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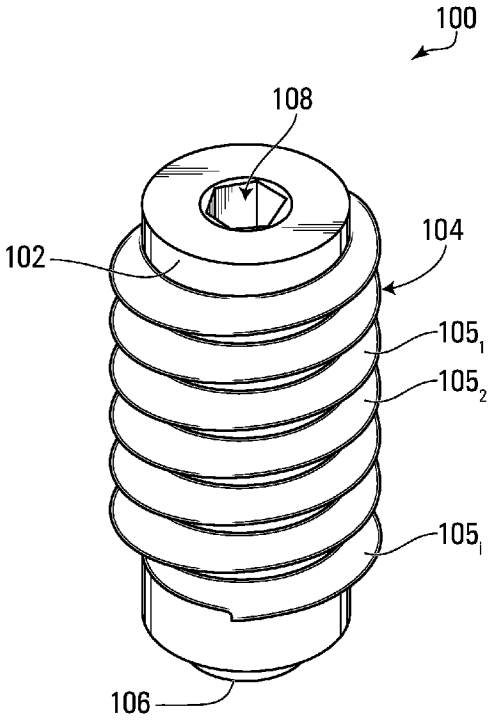

(57) Abrégé/Abstract:
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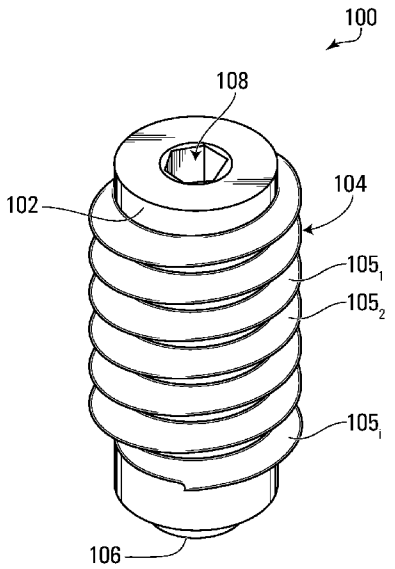

FIG. 3

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PLUG FOR BONE TISSUE

FIELD OF THE INVENTION

[0001] The present disclosure relates to a plug to seal a bone cavity and the use of the plug to seal the cavity.

BACKGROUND

[0002] Total knee replacement (TKR) is a widespread surgery in western countries recommended for patients who experience severe destruction of their knee joint. In 2010, approximately 700,000 TKRs were performed in the United States only. By 2030, it is projected that over 3.5 million procedures will be performed annually.

[0003] During the procedure, the femoral canal is opened by drilling a hole in the femur using a mesh having a diameter generally between 8 and 12mm. This femoral opening is subsequently used to position an intramedullary cutting guide as shown in Figs. 1a and 1b. This cutting guide ensures the proper orientation and position of the cut of the femoral bone for subsequent installation the femoral prosthesis component.

[0004] The femoral opening created during the procedure allows blood to flow from the femoral canal to the surgical area both during and after the surgical procedure which in turn contributes to the formation of hematomas in the knee joint. This contributes to pain and causes a drop in hemoglobin level which can lead to systemic complications, increased risks of infection and/or require blood transfusions.

[0005] Currently, in order to reduce the bleeding, some surgeons may attempt to seal the femoral opening by impacting small fragment of bone cut during the surgery to create a bone

plug, as shown in Fig. 2. Performing this procedure takes times and the cutting of bone fragments may damage surgical gloves which in turn increases the risks of infection and contamination. Furthermore, the bone plug being impacted into the femoral hole may be subsequently dislodged and may cause mechanical motion issues in the knee joint. Finally, this technique, although reducing bleeding from the femoral canal, does not seal the femoral opening in such a way that bleeding is eliminated.

[0006] There is accordingly a need to provide a plug for the femoral canal discussed above that alleviates at least some of the problems of the bone plugs currently used.

SUMMARY

[0007] According to various aspects of the present disclosure, there is provided a use of a substantially cylindrical plug to close a femoral opening drilled in a femur to receive an intramedullary cutting guide, to prevent bleeding from the opening after removal of the intramedullary cutting guide from the opening.

