section with at least two angular corners adapted to bite or incise into the bone cavity of a patient to prevent rotation of the implanted prosthesis relative to the bone.

19. The prosthesis of Claim 17, the sleeve further comprising a collet having a bore wherein the stem is received within the bore of the collet, the stem and collet together being further received within the bore of the body to lock them together.

20. The prosthesis of Claim 19, the sleeve further comprising a split collet.

21. The prosthesis of Claim 19 wherein the collet has a distal insertion end for receipt within the bore along the first axis and an opposed, proximal end including an annular flange.

22. The prosthesis of Claim 19 wherein the annular flange comprises a spacer shoulder having a selected thickness.

23. The prosthesis of Claim 17 wherein the stem comprises a unitary member.

24. The prosthesis of Claim 17, the first means further comprising a neck wherein the receives the neck for assembly with the body.

25. The prosthesis of Claim 17, the elongated portion further comprising a shaft having a free, distal end with a tip and a fixed, proximal end opposite the tip wherein the receives the fixed end for assembly with the body.

26. The prosthesis of Claim 17 wherein the stem further comprises a neck, carrying the joint motion surface, and a shaft opposite the neck, the shaft having a distal tip adapted for receipt within the medullary canal of a bone, the stem passing through the bore and being attached to the body in a fixed position along the first axis.

27. The prosthesis of Claim 26, the stem further comprising a neck attached to the body along the first axis.

28. The prosthesis of Claim 27 wherein the elongated portion is attached to the body along the first axis.

29. The prostheses of Claim 17 wherein the neck and the shaft comprise separate modular components of the stem.

30. The prostheses of Claim 17 wherein the body has an upper face defining an outer periphery of the bore, the sleeve having an end received within the bore and an opposite end with an annular flange juxtaposed with the outer periphery.

31. The prostheses of Claim 17 wherein the annular flange has a shoulder with an upper surface and the first means includes a neck with an abutment surface contacting the upper surface of the shoulder as the stem is locked within the body.

32. The prostheses of Claim 17 wherein the first means of the stem comprises a separate neck component and the elongated portion a separate shaft component, the neck having means adjacent the body for connecting within the bore of the sleeve, the shaft having a free end and a fixed end, the fixed end passing through the bore of the body and into the bore of the sleeve.

33. The prostheses of Claim 17 wherein the sleeve comprises an annular collet made of a super-elastic material.

34. The prostheses of Claim 33 wherein the super-elastic material is nitinol.

35. The prosthesis of Claim 17 wherein the bore of the body and an outer surface of the sleeve have mating tapers which, when seated together, activate the stem and body to lock together in fixed relative position.

36. The prosthesis of Claim 17, the sleeve having an inner bore that is tapered and the stem having at least one corresponding outer surface that is tapered wherein the mating tapers, when engaged, activate the stem and body to lock together in fixed relative position.

37. A modular orthopedic prosthesis comprising:

a stem having one end with an elongated portion and another, longitudinally opposed end with a first means presenting a joint motion surface;

a body including a bore defining at least a first axis and having a polygonal cross-section with at least two angular corners adapted to bite into the bone cavity of a patient to prevent rotation of the implanted prosthesis relative to the bone; and

a radially expansible sleeve having opposed ends and a bore, one end of the sleeve being received within the bore of the body and another end projecting outwardly from the bore of the body, wherein the stem is received within the bore of the sleeve, the stem and sleeve together being further received within the bore of the body to connect the stem and body together in a fixed position.

38. The prosthesis of Claim 37, the first means of the stem comprising a neck and the elongated portion comprising a shaft, the bore of the body being a through-bore, wherein the neck and shaft are a unitary member received in the through-bore.

33. The prosthesis of Claim 37, the first means of the stem comprising a neck and the elongated portion comprising a shaft, the bore of the body being a through-bore, wherein the neck and shaft are separate members each received within the through-bore.

40. The prosthesis of Claim 37, the body having first and second ends longitudinally opposed from one another along the first axis, the first end being adjacent the first means and the second end being adjacent the elongated portion, the body having a generally triangular cross-section in the region of the first end of the body.

41. The prosthesis of Claim 40, the body having a generally circular cross-section in the region of the second end of the body.

42. The prosthesis of Claim 37 wherein the sleeve comprises a split collet.

43. The prosthesis of Claim 37, the body having a pair of ends longitudinally opposed from one another along the first axis of the bore with one of the ends presenting a top surface adjacent the first means and another end being adjacent the elongated portion, wherein the collet further has an end received within the bore of the body and an opposed end spaced from the top of the body.

44. The prosthesis of Claim 37, wherein the collet has an annular flange on the end of the collet that is spaced from the top surface of the body, the flange being of a larger size than the bore of the body and limiting motion of the collet within the bore.

45. The prosthesis of Claim 37 wherein the sleeve comprises an annular collet made of a super-elastic material.

46. The prosthesis of Claim 45 wherein the super-elastic material is nitinol.

47. The prosthesis of Claim 37 wherein the bore of the body and an outer surface of the sleeve have mating tapers which, when seated together, activate the stem and body to lock together in fixed relative position.

48. The prosthesis of Claim 37, the sleeve having an inner bore that is tapered and the stem having at least one corresponding outer surface that is tapered wherein the mating tapers, when engaged, activate the stem and body to lock together in fixed relative position.

49. A modular orthopedic prosthesis comprising:

a stem having one end with a neck presenting a joint motion surface and another, longitudinally opposed end having a shaft;

a body including a through-bore having at least a tapered portion, defining a first axis, the body having first and second ends longitudinally opposed from one another along the first axis, the first end being adjacent the neck and presenting an upper face, the second end being adjacent the shaft, the body having a generally triangular cross-section in the region of its first end with at least two angular corners adapted to bite and incise into the bone cavity of a patient to prevent rotation of the implanted prosthesis relative to the bone, the body having a generally circular cross-section in the region of the second end; and

a radially expansible collet having opposed ends including an internal bore and a tapered external surface mating with the tapered portion of the bore, the collet being received within the bore of the body and projecting outwardly from the bore of the body, wherein the stem is received within the bore of the sleeve, the stem and sleeve together being further received within the bore of the body to lock the stem and body together in a fixed position as the mating tapers are engaged.

50. The prosthesis of Claim 49 wherein the stem comprises a unitary member.

51. The prostheses of Claim 49 wherein the neck and the shaft comprise separate modular components of the stem.

52. A modular humeral prosthesis comprising:

a humeral stem having a proximal neck, carrying a joint motion surface, and a shaft opposite the neck, the shaft having a distal tip adapted for receipt within the medullary canal of the humerus;

a body including a bore defining at least a first axis, the shaft being received by the body; and

a radially expansible sleeve having opposed proximal and distal ends, the distal end received within the bore and the proximal end projecting outwardly from the bore, the sleeve connecting the stem and body together in a fixed position.

53. The humeral prosthesis of Claim 52, the neck having a platform and a connector projecting proximally from the platform, with a fin extending laterally from the neck.

54. The humeral prosthesis of Claim 53 further comprising a humeral head component having an outer hemispherical surface , adapted to be received withing the glenoid cavity, the head further including a connector that mates with the connector of the neck.

55. The humeral prosthesis of Claim 54, the sleeve further comprising a split collet.

56. The humeral prosthesis of Claim 55 wherein the shaft and neck further comprise separate, modular components of the stem.

