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[Continued on next page]

(54) Title: MODULAR INTRAMEDULLARY NAIL

(57) Abstract: An intramedullary nail having (14) at least a first segment (32) and a second segment (30). An exterior surface of the first segment includes a plurality of open spaces (52) therein to permit bone growth into the intramedullary nail. Such bone ingrowth may enhance the fixation between the intramedullary nail and the bone. The first and second segments are detachably secured to one another to accommodate a prosthetic implant.

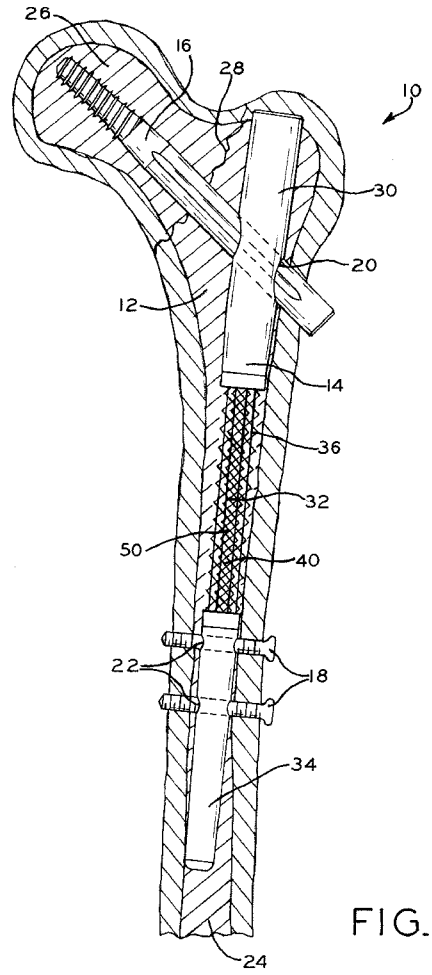

FIG. 1

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MODULAR INTRAMEDULLARY NAIL

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims priority from U.S. Provisional Patent Application No. 61/105,069, entitled "Modular Intramedullary Nail," filed on October 14, 2008, by the same inventor hereof, the disclosure of which is expressly incorporated herein by reference.

BACKGROUND

1. Field of the Invention.

[0002] The present invention relates to an intramedullary nail. More particularly, the present invention relates to a modular intramedullary nail and to a method for using the same.

2. Description of the Related Art.

[0003] An intramedullary nail may be used to align and stabilize a fracture of a long bone. For example, in a fractured femur, an intramedullary nail may be inserted into an intramedullary canal of the femur to align and stabilize the fracture. The intramedullary nail may include bores that receive screws or other attachment devices for securing the intramedullary nail to the bone. To stabilize opposing portions of the fractured bone, the intramedullary nail itself or screws extending through the intramedullary nail may extend across the fracture line of the femur. For example, if the head of a long bone, such as the head of a femur, has fractured, screws may extend through bores of the intramedullary nail, across the fracture line, and into the head of the femur.

[0004] For various reasons, the intramedullary nail may be removed after the fractured bone heals. For example, the intramedullary nail may be removed if the nail causes the patient pain or discomfort or if the bone becomes infected. Also, the intramedullary nail may be removed if the patient must undergo a subsequent arthroplasty procedure to accommodate a prosthetic implant, such as a prosthetic hip stem. Therefore, known intramedullary nails are constructed of solid, non-porous materials that permit subsequent removal of the intramedullary nail.

SUMMARY

[0005] The present invention provides an intramedullary nail having at least a first segment and a second segment. An exterior surface of the first segment includes a plurality of open spaces therein to permit bone growth into the intramedullary nail. Such bone ingrowth may enhance the fixation between the intramedullary nail and the bone. The first and second segments are detachably secured to one another to accommodate a subsequent prosthetic implant.

[0006] According to an embodiment of the present invention, an intramedullary nail is provided that includes an elongate body sized for receipt within a bone and having at least one bore extending therethrough, the at least one bore sized to receive a fixation device for securing the elongate body to the bone. The elongate body includes a first segment and a second segment. The first segment has an exterior surface configured to contact the bone, the exterior surface of the first segment having a plurality of open spaces therein. The second segment is detachably secured to the first segment of the elongate body.

[0007] According to another embodiment of the present invention, an intramedullary nail is provided that includes an elongate body sized for receipt within a bone. The elongate body includes a first segment and a second segment. The first segment has an exterior portion configured to contact the bone and an interior portion, the exterior portion of the first segment having a plurality of open spaces therein and the

interior portion of the first segment being hollow. The second segment is detachably secured to the first segment of the elongate body.

[0008] According to yet another embodiment of the present invention, a method is provided for performing revision surgery. The method includes the steps of providing access to an intramedullary nail implanted in a bone, the intramedullary nail including a first segment and a second segment, the first segment having an exterior surface with a plurality of open spaces therein; separating the second segment of the intramedullary nail from the first segment of the intramedullary nail; and removing the second segment of the intramedullary nail from the bone while retaining the first segment of the intramedullary nail within the bone.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become more apparent and the invention itself will be better understood by reference to the following description of embodiments of the invention taken in conjunction with the accompanying drawings, wherein:

[0010] Figure 1 is a cross-sectional view of a femur with an orthopedic assembly of the present invention implanted therein;

[0011] Figure 2A is an elevational view of an intramedullary nail of the present invention;

[0012] Figure 2B is an elevational view of another intramedullary nail of the present invention;

[0013] Figure 3A is a cross-sectional view of the intramedullary nail of Figure 2A, taken along line 3A-3A of Figure 2A;

[0014] Figure 3B is a cross-sectional view of the intramedullary nail of Figure 2B, taken along line 3B-3B of Figure 2B;

[0015] Figure 4A is a cross-sectional view of the intramedullary nail of Figure 2A, taken along line 4A-4A of Figure 2A;

[0016] Figure 4B is a cross-sectional view of the intramedullary nail of Figure 2B, taken along line 4B-4B of Figure 2B;

[0017] Figure 5A is a cross-sectional view of a femur with a prosthetic hip stem and middle and distal segments of an intramedullary nail implanted therein;

[0018] Figure 5B is a cross-sectional view of a femur with a prosthetic hip stem and middle and distal segments of an intramedullary nail implanted therein; and

[0019] Figure 5C is a cross-sectional view of a femur with a distal femoral prosthetic knee stem and middle and proximal segments of an intramedullary nail implanted therein.