[0008] According to another aspect of the present disclosure, there is provided a use pf a drill to drill an opening in a femur; intramedullary cutting guide configured for insertion into the femur; a substantially cylindrical plug having a size selected according to a size of the opening to close the opening subsequent a removal for the intramedullary cutting guide from the opening.

[0009] According to a third aspect of the present disclosure, there is provided a method for performing a knee surgery, comprising the steps of drilling a femoral opening in the femur; positioning an intramedullary cutting guide in the opening; cutting the femur; removing the intramedullary cutting guide from the opening; providing a substantially cylindrical plug selected according to a size of the opening in the femur; inserting the plug in the femoral opening to

close the opening and prevent bleeding from the opening; and performing any additional step to complete the knee surgery.

[00010] According to a fourth aspect of the present disclosure, there is provided a plug configured to seal a femoral opening drilled in a femur to position an intramedullary cutting guide, the plug including a substantially cylindrical body for insertion into the opening to engage bone surrounding the opening in order to create a seal to prevent blood loss through the opening.

[00011] According to a fifth aspect of the present disclosure, there is provided a kit comprising an intramedullary cutting guide including a member configured for insertion in a femoral opening drilled in a femur to position the intramedullary cutting guide, the kit including a plug having a generally cylindrical body, the plug having a transverse dimensions selected according to a transverse dimensions of the member in order to create close the opening after removal of the member from the opening.

[00011a] According to another aspect, there is provided a femoral plug for sealing a femoral opening drilled in a distal region of a femur forming part of a knee joint to position an intramedullary cutting guide configured for cutting a portion of the distal region of the femur, the femoral plug comprising: an elongated body sized for insertion into the femoral opening; and threads extending around a least a portion of the elongated body to engage bone surrounding the femoral opening and form a seal with the bone to prevent bleeding from the femoral opening into the knee joint.

[00011b] According to another aspect, there is provided a use of the femoral plug as defined herein to form a seal with the bone to prevent bleeding from the femoral opening into the knee joint.

[00011c] According to another aspect, there is provided a kit comprising: an intramedullary cutting guide comprising: a member having a member diameter and being configured for insertion in a

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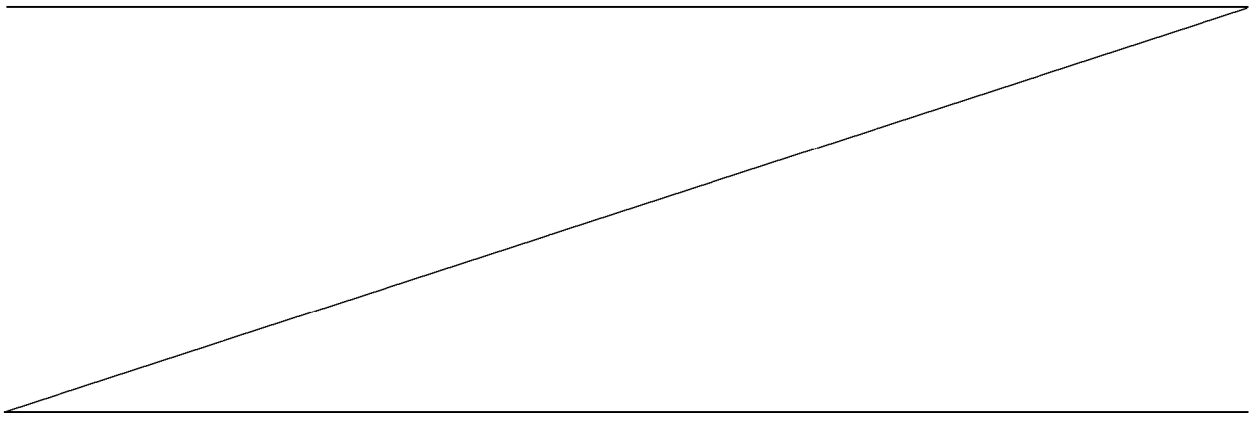
femoral opening drilled in a distal portion of a femur forming part of a knee joint to position the intramedullary cutting guide; and a femoral plug having a femoral plug diameter selected according to the member diameter, the femoral plug comprising: an elongated body; and threads extending around a least a portion of the elongated body to engage bone surrounding the femoral opening and form a seal with the bone to prevent bleeding from the femoral opening into the knee joint after removal of the member from the femoral opening.