57. The humeral prosthesis of Claim 55 wherein the shaft and neck further comprise a unitary structure.

58. The humeral prosthesis of Claim 52 wherein the sleeve comprises an annular collet made of super-elastic material.

59. The humeral prosthesis of Claim 55 wherein the super-elastic material is nitinol.

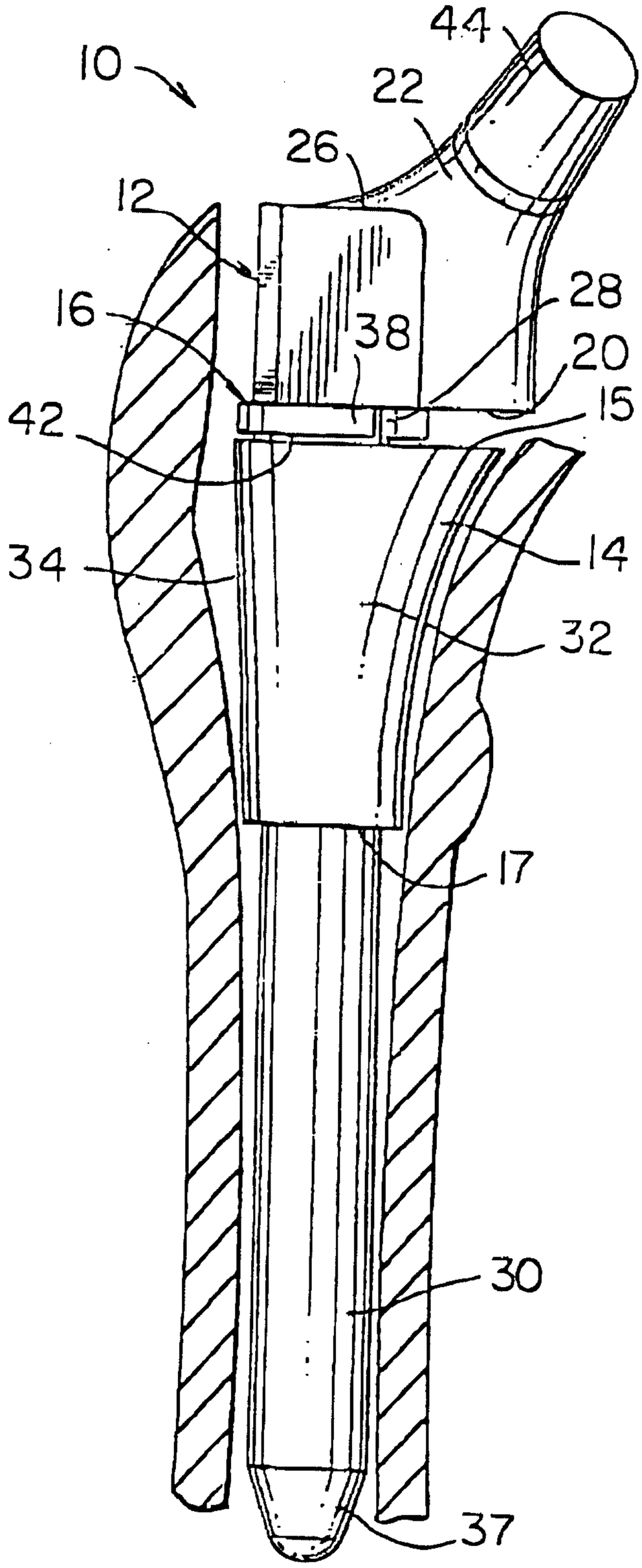


FIG. 1

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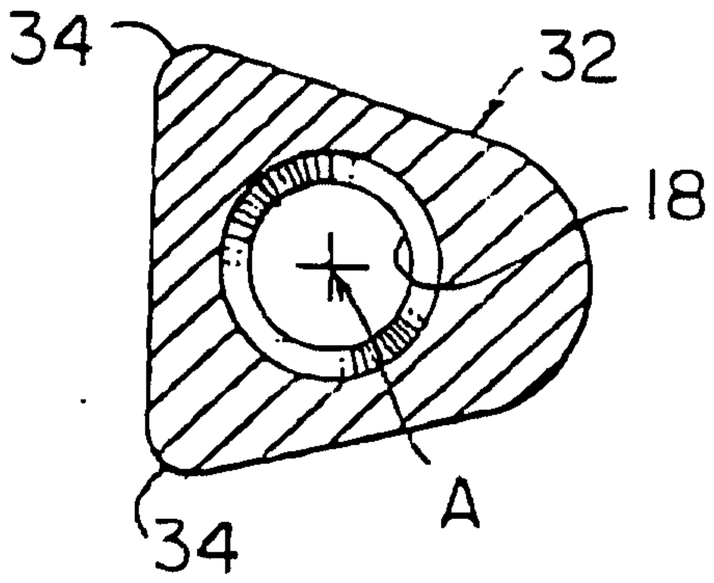