[0020] Corresponding reference characters indicate corresponding parts throughout the several views. The exemplifications set out herein illustrate exemplary embodiments of the invention and such exemplifications are not to be construed as limiting the scope of the invention in any manner.

DETAILED DESCRIPTION

[0021] Referring to Figure 1, orthopedic assembly 10 is shown implanted into femur 12. Although orthopedic assembly 10 is described and depicted herein as being implanted into femur 12, orthopedic assembly 10 may be used in other long bones of the body, such as the tibia, fibula, radius, ulna, clavicle, and other long bones. Orthopedic assembly 10 includes intramedullary nail 14, transverse member or lag screw 16, and distal screws 18. Intramedullary nail 14 of orthopedic assembly 10 includes transverse bore 20 for receiving lag screw 16 and distal bores 22 for receiving distal screws 18.

[0022] During surgery, intramedullary nail 14 is implanted into prepared intramedullary canal 24 of femur 12. To prevent rotation and removal of intramedullary nail 14, a surgeon implants distal screws 18 into femur 12 through distal bores 22 of

intramedullary nail 14. In cases of a fracture or other trauma to femoral head 26, such as fracture 28 shown in Figure 1, a surgeon implants lag screw 16 into femoral head 26 of femur 12 through transverse bore 20 of intramedullary nail 14.

[0023] Referring next to Figure 2A, intramedullary nail 14 of the present invention includes proximal segment 30, middle segment 32, and distal segment 34. Transverse bore 20 for receiving lag screw 16 (Figure 1) extends through proximal segment 30, and distal bores 22 for receiving distal screws 18 (Figure 1) extend through distal segment 34.

[0024] Referring to Figure 3A, intramedullary nail 14 includes exterior portion 36 and interior portion 38. Exterior portion 36 of intramedullary nail 14 is configured to contact bone of femur 12 (Figure 1). Interior portion 38 of intramedullary nail 14 is located radially within the surrounding exterior portion 36.

[0025] Proximal segment 30 and distal segment 34 of intramedullary nail 14 may be constructed of any suitable biocompatible material. For example, proximal segment 30 and distal segment 34 may be constructed of a biocompatible ceramic, a rigid, biocompatible thermoplastic or fiber reinforced thermoplastic material, including, but not limited to, carbon fiber reinforced poly ether ether ketone (PEEK), or a biocompatible metal, including, but not limited to, titanium, a titanium alloy, cobalt chromium, or cobalt chromium molybdenum. Exterior portion 36 of proximal segment 30 and distal segment 34 of intramedullary nail 14 may be smooth, solid, and non-porous so that a surgeon can later remove proximal segment 30 and/or distal segment 34 from femur 12 (Figure 1). Interior portion 38 of proximal segment 30 and distal segment 34 of intramedullary nail 14 may be hollow or cannulated and capable of receiving a guide wire, for example.

[0026] Middle segment 32 of intramedullary nail 14 may be constructed of a three dimensional truss structure, also known as space truss structure 40. Space truss structure 40 includes support members 42 that extend in three dimensions and are joined together at joints 44 formed at the ends of support members 42. Support members 42 may be straight, rigid objects defining open spaces 52 therebetween.

[0027] According to an exemplary embodiment of the present invention, space truss structure 40 may include both diagonal support members 46 and axial support members 48. As shown in Figure 3A, diagonal support members 46 wind helically around a central axis of space truss structure 40, and axial support members 48 run parallel to the central axis of space truss structure 40 and interconnect with diagonal support members 46 at joints 44.

[0028] According to another exemplary embodiment of the present invention, interior portion 38 of space truss structure 40 may be hollow, which portion is referred to herein as channel 50. Channel 50 may be defined along the central axis of space truss structure 40 between support members 42, for example. As shown in Figure 4A, channel 50 may be defined between support members 42 of space truss structure 40 having a cross-sectional shape of overlapping polygons, such as triangles, squares, hexagons, or octagons.

[0029] An exemplary space truss structure 40 is disclosed in U.S. Patent No. 5,921,048, the disclosure of which is expressly incorporated herein by reference. Also, an exemplary space truss structure 40 is the IsoTruss™ structure generally currently available from Advanced Composite Solutions, LLC, of Payson, Utah. IsoTruss™ is a registered trademark of Brigham Young University of Provo, Utah.

[0030] Advantageously, middle segment 32 of intramedullary nail 14 may be constructed of space truss structure 40 to provide durability and rigidity to intramedullary nail 14 when implanted in femur 12 (Figure 1). Also advantageously, middle segment 32 of intramedullary nail 14 may be constructed of space truss structure 40 to permit bone growth into exterior portion 36 of intramedullary nail 14. Specifically, middle segment 32 of intramedullary nail 14 may permit bone growth into open spaces 52 defined between support members 42 of middle segment 32. Such bone ingrowth into middle segment 32 of intramedullary nail 14 may provide fixation of intramedullary nail 14 to femur 12 (Figure 1). Middle segment 32 of intramedullary nail 14 may also be provided with osteoconductive materials or osteoinductive materials to enhance bone growth. For example, if channel 50 of middle segment 32 is packed with osteoconductive materials or

osteoinductive materials, these materials will travel through open spaces 52 of space truss structure 40 and toward femur 12 to encourage bone growth into middle segment 32.

[0031] Referring next to Figure 2B, another intramedullary nail 14' of the present invention is provided. Corresponding portions of intramedullary nail 14' and intramedullary nail 14 are labeled with corresponding reference numerals. Intramedullary nail 14' includes proximal segment 30', middle segment 32', and distal segment 34'. Transverse bore 20' for receiving lag screw 16 (Figure 1) extends through proximal segment 30', and distal bores 22' for receiving distal screws 18 (Figure 1) extend through distal segment 34'.

[0032] Referring to Figure 3B, intramedullary nail 14 includes exterior portion 36' and interior portion 38'. Exterior portion 36' of intramedullary nail 14' is configured to contact bone of femur 12 (Figure 1). Interior portion 38' of intramedullary nail 14' is located radially within the surrounding exterior portion 36'.