[00012] These and other aspects of the present disclosure will now become apparent to those of ordinary skill in the art upon review of the following description of embodiments in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[00013] Fig. 1a shows an isometric view of a femur with a femoral opening (in dotted lines) to be drilled.

[00014] Fig. 1b shows an isometric view of an intramedullary cutting guide positioned into the femoral opening.



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[00015] Fig. 2 shows a bone plug as currently used to be impacted in the femoral opening of Figs. 1a and 1b without preventing bleeding from the femoral opening.

[00016] Fig. 3 shows an isometric view of a plug for a femoral opening in accordance with one non-limiting embodiment.

[00017] Fig. 4 shows a femoral opening drilled in the femur prior to positioning an intramedullary cutting guide during a TKR surgery.

[00018] Fig. 5 shows the femoral opening of Fig. 4 being sealed by the plug after the femur has been cut during a TKR surgery in accordance with one non-limiting embodiment.

DETAILED DESCRIPTION

[00019] With reference to Fig. 1 there is provided a plug 100 according to a non-limiting embodiment of the present disclosure. The plug 100 may be of a screw type, consisting of a generally cylindrical body 102 having a lower portion and higher portion and featuring a helical thread structure 104 running at least in part alongside a periphery of the cylindrical body 102. The plug 100 may be of any other suitable type (i.e., not of a screw type) in other embodiments. The plug 100 is configured to be inserted inside a cavity in a bone, in this non-limiting embodiment via its lower portion.

[00020] The helical thread structure 104 may be configured to engage an internal wall of the cavity when the plug 100 is inserted inside the cavity and generally prevent any fluid communication between the anatomical regions facing the lower and higher portions of the cylindrical body 102, respectively, when inserted in the cavity. In this non-limiting embodiment, the cavity is a femoral opening drilled in the femur to position an intramedullary cutting guide. The cavity may notably be drilled during a TKR surgery. However, other cavities may be

suitable in other embodiments and the plug 100 may be configured to be inserted in a cavity during other surgical procedures such as, but not limited to, a revision of total knee prosthesis, a retrograde rodding of the femur and the likes. The helical thread structure 104 may comprise a series of parallel ridges $105_1 - 105_i$ generally extending about a periphery of the cylindrical body 102. In this embodiment, the ridges $105_1 - 105_i$ comprise a single helix that spirals about the periphery of the cylindrical body 102. In other embodiments, the ridges $105_1 - 105_i$ may comprise separate, discrete parallel bands around the periphery of the plug 100. The helical thread structure 104 may have any other suitable configuration in other embodiments. In yet further embodiments, the plug 100 may not comprise a helical thread structure 104, as further disclosed below.

[00021] The plug 100 may comprise a chamfered edge 106 at the bottom portion of the cylindrical body 102, the chamfered edge 106 being configured to facilitate entry and positioning of the plug 100 in the cavity. In other embodiments, the chamfered edge 106 may be absent and/or the bottom portion of the cylindrical body 102 may comprise any suitable element to facilitate entry and positioning of the plug 100 in the cavity.

[00022] The plug 100 may comprise a socket 108 in the upper portion of the cylindrical body 102 configured for facilitating insertion of the plug 100 inside the cavity. In this non-limiting embodiment, the socket 108 may be of a traditional hex type socket or a 12-point torx type socket or any other suitable type of socket that enables a user to impart a rotational motion to the plug 100 inside the cavity. This contributes to the insertion of the helical thread structure 104 inside the walls of the cavity. The plug 100 may be inserted inside the cavity in any other suitable way (e.g., without imparting a rotational movement to the plug 100) in other embodiments.

[00023] Once inserted inside the cavity, the plug 100 is configured to generally prevent any fluid communication between the anatomical regions facing the bottom and the higher portions of the cylindrical body 102. That is, where the cavity is a femoral opening drilled in the femur to position an intramedullary cutting guide, the plug 100 is configured to generally prevent bleeding from the femoral canal inside the region of the knee joint. The plug 100 is also configured to be generally stable once inserted in the cavity, such that the plug 100 generally does not move laterally or vertically in the cavity and remains inside the cavity once inserted. That is, where the cavity is a femoral opening drilled in the femur to position an intramedullary cutting guide, the plug 100 is configured to generally remain in the femoral opening and to not be dislodged from the femoral opening.