FIG.2A

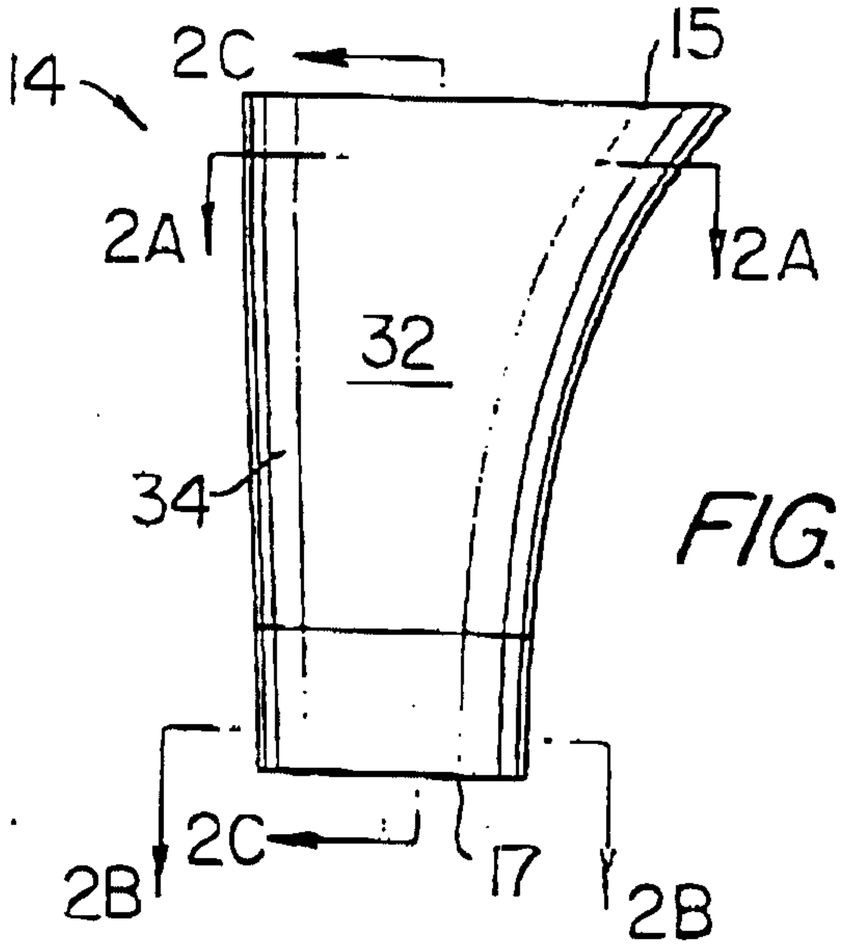

FIG.2

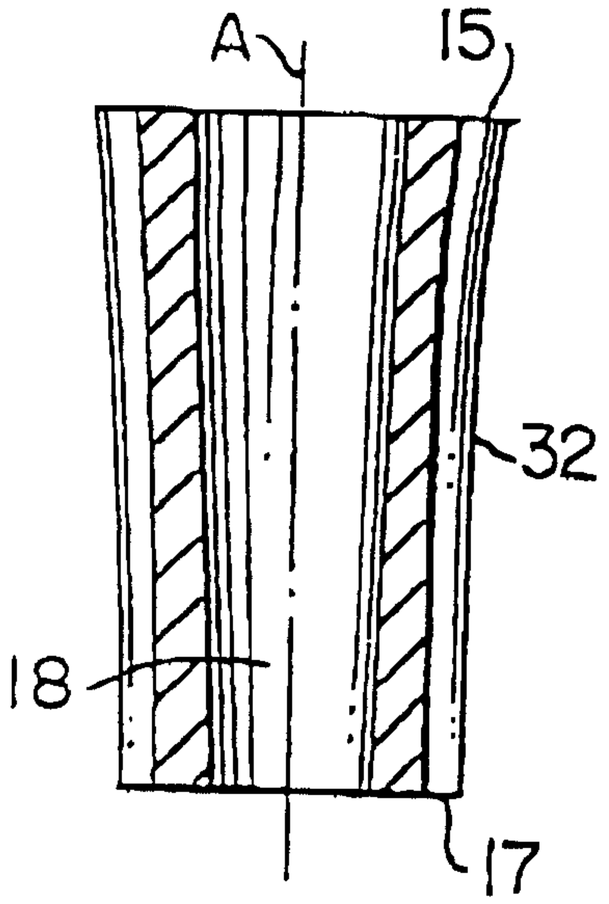

FIG.2C

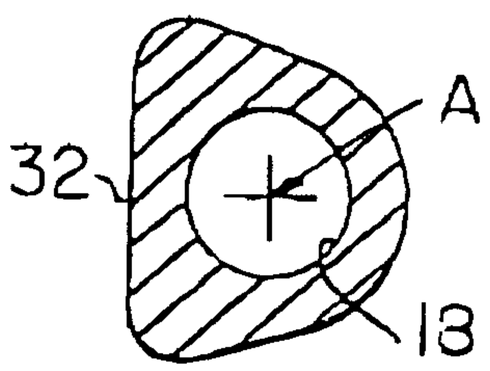

FIG.2B

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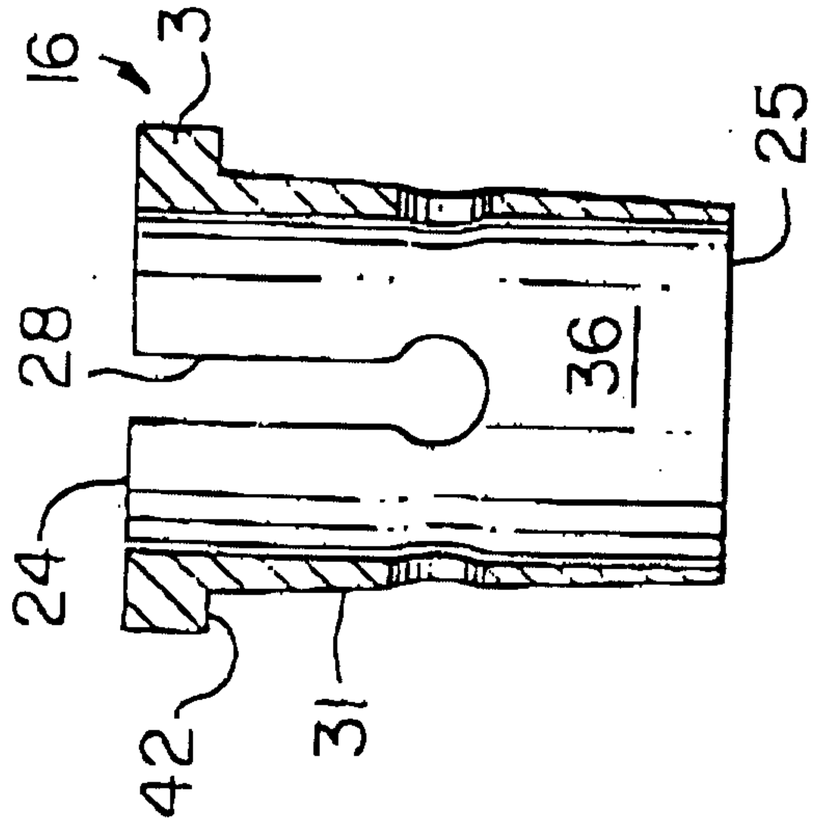

FIG.3A

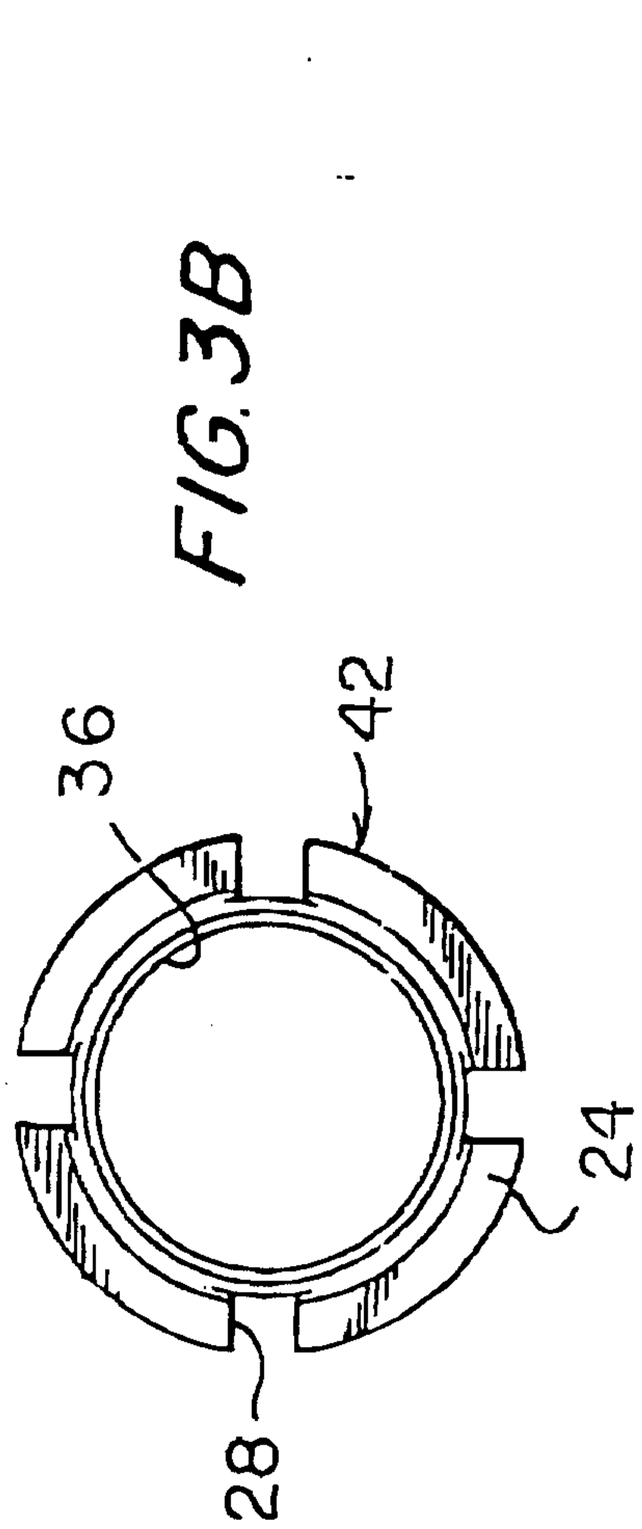

FIG.3B

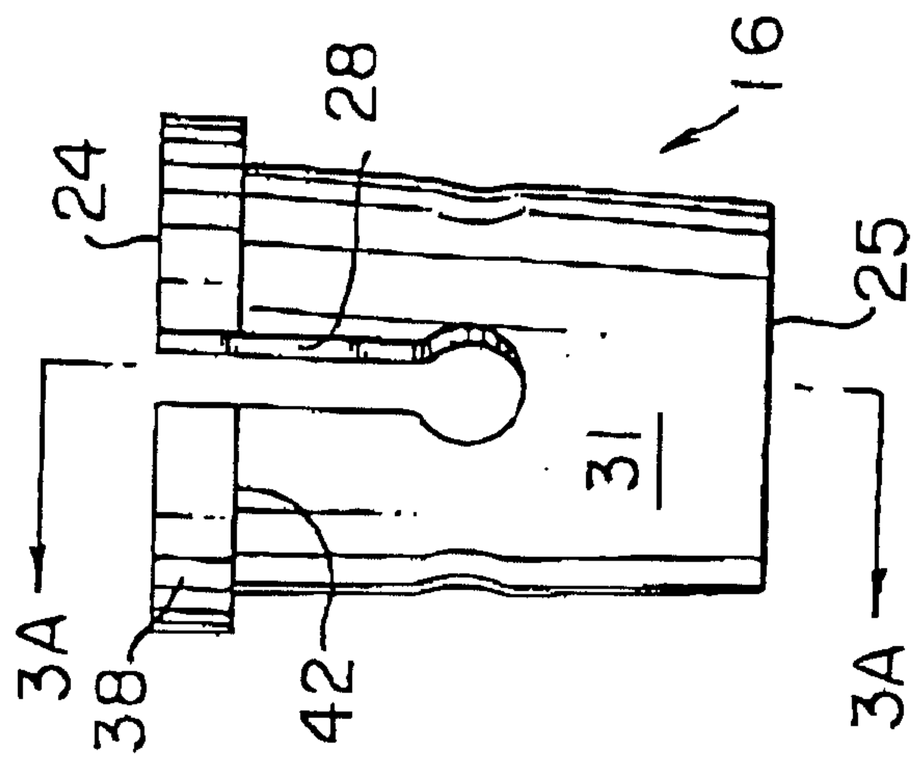

FIG.3

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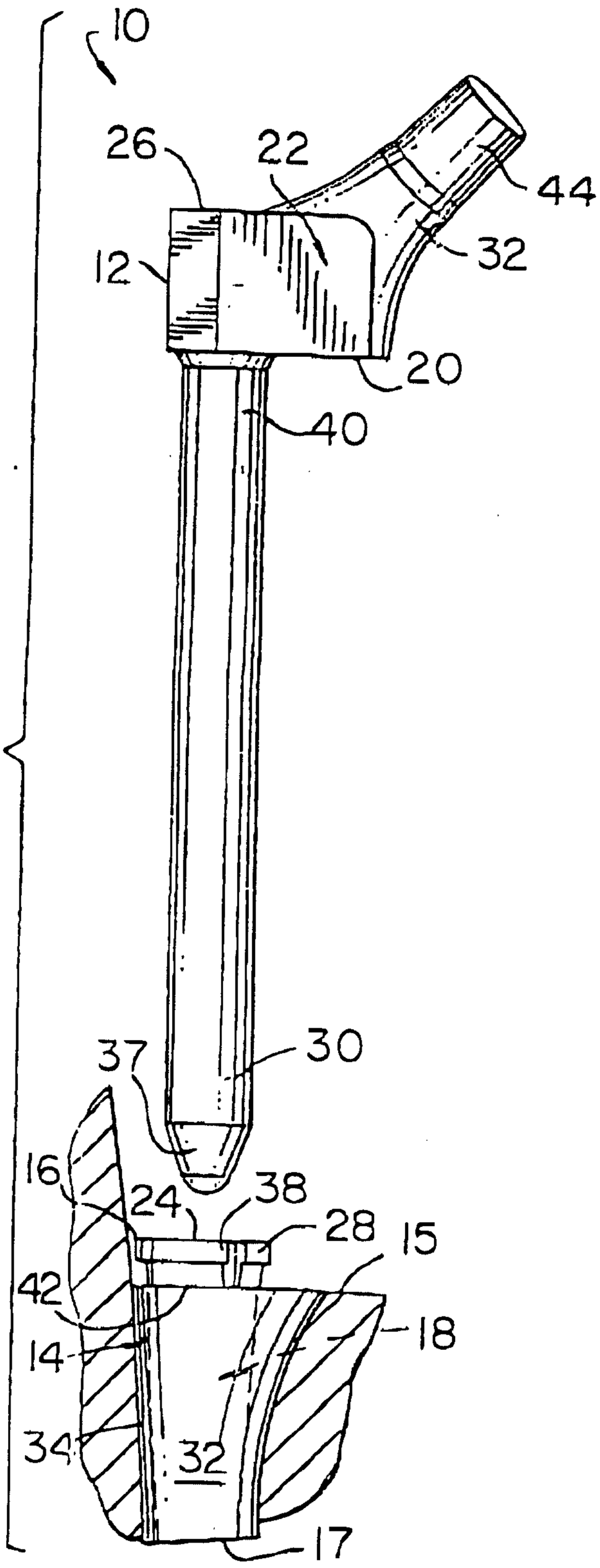