[0033] Proximal segment 30' and distal segment 34' of intramedullary nail 14' may be constructed of any suitable biocompatible material. For example, proximal segment 30' and distal segment 34' may be constructed of a biocompatible ceramic, a rigid, biocompatible thermoplastic or fiber reinforced thermoplastic material, including, but not limited to, carbon fiber reinforced poly ether ether ketone (PEEK), or a biocompatible metal, including, but not limited to, titanium, a titanium alloy, cobalt chromium, or cobalt chromium molybdenum. Exterior portion 36' of proximal segment 30' and distal segment 34' of intramedullary nail 14' may be smooth, solid, and non-porous so that a surgeon can later remove proximal segment 30' and/or distal segment 34' from femur 12 (Figure 1). Interior portion 38' of proximal segment 30' and distal segment 34' of intramedullary nail 14' may be hollow or cannulated and capable of receiving a guide wire, for example.

[0034] Middle segment 32' of intramedullary nail 14' may be constructed of a porous material, such as an open-cell material. As used herein, an "open-cell material" is a material containing a plurality of struts defining pores or open spaces 52' that are

connected to each other and form an interconnected network. Middle segment 32' of intramedullary nail 14' may have a porosity as low as 55, 60, or 65 percent and as high as 80, 85, or 90 percent or more.

[0035] According to an exemplary embodiment of the present invention, interior portion 38' of middle segment 32' of intramedullary nail 14' may be hollow, which portion is referred to herein as channel 50'. Channel 50' may be defined along the central axis of middle segment 32'. As shown in Figure 4B, channel 50' may be defined within hollow rod 54' that is formed entirely of a porous material. In another embodiment, hollow rod 54' could include a solid substrate that is coated by a porous material, such as a wire mesh or a beaded material.

[0036] An exemplary porous, open-cell material is produced using Trabecular Metal™ technology generally available from Zimmer, Inc., of Warsaw, Indiana. Trabecular Metal™ is a trademark of Zimmer Technology, Inc. Such a material may be formed from a reticulated vitreous carbon foam substrate which is infiltrated and coated with a biocompatible metal, such as tantalum, by a chemical vapor deposition ("CVD") process in the manner disclosed in detail in U.S. Patent No. 5,282,861, the disclosure of which is expressly incorporated herein by reference. In addition to tantalum, other metals such as niobium, or alloys of tantalum and niobium with one another or with other metals may also be used.

[0037] Generally, the porous tantalum structure includes a large plurality of struts defining the open cells, or open spaces, therebetween, with each strut generally including a carbon core covered by a thin film of metal such as tantalum, for example. The open spaces between the struts form a matrix of continuous channels having no dead ends, such that growth of cancellous bone through the porous tantalum structure is uninhibited. The porous tantalum may have a porosity as low as 55, 60, or 65 percent and as high as 80, 85, or 90 percent or more. Thus, porous tantalum is a lightweight, strong porous structure which is substantially uniform and consistent in composition, and closely resembles the structure of natural cancellous bone, thereby providing a matrix into which

cancellous bone may grow to provide fixation of intramedullary nail 14' to femur 12 (Figure 1).

[0038] The porous tantalum structure may be made in a variety of densities to selectively tailor the structure for particular applications. In particular, as discussed in the above-incorporated U.S. Patent No. 5,282,861, the porous tantalum may be fabricated to virtually any desired porosity and pore size, and can thus be matched with the surrounding natural bone to provide an improved matrix for bone ingrowth and mineralization.

[0039] Advantageously, middle segment 32' of intramedullary nail 14' may be constructed of a porous material to provide durability and rigidity to intramedullary nail 14' when implanted in femur 12 (Figure 1). Also advantageously, middle segment 32' of intramedullary nail 14' may be constructed of a porous material to permit bone growth into exterior portion 36' of intramedullary nail 14'. Specifically, middle segment 32' of intramedullary nail 14' may permit bone growth into open spaces 52', such as the pores defined between the fibrous struts of middle segment 32'. Such bone ingrowth into middle segment 32' of intramedullary nail 14' may provide fixation of intramedullary nail 14' to femur 12 (Figure 1). Middle segment 32' of intramedullary nail 14' may also be provided with osteoconductive materials or osteoinductive materials to enhance bone growth.

[0040] Referring again to Figure 1, an exemplary intramedullary nail 14 of the present invention is configured to permit bone growth into intramedullary nail 14. Such bone growth into intramedullary nail 14, specifically middle segment 32 intramedullary nail 14, may enhance the fixation between intramedullary nail 14 and femur 12. However, a patient may later require a subsequent arthroplasty procedure. For example, if fracture 28 in femur 12 does not heal adequately, a surgeon may choose to perform a partial hip arthroplasty procedure, replacing femoral head 26 of femur 12 with a prosthetic implant.

[0041] Middle segment 32 of intramedullary nail 14 may be detachably secured to proximal segment 30 and/or distal segment 34. For example, in the embodiment of Figure 3A, middle segment 32 includes proximal end 60 and distal end 64 having female threads 66 that are configured to detachably mate with corresponding male threads 68 of proximal segment 30 and distal segment 34, respectively. As another example, in the embodiment of Figure 3B, middle segment 32' includes proximal end 60' and distal end 64' having annular groove 70' configured to detachably mate with corresponding annular ridges 72' of proximal segment 30' and distal segment 34', respectively. The segments may also have tapered engagements. It is also within the scope of the present invention that a separate fastener device may be used to detachably secure middle segment 32 of intramedullary nail 14 to proximal segment 30 and distal segment 34. For example, a screw may be driven from proximal segment 30 into middle segment 32. Further, it is within the scope of the present invention that middle segment 32 may be secured to proximal segment 30 differently than middle segment 32 is secured to distal segment 34.

[0042] Prior to or during a subsequent arthroplasty procedure, lag screw 16 and/or distal screws 18 (Figure 1) may be removed from intramedullary nail 14. Next, proximal segment 30 and/or distal segment 34 of intramedullary nail 14 may be separated or detached from middle segment 32 of intramedullary nail 14. Then, proximal segment 30 and/or distal segment 34 of intramedullary nail 14 may be removed from intramedullary canal 24 of femur 12 while middle segment 32 of intramedullary nail 14 is retained within intramedullary canal 24 of femur 12. For example, proximal segment 30 may be removed proximally from intramedullary canal 24 of femur 12, and distal segment 34 may be removed distally from intramedullary canal 24 of femur 12. The ingrowth of bone into middle segment 32 of intramedullary nail 14 may enhance the fixation between the retained middle segment 32 of intramedullary nail 14 and femur 12. Finally, a prosthetic implant, such as proximal femoral hip stem 80 (Figure 5A), proximal femoral hip stem 80' (Figure 5B), or distal femoral knee stem 86 (Figure 5C), may be coupled to middle segment 32 of intramedullary nail 14.