[00024] The plug 100 has a diameter and a length generally configured to seal the cavity, which may be a femoral opening drilled in the femur to position an intramedullary cutting guide. In one non-limiting example, the cylindrical body 102 of the plug 100 may have a diameter comprised between 6 and 15mm and a length between 10 and 30mm. The cylindrical body 102 may have any other suitable diameter and/or length in other embodiments. In one embodiment, the cylindrical body 102 may have a diameter selected based on a diameter of a drill bit used to drill the femoral opening in the femur such that the cylindrical body has a diameter configured to ensure the stability of the plug 100 once inserted in the cavity, such that the plug 100 generally does not move laterally or vertically in the cavity and remains inside the cavity once inserted.

[00025] The chamfered edge 106 may have any suitable angle and size. The helical thread structure 104 may have any suitable dimension and configuration such as pitch, pitch diameter and angle of the ridges 105_1 – 105_i.

[00026] In this non-limiting embodiment, the cylindrical body 102 is generally not hollow. In other non-limiting embodiments, the cylindrical body 102 may be generally hollow and configured to be inflated or mechanically deformed in order to make the plug 100 engage the cavity when the plug 100 is inserted in the cavity and generally prevent any fluid communication between the bottom portion and a higher portion of the cylindrical body 102 when inserted in the cavity. In this embodiment, the cylindrical body 102 may be configured to retain its inflated or mechanically deformed shape after being inflated or mechanically deformed. It is appreciated that in the configuration where the cylindrical body 102 may be generally hollow and inflatable or mechanically deformable, the plug 100 may not comprise a helical thread structure 104 and may not be inserted via a rotational motion to the plug 100 inside the cavity.

[00027] In this non-limiting embodiment, the plug 100 may be made of a metallic biocompatible material, such as a titanium or stainless steel alloy. The plug 100 may be made of any other suitable biocompatible material, metallic or non-metallic, in other embodiments. The plug 100 may also be made of a non-biological material such that the plug 100 is not made of bone tissue or any other bodily tissue. In other non-limiting embodiments, the plug may be made of any suitable biodegradable material.

[00028] The plug 100 may be a permanent plug. That is, the plug 100 may be configured to remain in the cavity. In other non-limiting embodiments, the plug 100 may be temporary, notably when the plug 100 is made of a biodegradable material.

[00029] In a non-limiting embodiment, the plug 100 may be used to seal a femoral opening drilled in the femur to position an intramedullary cutting guide. This may notably be the case during a TKR surgery. In other embodiments, the plug 100 may be used to seal a cavity in a bone during other surgical procedures such as, but not limited to, a revision of total knee prosthesis, a retrograde rodding of the femur and the likes.

[00030] With reference to Fig. 4, a step of TKR surgery is shown in which a femoral opening 400 has been drilled in the femur 402. The femoral opening is used at a subsequent step (not shown) to position an intramedullary cutting guide. The intramedullary cutting guide is then used to cut the femur 402 (not shown).

[00031] With further reference to Fig. 5, the cut portion 500 of the femur 402 is shown after the intramedullary cutting guide has been removed and with the plug 100 sealing the femoral opening 400, the plug 100 generally preventing bleeding from the femoral canal inside the region of the knee joint. It is appreciated that the femoral opening 400 is sealed with a minimum of handling required from the operating surgeon.

[00032] Certain additional elements that may be needed for operation of some embodiments have not been described or illustrated as they are assumed to be within the purview of those of ordinary skill in the art. Moreover, certain embodiments may be free of, may lack and/or may function without any element that is not specifically disclosed herein.

[00033] Any feature of any embodiment discussed herein may be combined with any feature of any other embodiment discussed herein in some examples of implementation.

[00034] Although various embodiments and examples have been presented, this was for the purpose of describing, but not limiting, the present disclosure. Various modifications and

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enhancements will become apparent to those of ordinary skill in the art and are within the scope of the invention, which is defined by the appended claims.

CLAIMS

1. A femoral plug for sealing a femoral opening drilled in a distal region of a femur forming part of a knee joint to position an intramedullary cutting guide configured for cutting a portion of the distal region of the femur, the femoral plug comprising:

   an elongated body sized for insertion into the femoral opening; and

   threads extending around a least a portion of the elongated body to engage bone surrounding the femoral opening and form a seal with the bone to prevent bleeding from the femoral opening into the knee joint.