FIG. 4

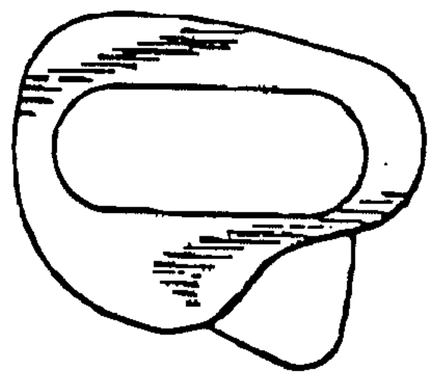

FIG. 5A

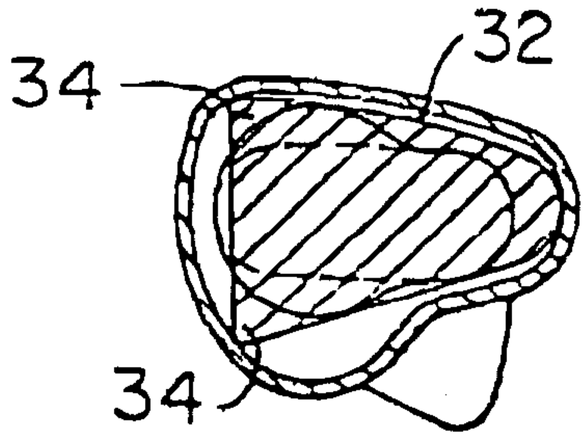

FIG. 5B

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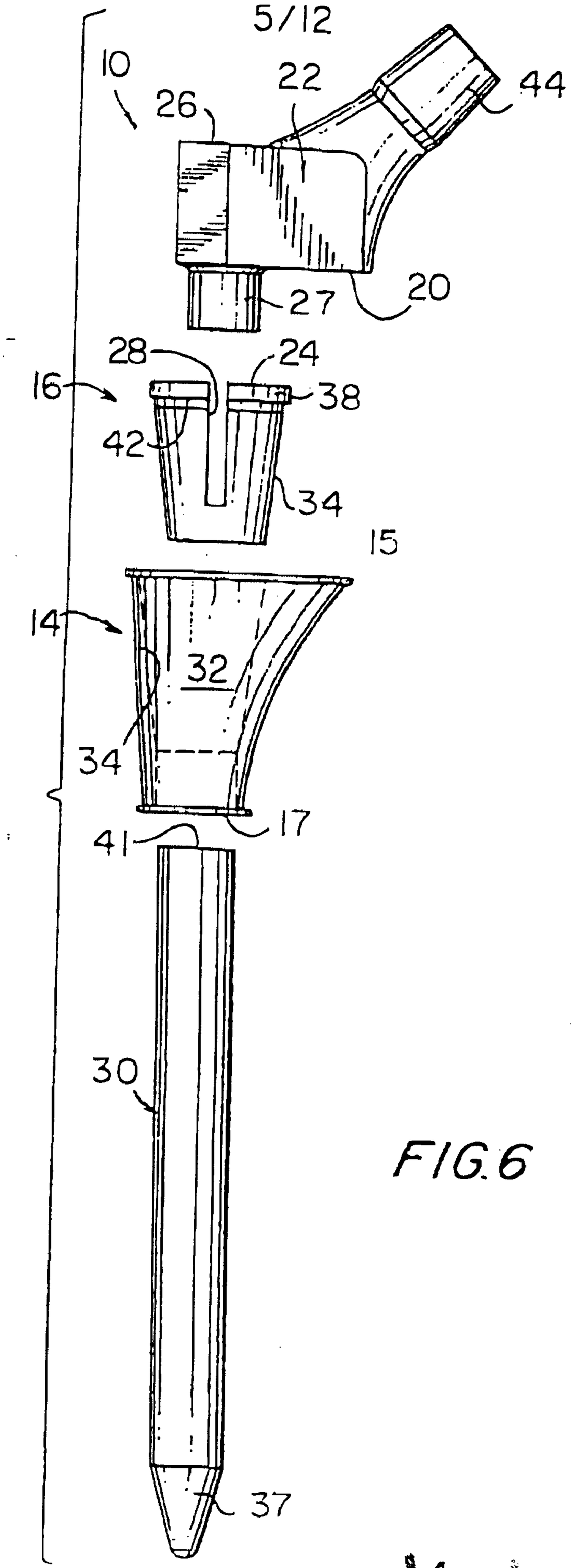

FIG.6

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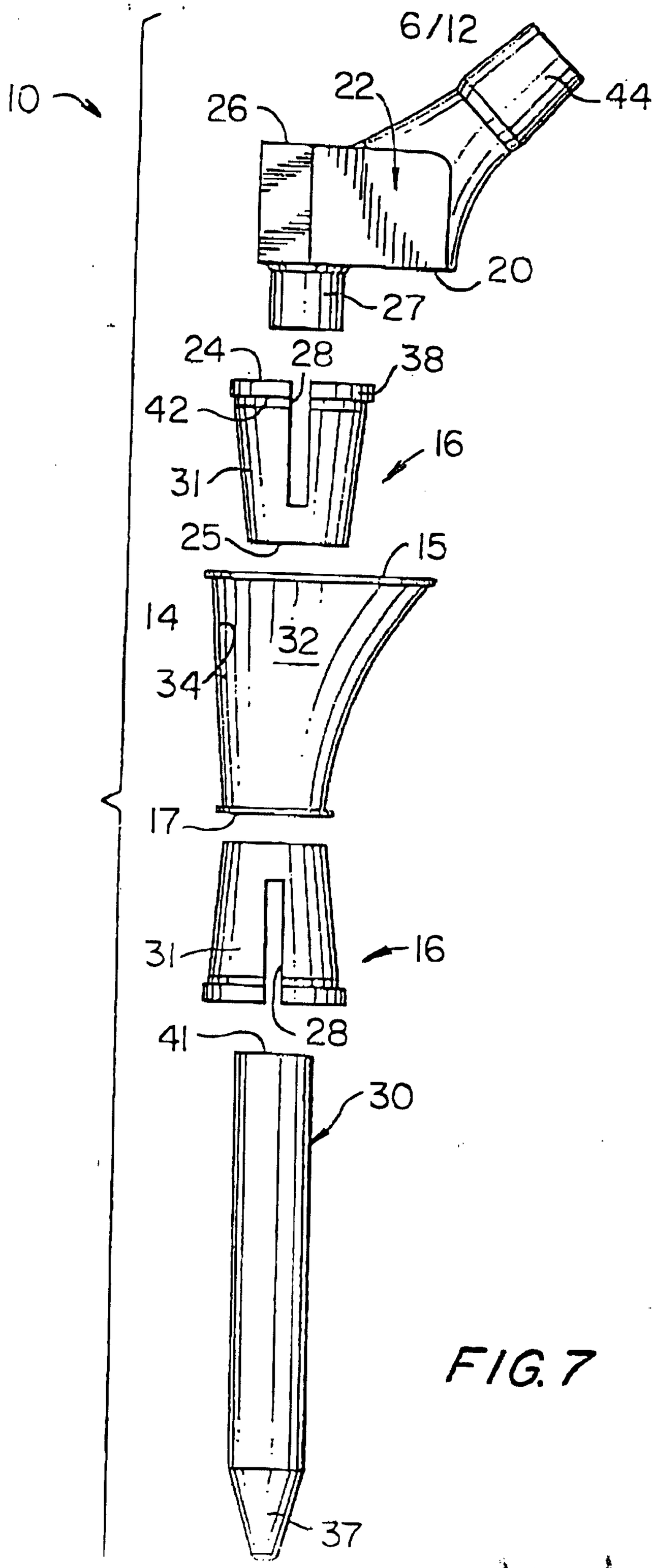