[0043] According to an exemplary embodiment of the present invention, illustrated in Figure 5A, proximal femoral hip stem 80 may be implanted into femur 12 through middle segment 32 of intramedullary nail 14. Specifically, proximal femoral hip stem 80 may include distal end 82 that extends into channel 50 of middle segment 32 of intramedullary nail 14. As shown in Figure 5A, proximal segment 30 of intramedullary nail 14 (Figure 2A) was removed from femur 12 to accommodate proximal femoral hip stem 80. Over the life of proximal femoral hip stem 80, middle segment 32 and the retained distal segment 34, including distal screws 18, of intramedullary nail 14 may enhance the fixation between proximal femoral hip stem 80 and femur 12.

[0044] According to another exemplary embodiment of the present invention, illustrated in Figure 5B, proximal femoral hip stem 80' may be implanted into femur 12 and attached to middle segment 32' of intramedullary nail 14'. Specifically, proximal femoral hip stem 80' may include distal end 82' that attaches to middle segment 32' of intramedullary nail 14', and more specifically to proximal end 60' of middle segment 32' of intramedullary nail 14'. Distal end 82' of proximal femoral hip stem 80' may attach to middle segment 32' of intramedullary nail 14' in the same manner that proximal segment 30' (Figure 3B) once attached to middle segment 32' of intramedullary nail 14'. For example, if proximal end 60' of middle segment 32' includes annular groove 70' (Figure 3B), distal end 82' of proximal femoral hip stem 80' may include annular ridge 84' configured to mate with groove 70' of middle segment 32'. As shown in Figure 5B, proximal segment 30' of intramedullary nail 14' (Figure 3B) was removed from femur 12 to accommodate proximal femoral hip stem 80'. Over the life of proximal femoral hip stem 80', middle segment 32' and the retained distal segment 34', including distal screws 18, may enhance the fixation between proximal femoral hip stem 80' and femur 12.

[0045] According to yet another exemplary embodiment of the present invention, illustrated in Figure 5C, distal segment 34 of intramedullary nail 14 may be removed from femur 12 (Figure 1) to accommodate distal femoral knee stem 86, for example. Over the life of distal femoral knee stem 86, middle segment 32 and the retained proximal segment 30 of intramedullary nail 14 may enhance the fixation between distal

femoral knee stem 86 and femur 12. Distal femoral knee stem 86 may include proximal end 88 that extends into channel 50 of middle segment 32, as shown in Figure 5C, or distal femoral knee stem 86 may attach to distal end 64' of middle segment 32' (as shown in Figure 5B with respect to proximal femoral hip stem 80'). Also, distal femoral knee stem 86 may include distal end 89 that is configured to couple to an articulating femoral component 90.

[0046] To accommodate either proximal femoral hip stem 80 (Figure 5A) or proximal femoral hip stem 80' (Figure 5B) in the proximal end of femur 12 and distal femoral knee stem 86 (Figure 5C) in the distal end of femur 12, both proximal segment 30 and distal segment 34 of intramedullary nail 14 may be removed from intramedullary canal 24 of femur 12 (Figure 1). Middle segment 32 of intramedullary nail 14 may be retained within intramedullary canal 24 of femur 12 and coupled to both proximal femoral hip stem 80, 80', and distal femoral knee stem 86.

[0047] Advantageously, intramedullary nail 14 may enhance the fixation between intramedullary nail 14 and femur 12 while also accommodating a subsequent prosthetic implant. The above-described intramedullary nail 14 may be modified to accommodate various bones, fractures, and prosthetic implants. For example, the number and arrangement of the modular segments of intramedullary nail 14 may vary.

[0048] While this invention has been described as having preferred designs, the present invention can 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 and which fall within the limits of the appended claims.

WHAT IS CLAIMED IS:

1. An intramedullary nail comprising:

an elongate body sized for receipt within a bone and having at least one bore extending therethrough, the at least one bore sized to receive a fixation device for securing the elongate body to the bone, the elongate body comprising:

a first segment having an exterior surface configured to contact the bone, the exterior surface of the first segment having a plurality of open spaces therein; and

a second segment detachably secured to the first segment of the elongate body.

2. The intramedullary nail of claim 1, wherein the first segment of the elongate body comprises a hollow interior sized to receive an implant stem therethrough.

3. The intramedullary nail of claim 2, wherein the plurality of open spaces extend through the first segment from the exterior surface to the hollow interior.

4. The intramedullary nail of claim 1, wherein the first segment of the elongate body includes an end configured to mate with a corresponding end of an implant stem.

5. The intramedullary nail of claim 1, further comprising a third segment of the elongate body, wherein the first segment of the elongate body includes a proximal end configured to detachably mate with the second segment of the elongate body and a distal end configured to detachably mate with the third segment of the elongate body.

6. The intramedullary nail of claim 5, wherein the second segment of the elongate body comprises the at least one bore sized to receive the fixation device in the form of a proximal screw, and wherein the third segment of the elongate body comprises at least one distal bore extending therethrough that is sized to receive a distal screw.

7. The intramedullary nail of claim 1, wherein the first segment of the elongate body comprises a space truss structure having a hollow interior.

8. The intramedullary nail of claim 1, wherein the first segment of the elongate body comprises a space truss structure having a plurality of support members defining open spaces therebetween.

9. The intramedullary nail of claim 1, wherein the first segment of the elongate body comprises a space truss structure having a cross-sectional shape comprising a plurality of overlapping polygons.

10. The intramedullary nail of claim 1, wherein the first segment of the elongate body comprises a porous material having a plurality of pores, whereby the plurality of open spaces in the first segment comprise the plurality of pores.

11. An intramedullary nail comprising:

an elongate body sized for receipt within a bone, the elongate body comprising:

a first segment having an exterior portion configured to contact the bone and an interior portion, the exterior portion of the first segment having a plurality of open spaces therein and the interior portion of the first segment being hollow; and

a second segment detachably secured to the first segment of the elongate body.