2. The femoral plug of claim 1, wherein the threads comprise a helical thread structure.

3. The femoral plug of claim 2, wherein the helical thread structure comprises a series of parallel ridges.

4. The femoral plug of claim 3, wherein the parallel ridges comprise a single helix that spirals about a periphery of the elongated body.

5. The femoral plug of claim 3, wherein the parallel ridges comprise discrete parallel bands around a periphery of the elongated body.

6. The femoral plug of any one of claims 1 to 5, further comprising a chamfered edge at a bottom end of the femoral plug to facilitate entry of the femoral plug into the femoral opening.

7. The femoral plug of any one of claims 1 to 6, further comprising a socket in an upper region of the femoral plug to aid in insertion of the femoral plug into the femoral opening.

8. The femoral plug of any one of claims 1 to 6, further comprising a tool-engaging portion in an upper region thereof, the tool-engaging portion being configured to be engaged by a tool for driving the femoral plug into the femoral opening.

9. The femoral plug of any one of claims 1 to 8, wherein the elongated body is configured as a hollow elongated body.

10. The femoral plug of claim 9, wherein the hollow elongated body is configured to be inflated to engage with the bone surrounding the femoral opening.

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11. The femoral plug of claim 9, wherein the hollow elongated body is configured to be mechanically deformed to engage with the bone surrounding the femoral opening.

12. The femoral plug of any one of claims 1 to 11, wherein the femoral plug is made of a biocompatible metallic material.

13. The femoral plug of any one of claims 1 to 11, wherein the femoral plug is made of a biocompatible non-metallic material.

14. The femoral plug of any one of claims 1 to 11, wherein the femoral plug is made of a biodegradable material.

15. The femoral plug of any one of claims 1 to 14, wherein the elongated body is a substantially cylindrical body.

16. The femoral plug of any one of claims 1 to 15, wherein the femoral plug has a femoral plug diameter that is selected based on a diameter of a drill bit used to drill the femoral opening in the distal region of the femur.

17. Use of the femoral plug as defined in any one of claims 1 to 16, to form a seal with the bone to prevent bleeding from the femoral opening into the knee joint.

18. The use of claim 17, wherein the femoral opening is drilled in the femur to position the intramedullary cutting guide during a total knee replacement surgery.

19. A kit comprising:

an intramedullary cutting guide comprising:

a member having a member diameter and being configured for insertion in a femoral opening drilled in a distal portion of a femur forming part of a knee joint to position the intramedullary cutting guide; and

a femoral plug having a femoral plug diameter selected according to the member diameter, the femoral plug comprising:

an elongated body; and

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threads extending around a least a portion of the elongated body to engage bone surrounding the femoral opening and form a seal with the bone to prevent bleeding from the femoral opening into the knee joint after removal of the member from the femoral opening.

20. The kit of claim 19, wherein the threads of the femoral plug comprise a helical thread structure.

21. The kit of claim 20, wherein the helical thread structure comprises a series of parallel ridges.

22. The kit of claim 21, wherein the parallel ridges comprise a single helix that spirals about a periphery of the elongated body.

23. The kit of claim 21, wherein the parallel ridges comprise discrete parallel bands around a periphery of the elongated body.

24. The kit of any one of claims 19 to 23, wherein the femoral plug further comprises a chamfered edge at a bottom end thereof to facilitate entry of the femoral plug into the femoral opening.

25. The kit of any one of claims 19 to 24, wherein the femoral plug further comprises a socket in an upper region thereof to aid in insertion of the femoral plug into the femoral opening.

26. The kit of any one of claims 19 to 24, wherein the femoral plug further comprises a tool-engaging portion in an upper region thereof, the tool-engaging portion being configured to be engaged by a tool for driving the femoral plug into the femoral opening.

27. The kit of any one of claims 19 to 26, wherein the elongated body of the femoral plug is configured as a hollow elongated body.

28. The kit of claim 27, wherein the hollow elongated body is configured to be inflated to engage with the bone surrounding the femoral opening.

29. The kit of claim 27, wherein the hollow elongated body is configured to be mechanically deformed to engage with the bone surrounding the femoral opening.