FIG. 7

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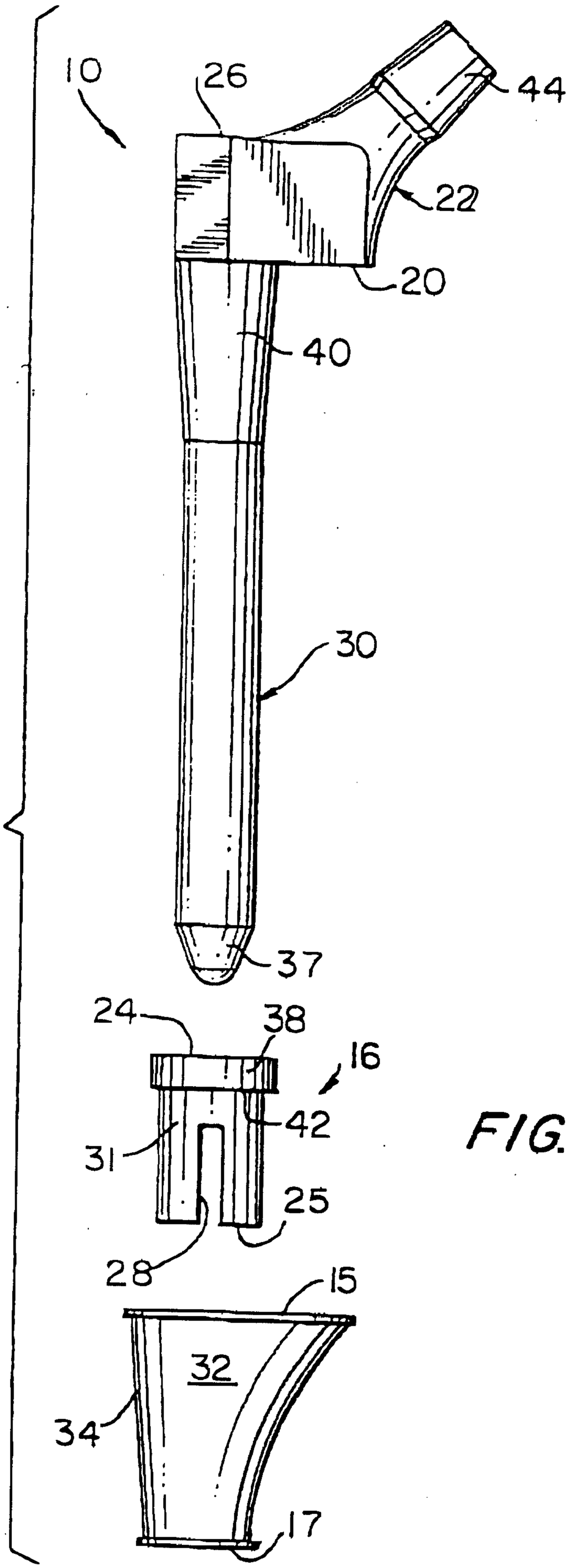

FIG.8

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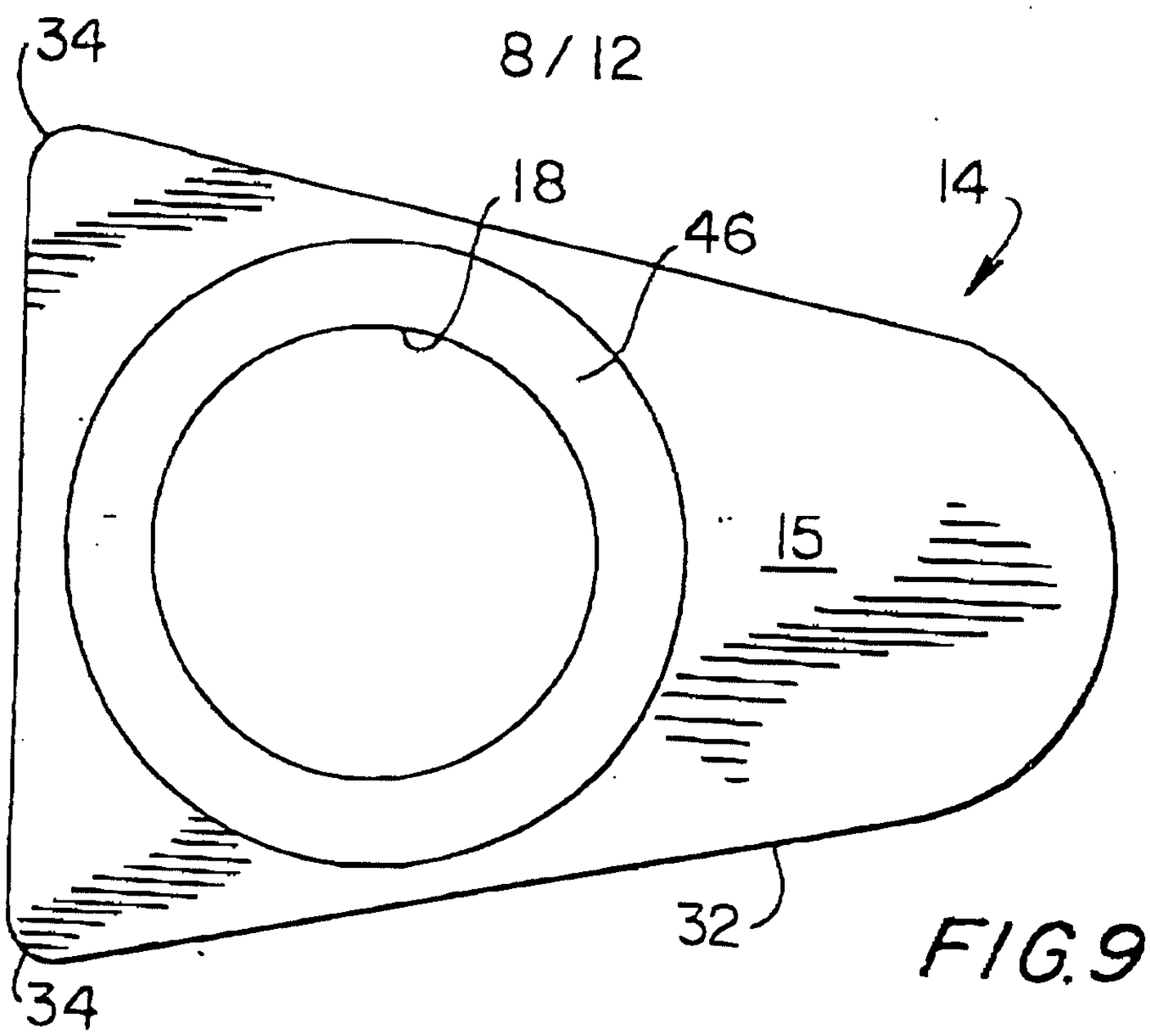