12. The intramedullary nail of claim 11, wherein the hollow interior portion of the first segment of the elongate body is sized to receive an implant stem.

13. The intramedullary nail of claim 11, wherein the first segment of the elongate body includes an end configured to mate with a corresponding end of an implant stem.

14. The intramedullary nail of claim 11, further comprising a third segment of the elongate body, wherein the first segment of the elongate body includes a proximal end configured to detachably mate with the second segment of the elongate body and a distal end configured to detachably mate with the third segment of the elongate body.

15. The intramedullary nail of claim 14, wherein the second segment of the elongate body comprises a proximal bore extending therethrough that is sized to receive a proximal screw, and wherein the third segment of the elongate body comprises at least one distal bore extending therethrough that is sized to receive a distal screw.

16. The intramedullary nail of claim 11, wherein the first segment of the elongate body comprises a space truss structure having a plurality of support members, whereby the plurality of open spaces in the first segment of the elongate body are defined between the plurality of support members.

17. The intramedullary nail of claim 11, wherein the first segment of the elongate body comprises a space truss structure having a cross-sectional shape comprising a plurality of overlapping polygons.

18. The intramedullary nail of claim 11, wherein the first segment of the elongate body comprises a hollow rod coated with a porous material having a plurality of pores, whereby the plurality of open spaces in the first segment comprise the plurality of pores.

19. A method of performing revision surgery comprising the steps of:

providing access to an intramedullary nail implanted in a bone, the intramedullary nail comprising a first segment and a second segment, the first segment having an exterior surface with a plurality of open spaces therein;

separating the second segment of the intramedullary nail from the first segment of the intramedullary nail; and

removing the second segment of the intramedullary nail from the bone while retaining the first segment of the intramedullary nail within the bone.

20. The method of claim 19, further comprising the steps of:

implanting a prosthetic implant into the bone; and

coupling the prosthetic implant to the retained first segment of the intramedullary nail.

21. The method of claim 20, wherein the step of coupling the prosthetic implant to the first segment of the intramedullary nail comprises inserting a stem of the prosthetic implant into a hollow interior of the first segment.

22. The method of claim 20, wherein the step of coupling the prosthetic implant to the first segment of the intramedullary nail comprises attaching an end of the prosthetic implant to a corresponding end of the first segment.

23. The method of claim 20, wherein the prosthetic implant comprises one of a proximal femoral hip stem and a distal femoral knee stem.