FIG. 9

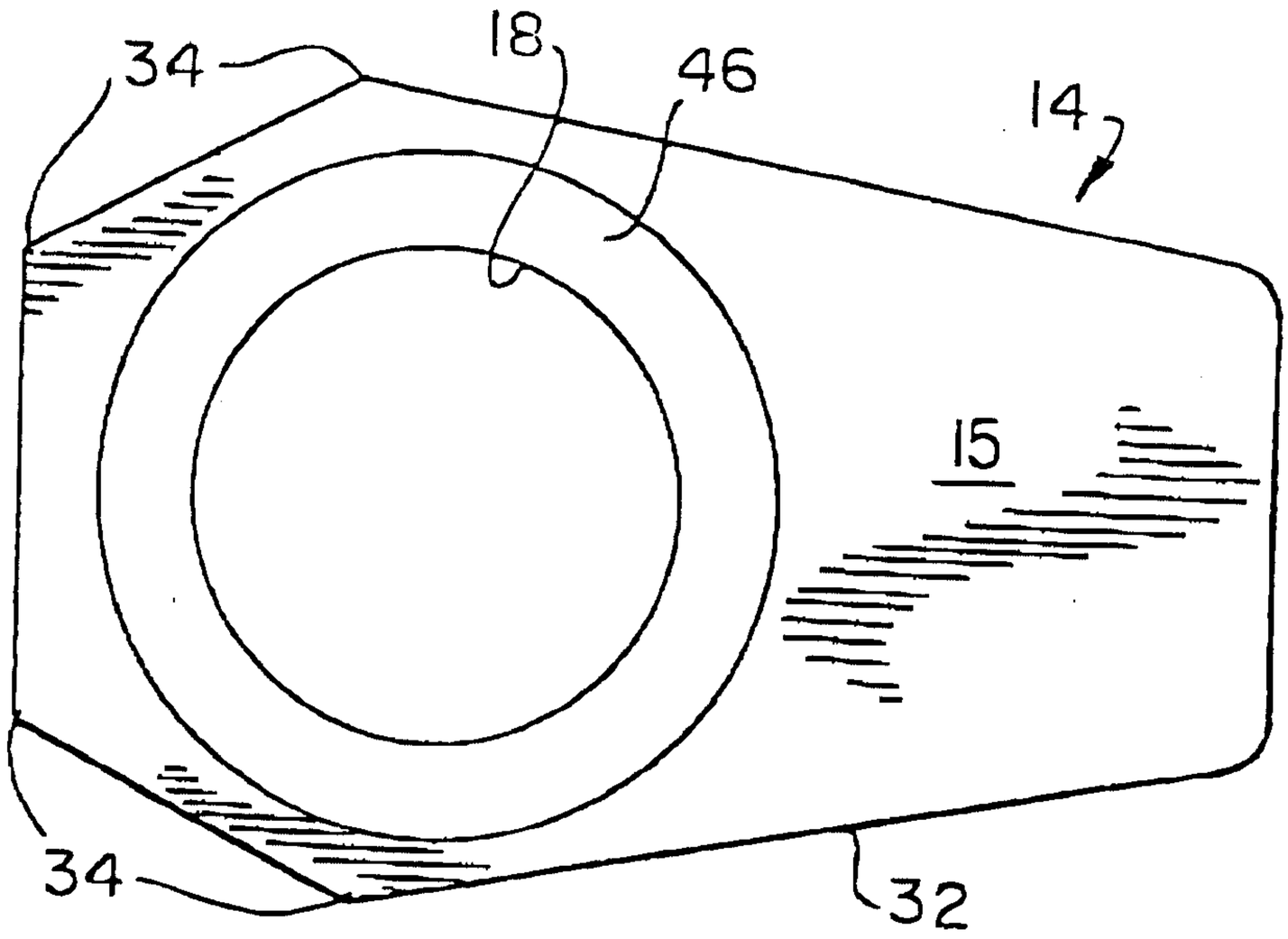

FIG. 10

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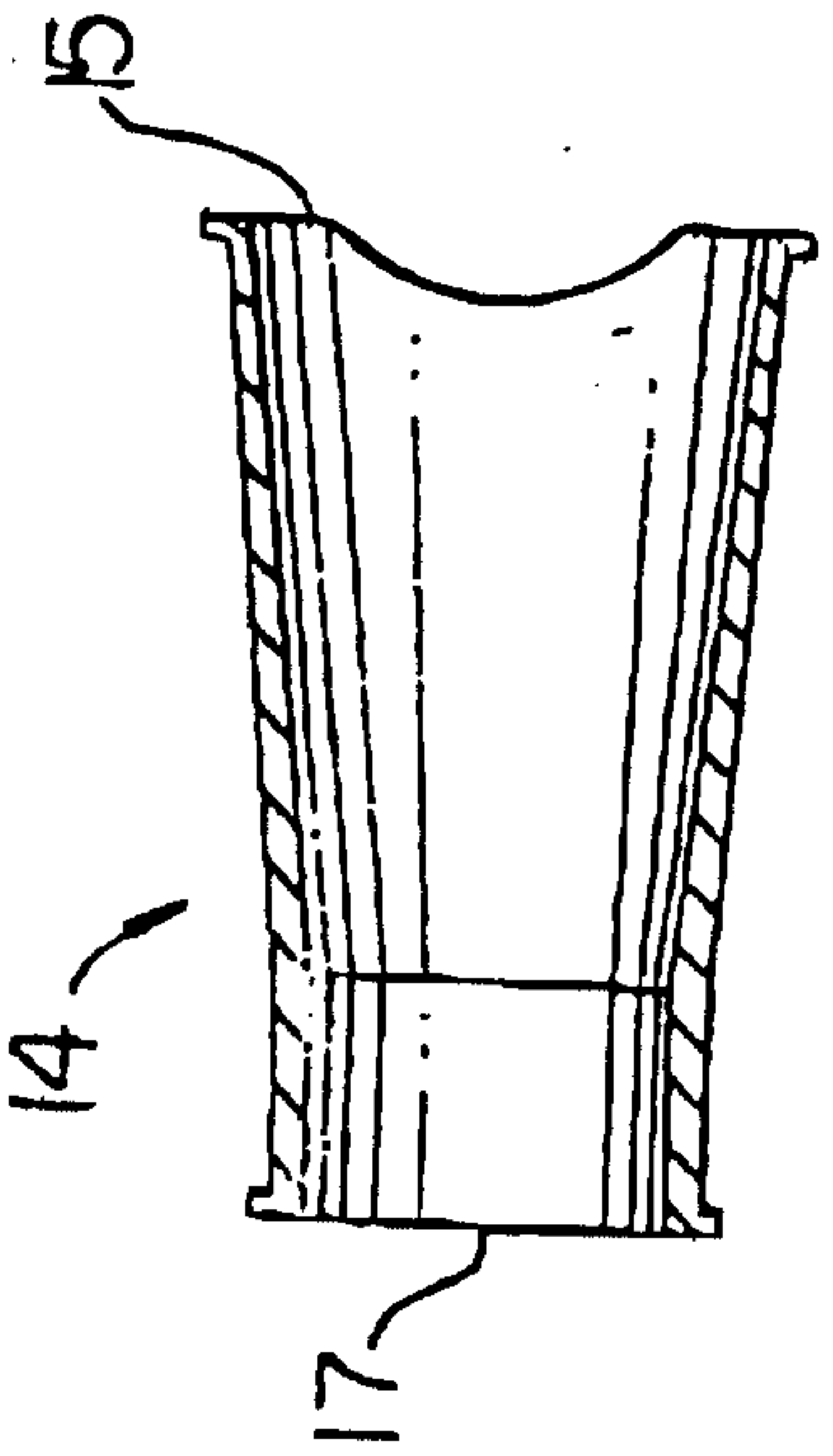

FIG.13

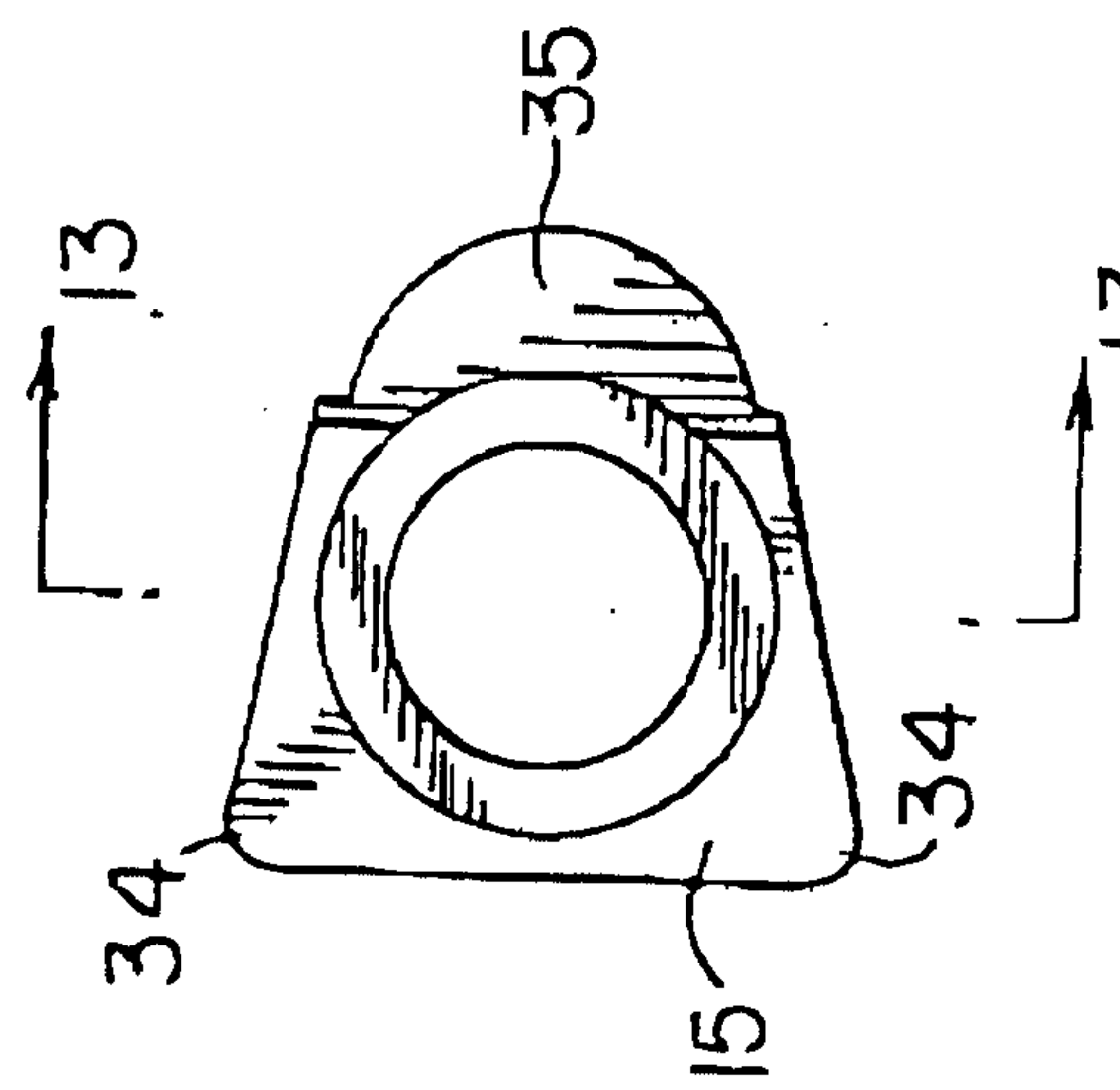

FIG.12

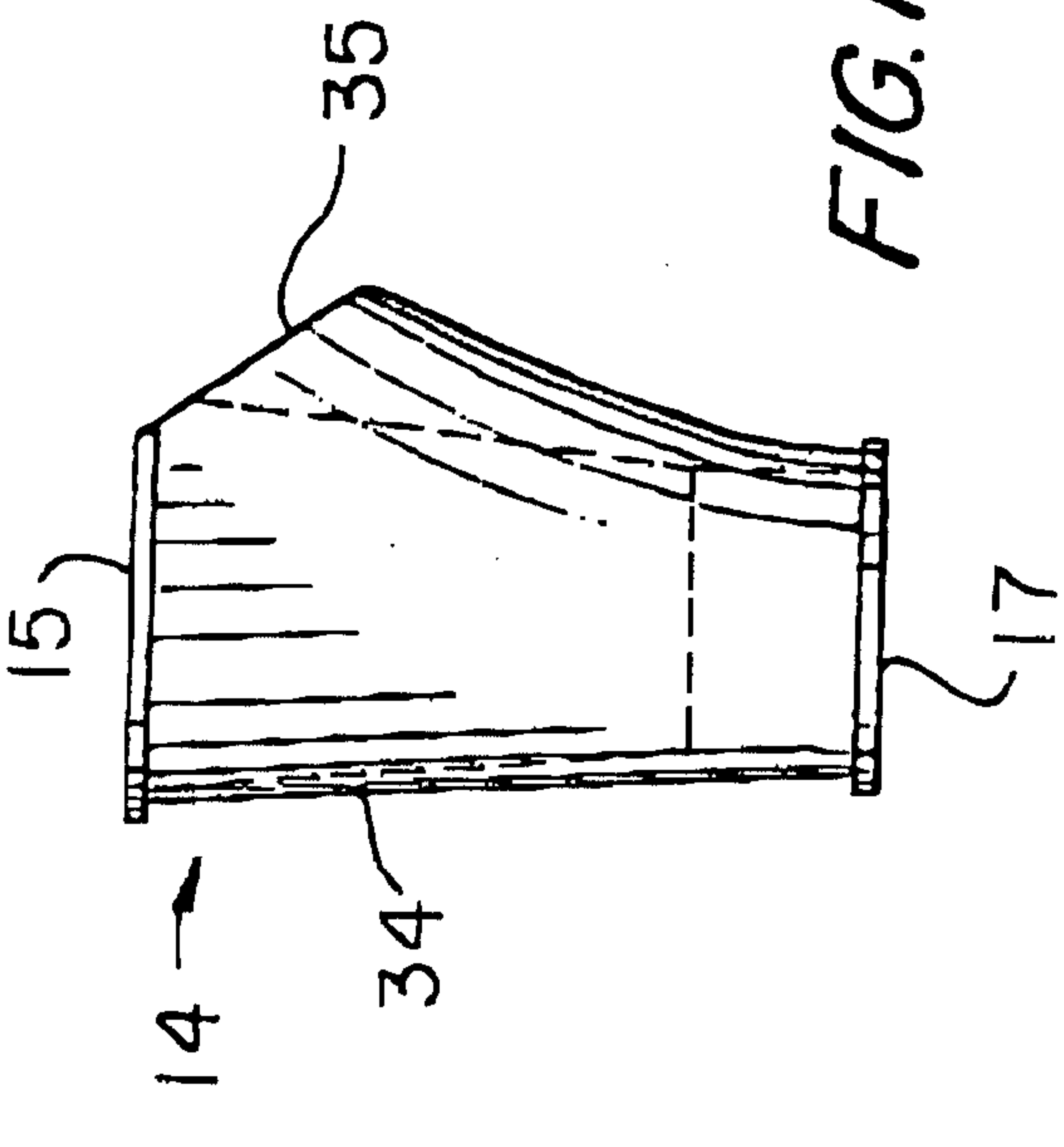

FIG.11

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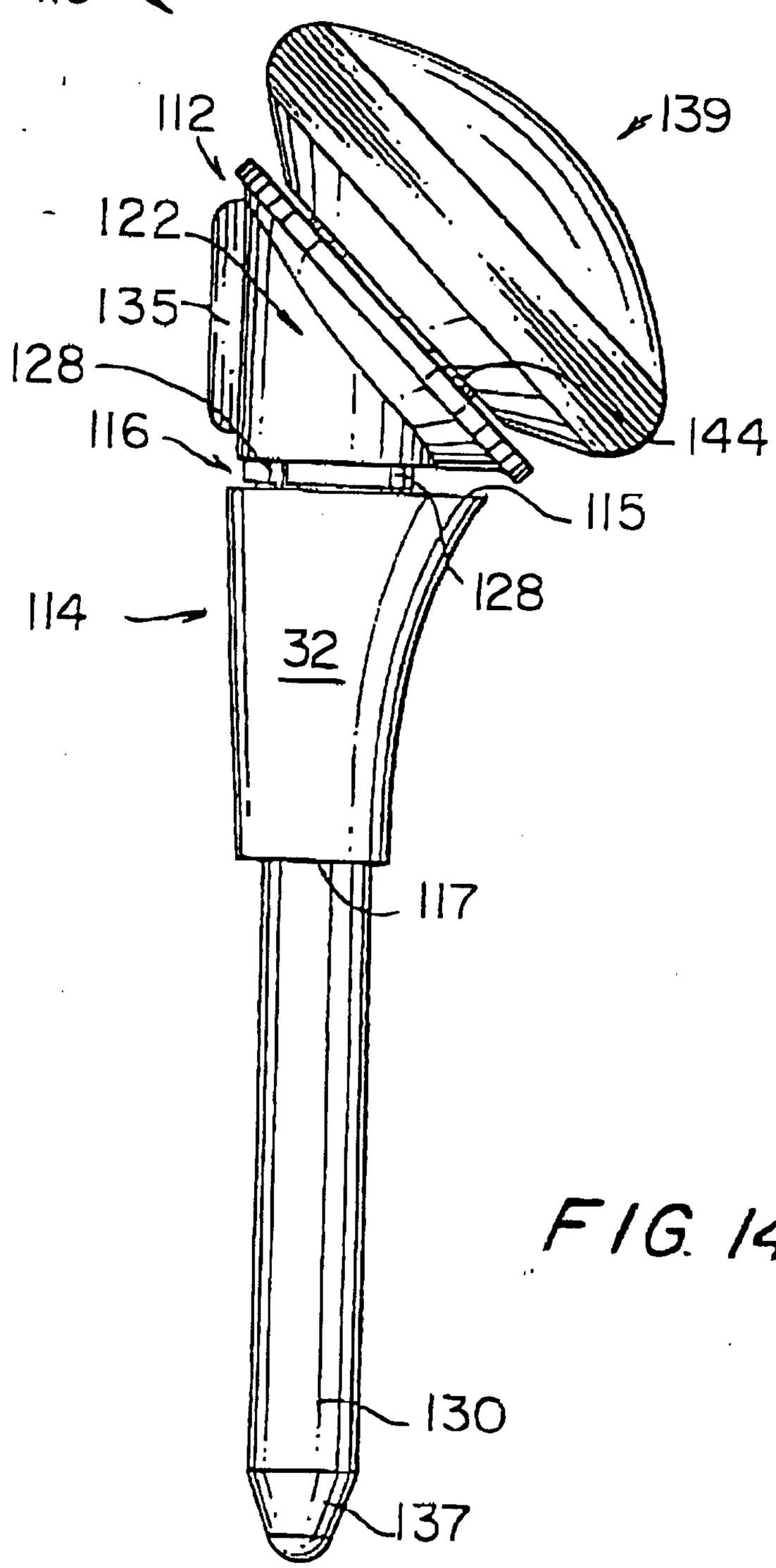