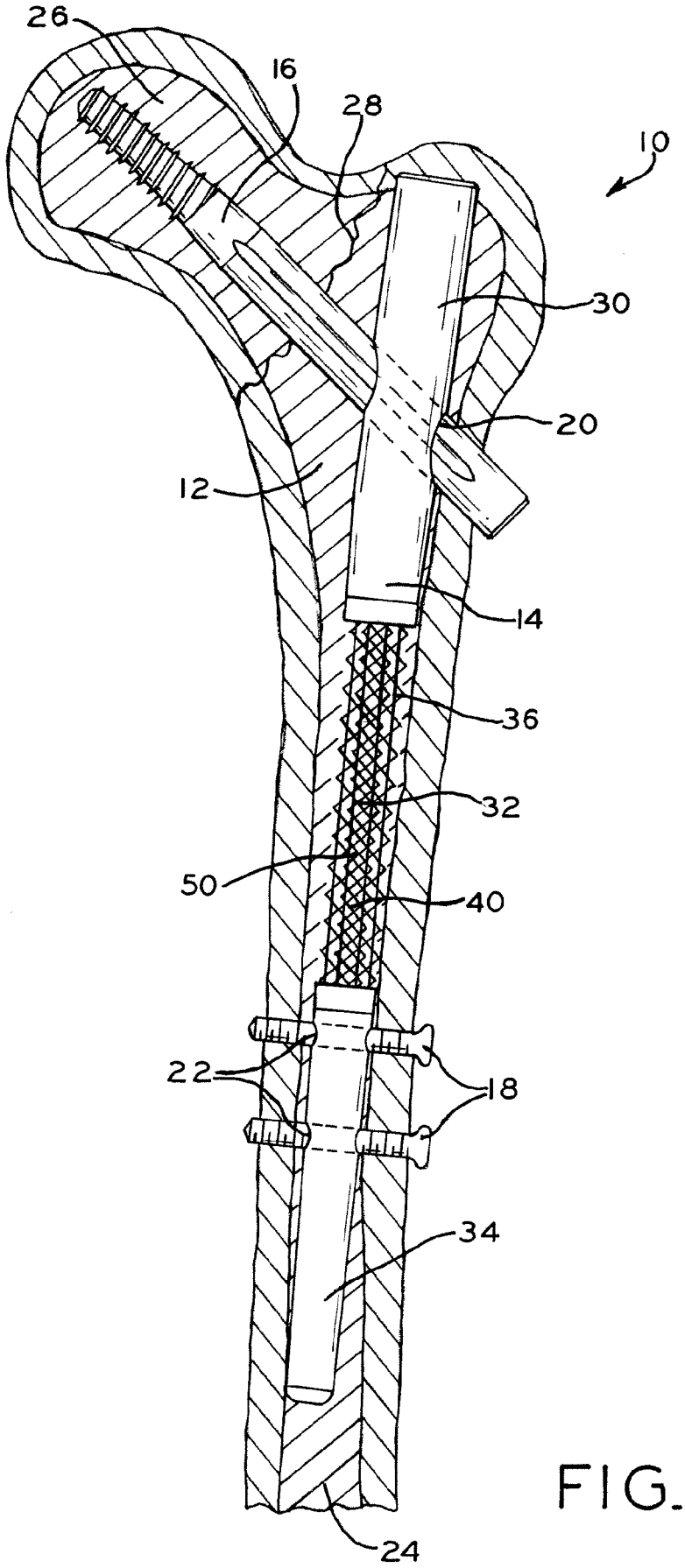

FIG. 1

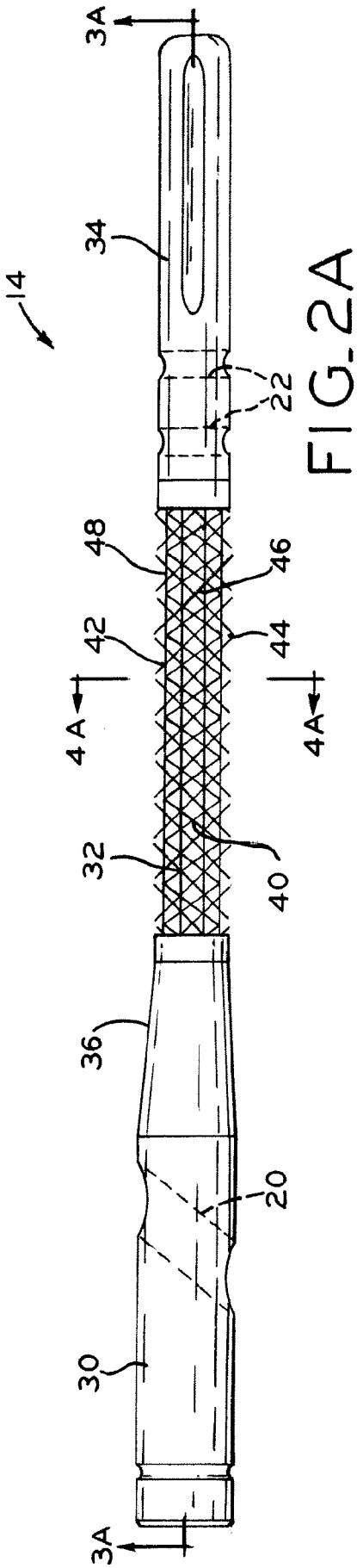
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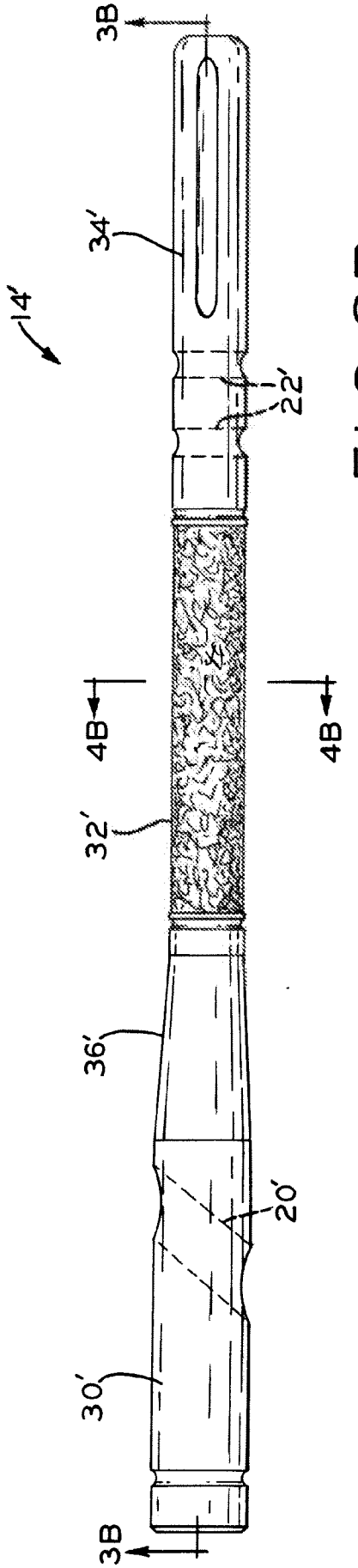
FIG_2A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3B

FIG_2B

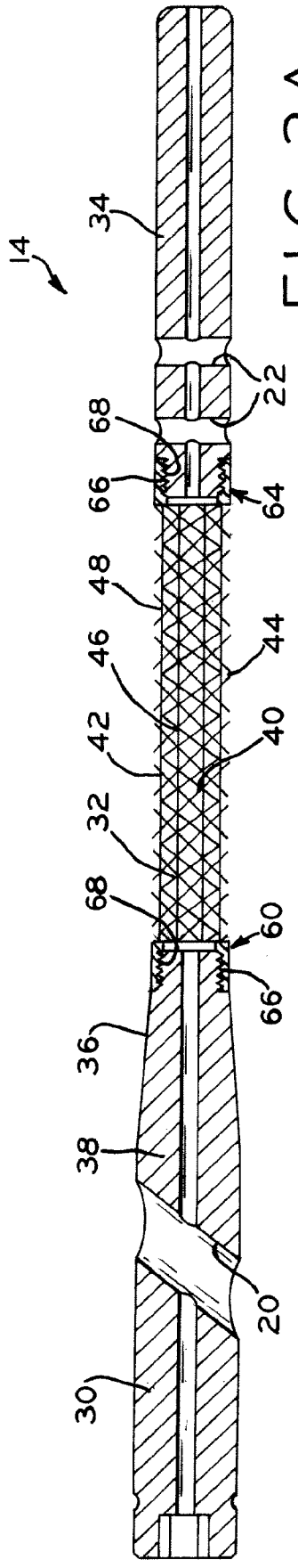


FIG. 3A

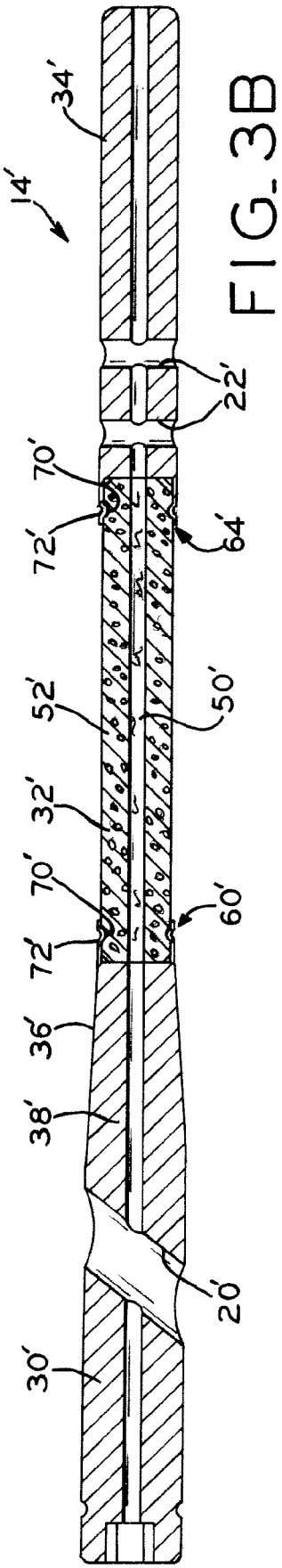
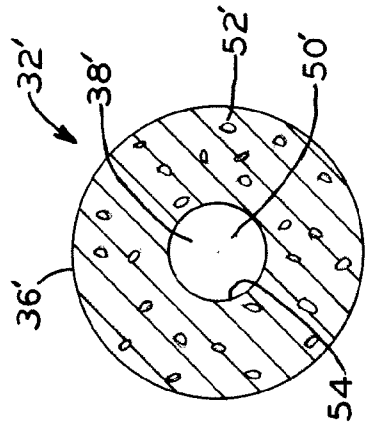