FIG. 14

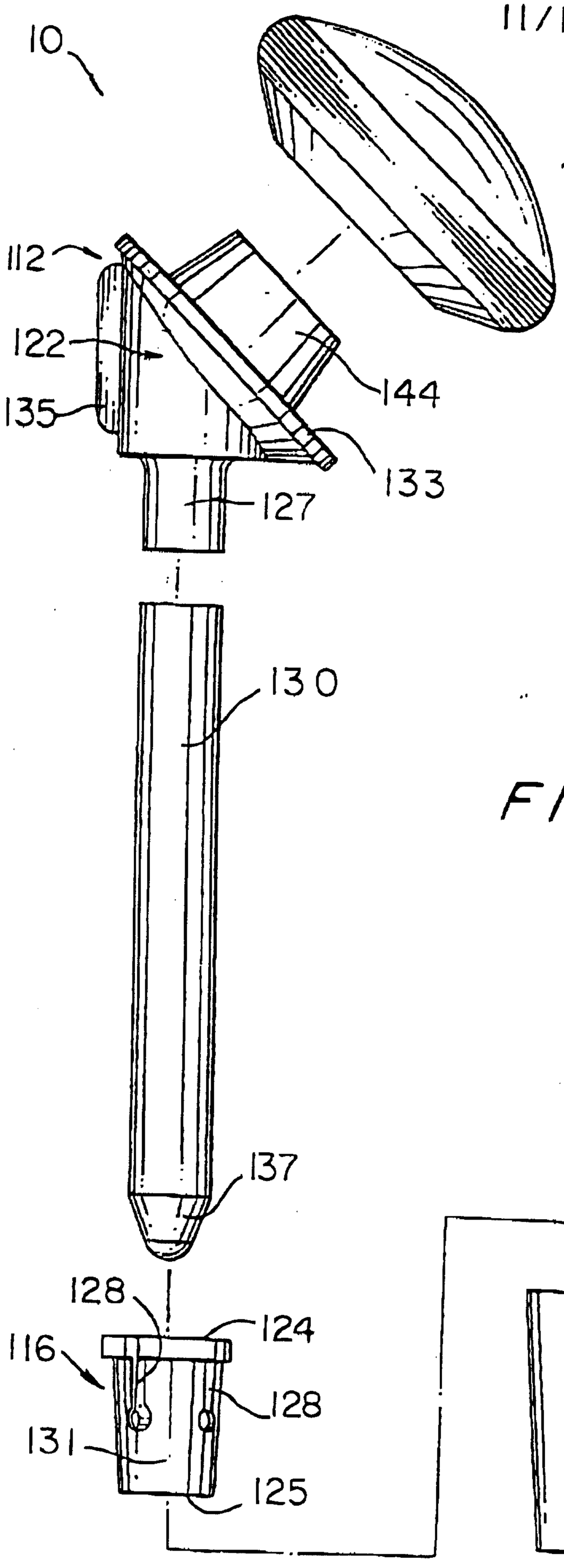

FIG. 15

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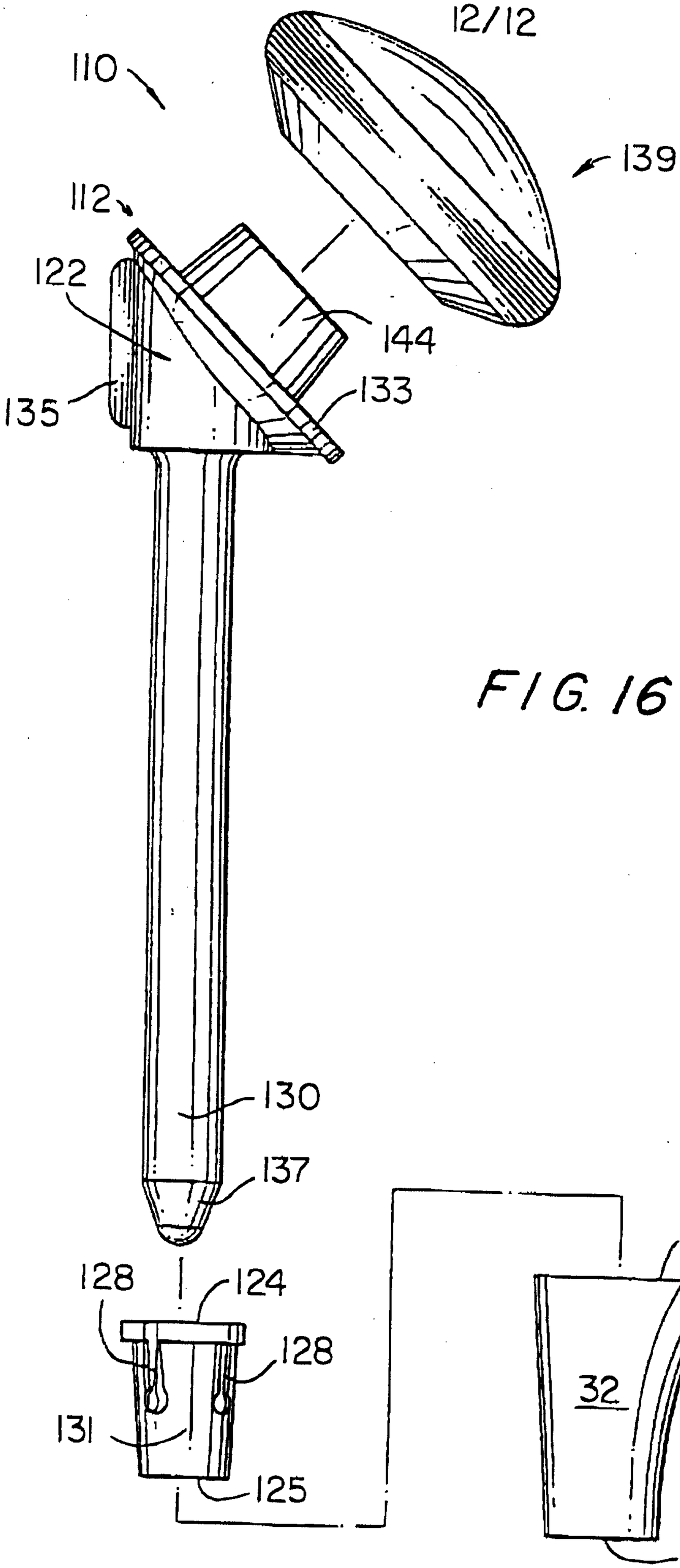

FIG. 16

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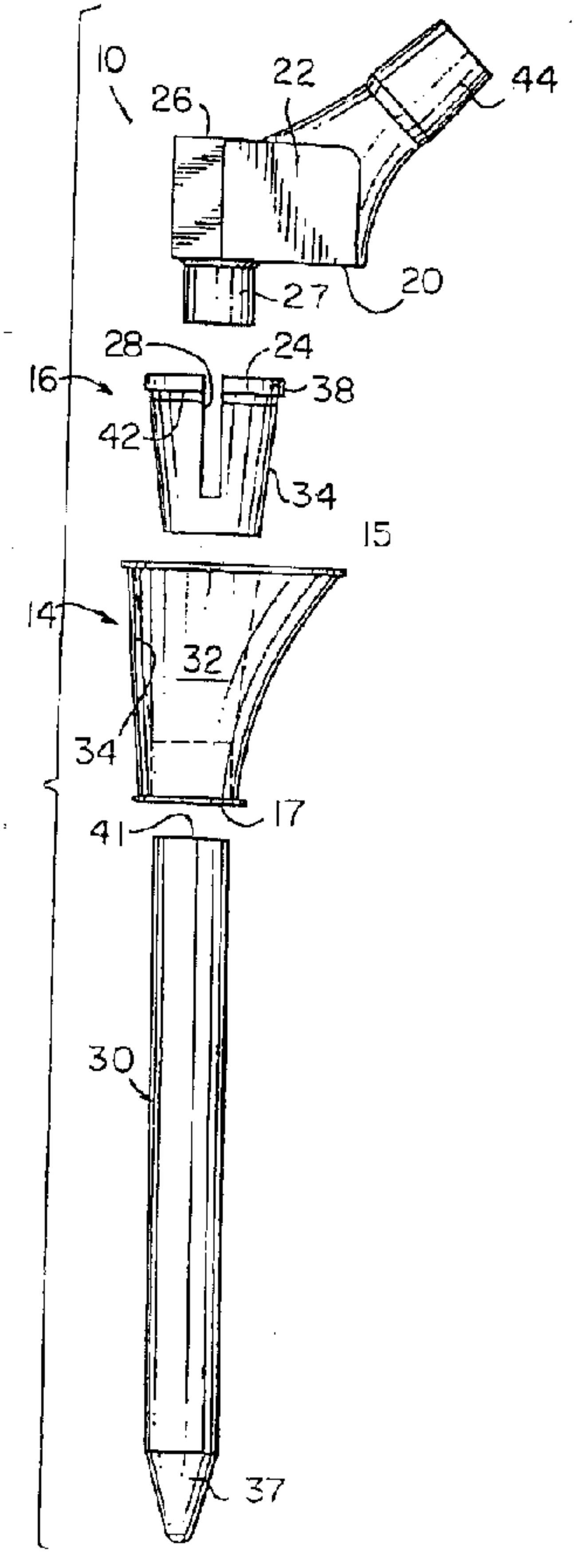
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