FIG. 3B



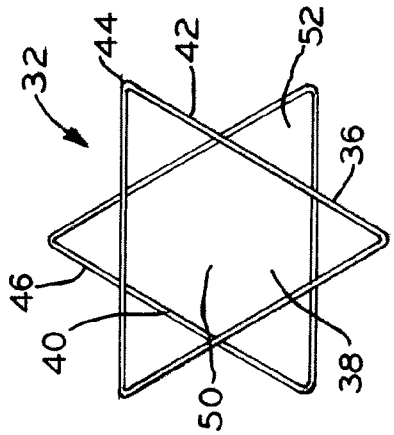


FIG. 4A FIG. 4B

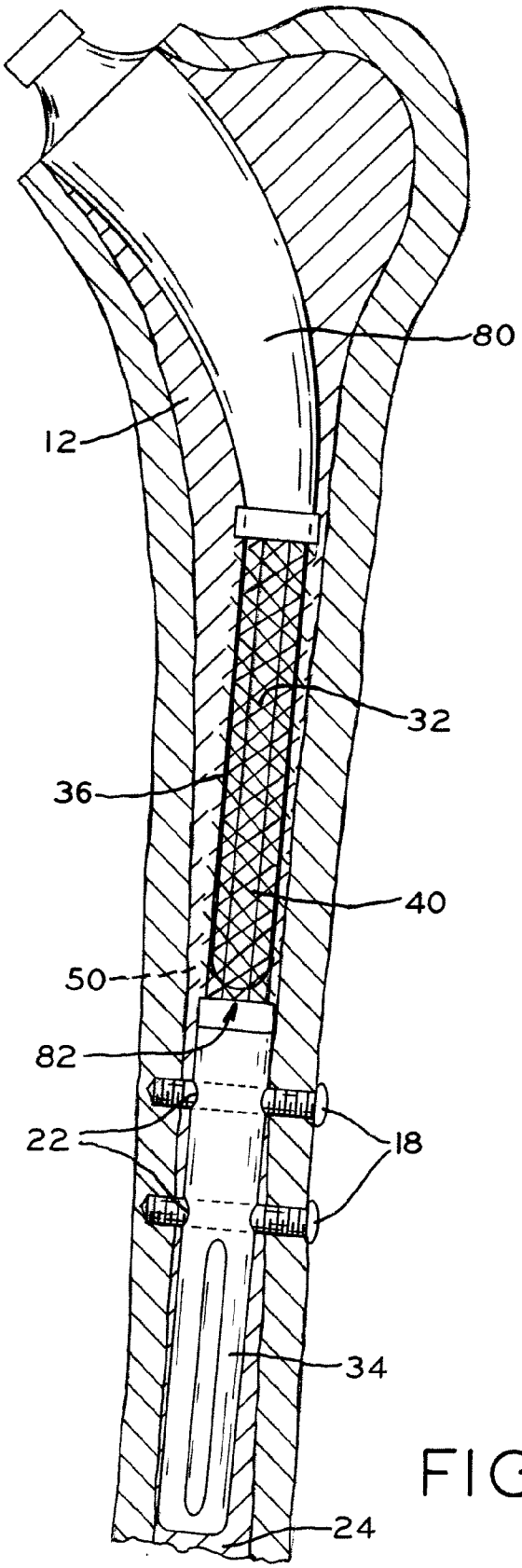


FIG. 5A

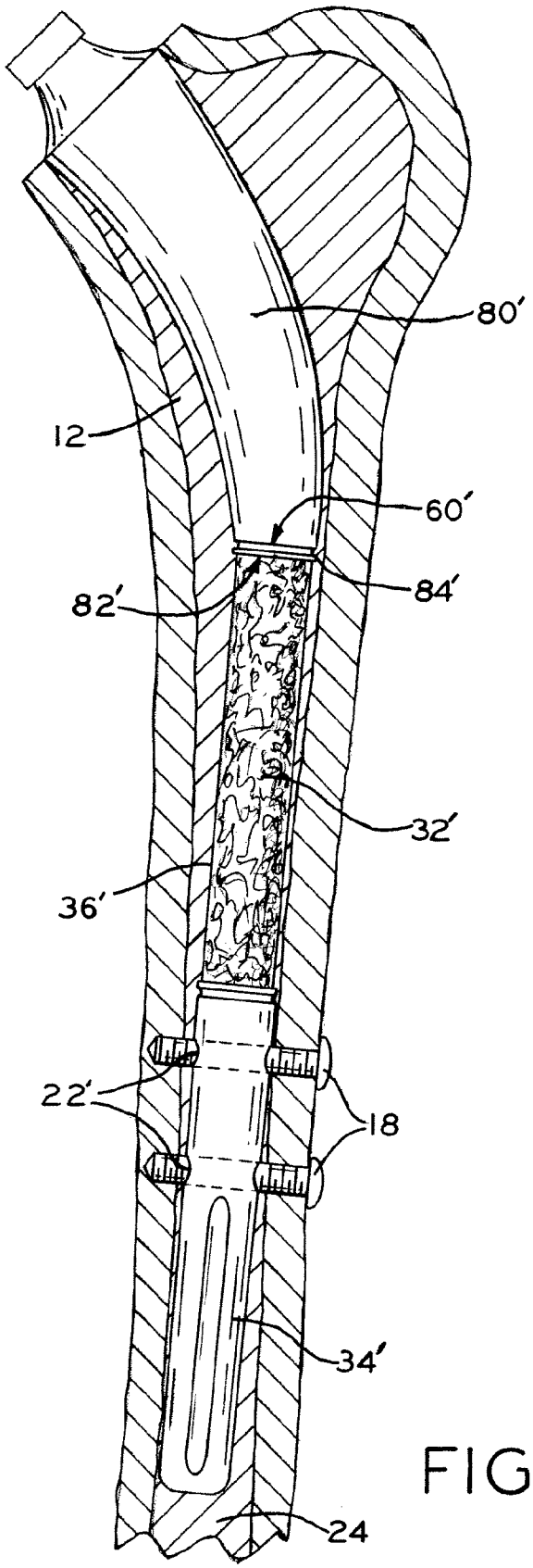


FIG_5B

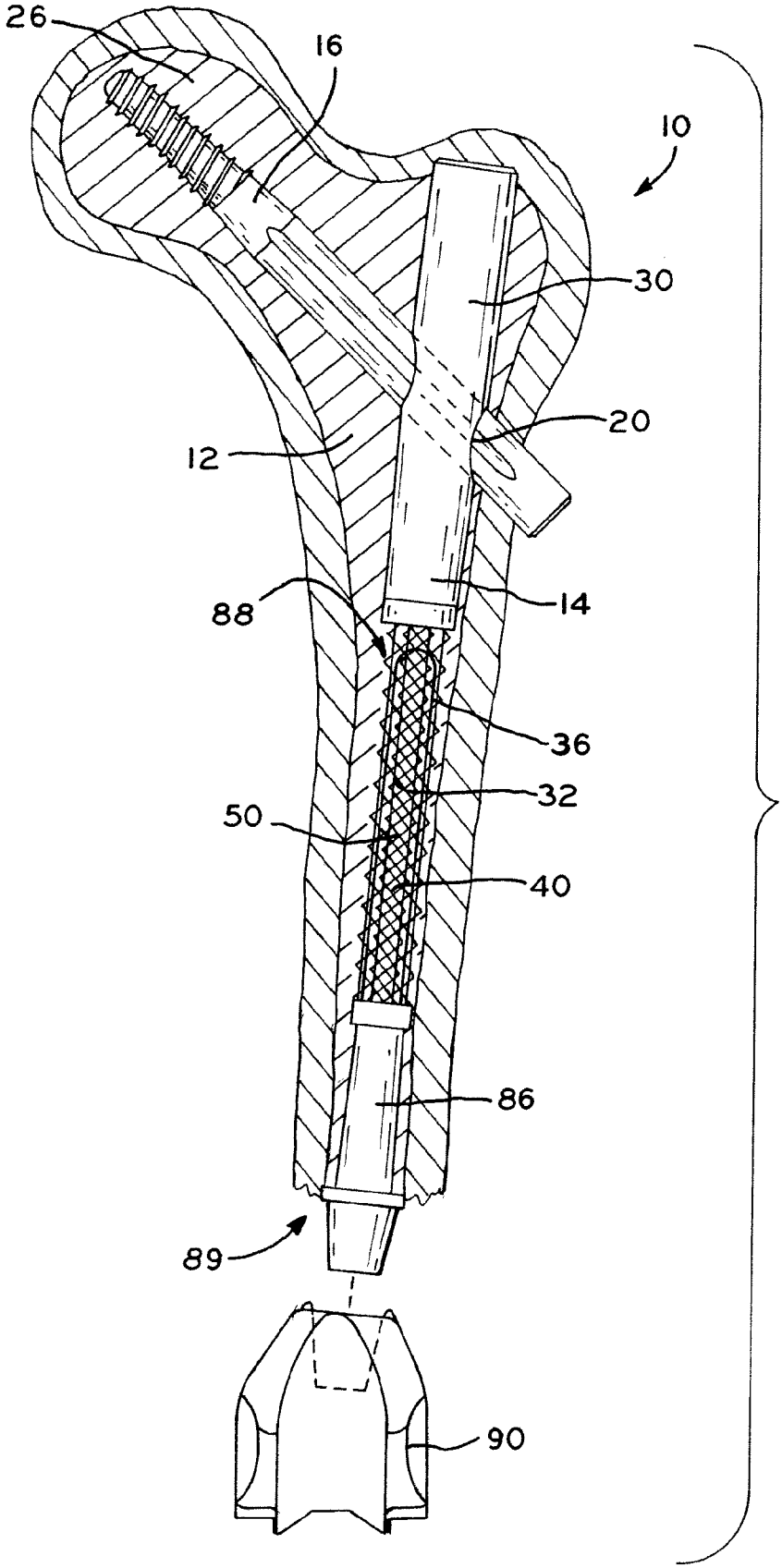


FIG_5C

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2009/060166

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B17/72 A61F2/36

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61B A61F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 6 322 591 B1 (AHRENS UWE [DE]) 27 November 2001 (2001-11-27) column 3, line 37 - line 60 figures 1-3	1-5, 11-14 6-8, 15-16
X	WO 2006/090226 A1 (TECRES SPA [IT]; SOFFIATTI RENZO [IT]; FACCIOLI GIOVANNI [IT]) 31 August 2006 (2006-08-31) page 6, line 25 - page 7, line 12 page 7, line 19 - line 31 figures 1-5	1-4, 10-13,18
X	FR 2 634 371 A1 (FLEGEAU GERARD [FR]) 26 January 1990 (1990-01-26) page 5, line 33 - page 7, line 24 figures 1-5	1-4, 11-13

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 December 2009	04/01/2010

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Fax: (+31–70) 340–3016	Storer, John

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Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2009/060166

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 620 445 A (BROSNAHAN ROBERT [US] ET AL) 15 April 1997 (1997-04-15) column 5, line 38 - line 65 column 7, line 6 - line 20 figures 1,2,7,8,11	6,15
Y	WO 2005/070314 A1 (EXPANDING ORTHOPEDICS INC [IL]; LEVY MARK M [IL]; GREENBERG ILAN [IL]) 4 August 2005 (2005-08-04) page 17, line 3 - line 19 page 18, line 18 - page 20, line 6 figures 7,9A,9B	7-8,16

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2009/060166

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [X] Claims Nos.: 19-23
because they relate to subject matter not required to be searched by this Authority, namely:

Rule 39.1(iv) PCT - Method for treatment of the human or animal body by surgery

2. [ ] Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. [ ] Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. [ ] As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. [ ] As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

[ ] The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

[ ] No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2009/060166

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