30. The kit of any one of claims 19 to 29, wherein the femoral plug is made of a biocompatible metallic material.

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31. The kit of any one of claims 19 to 29, wherein the femoral plug is made of a biocompatible non-metallic material.

32. The kit of any one of claims 19 to 29, wherein the femoral plug is made of a biodegradable material.

33. The kit of any one of claims 19 to 32, wherein the elongated body of the femoral plug is a substantially cylindrical body.

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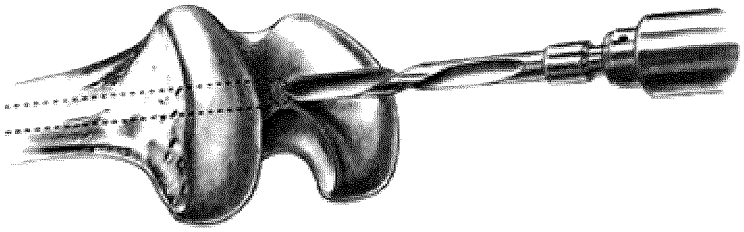
FIG. 1A
Prior Art



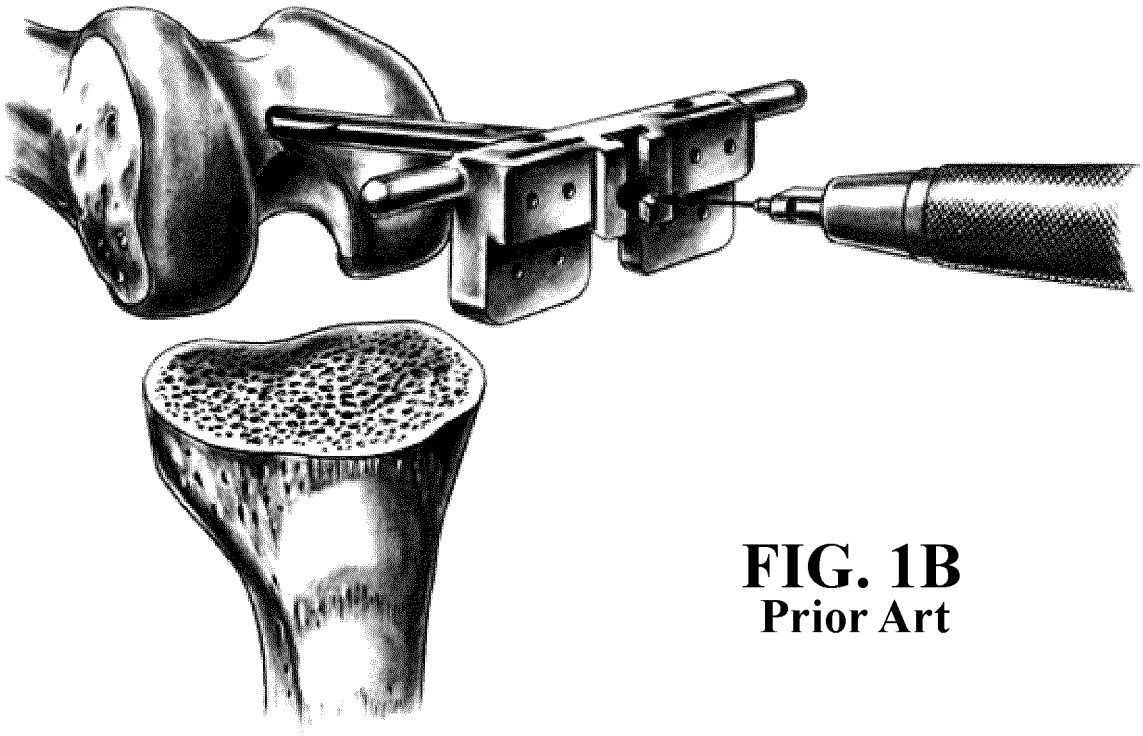


FIG. 1B
Prior Art

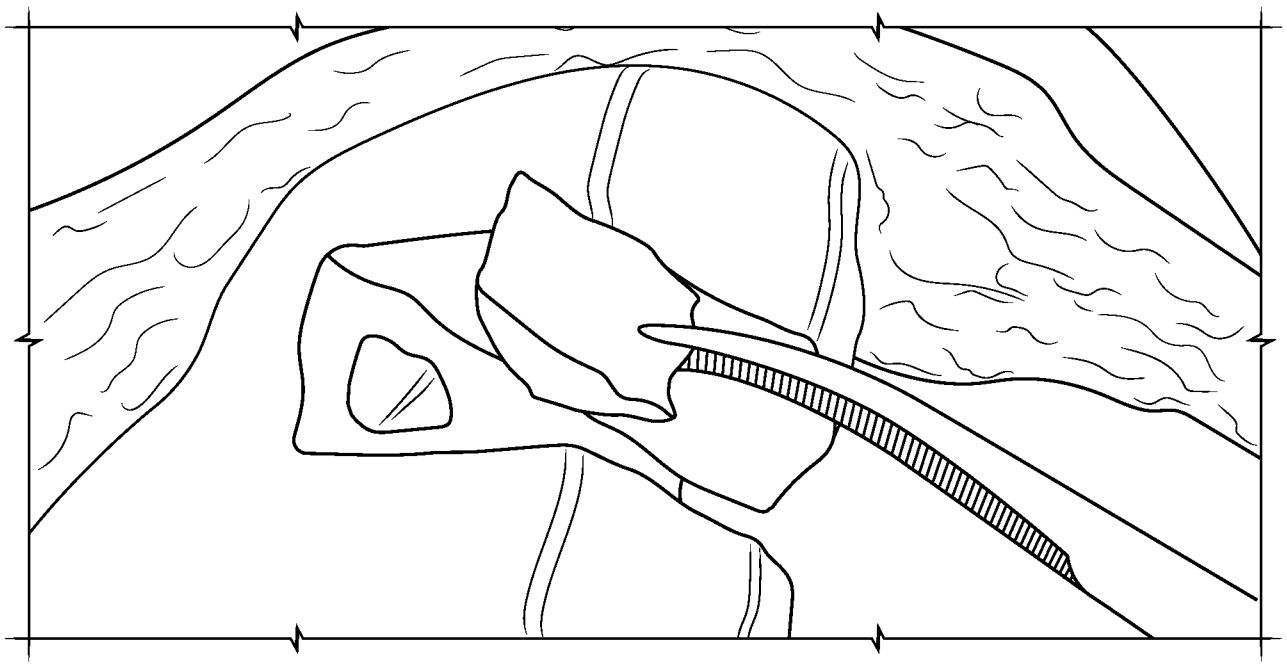


FIG. 2
Prior Art

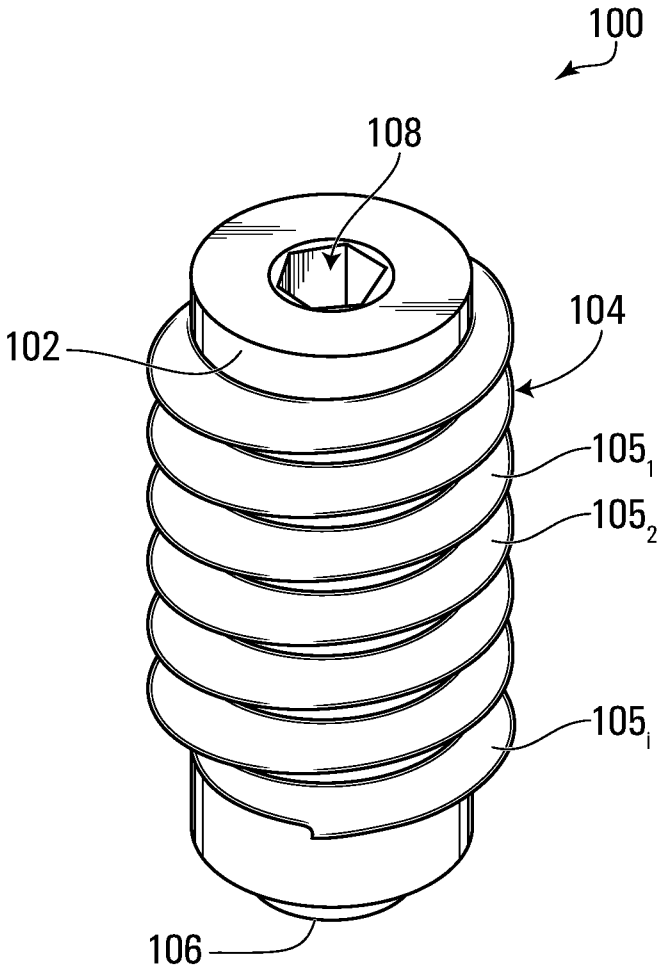


FIG. 3

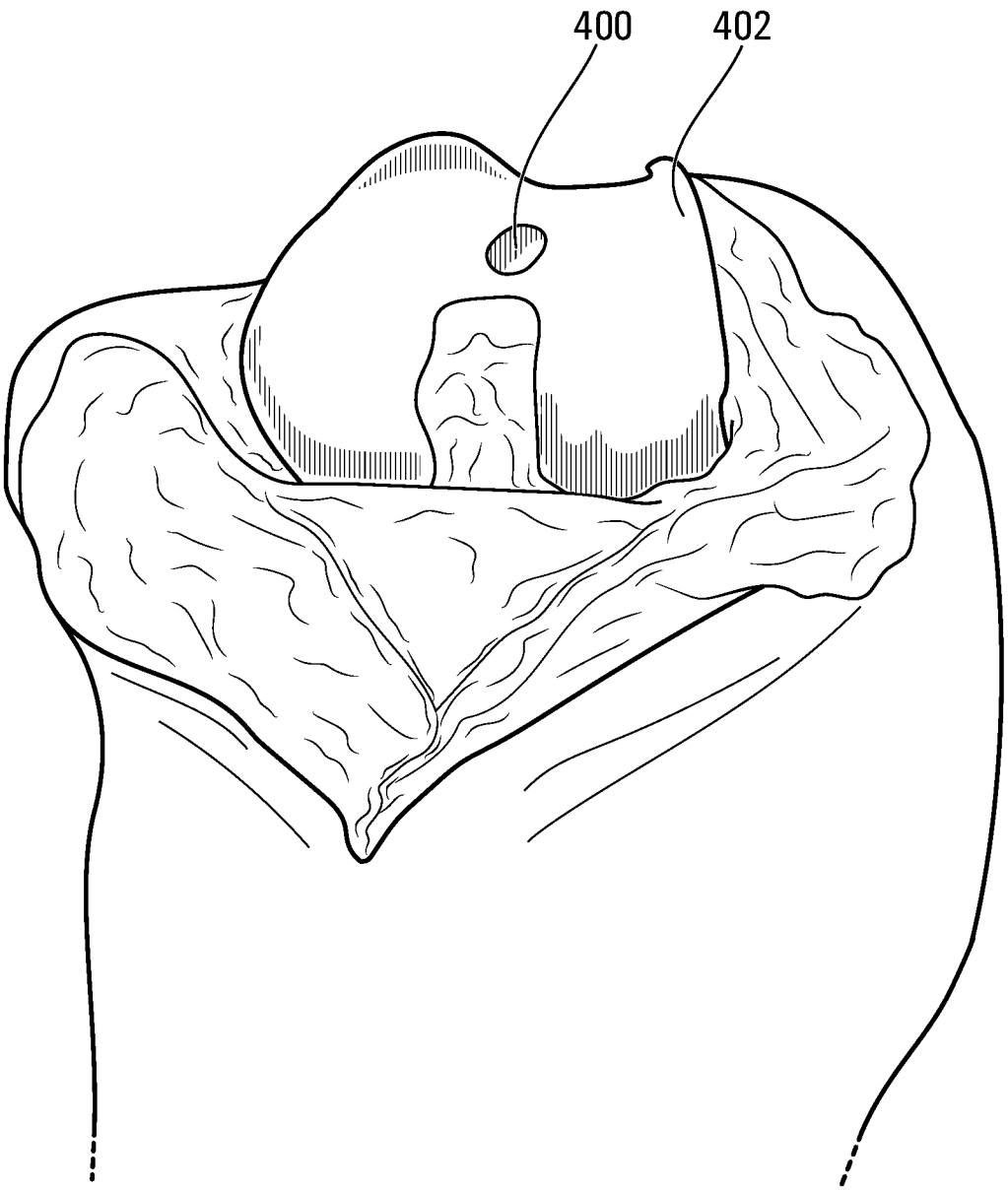


FIG. 4

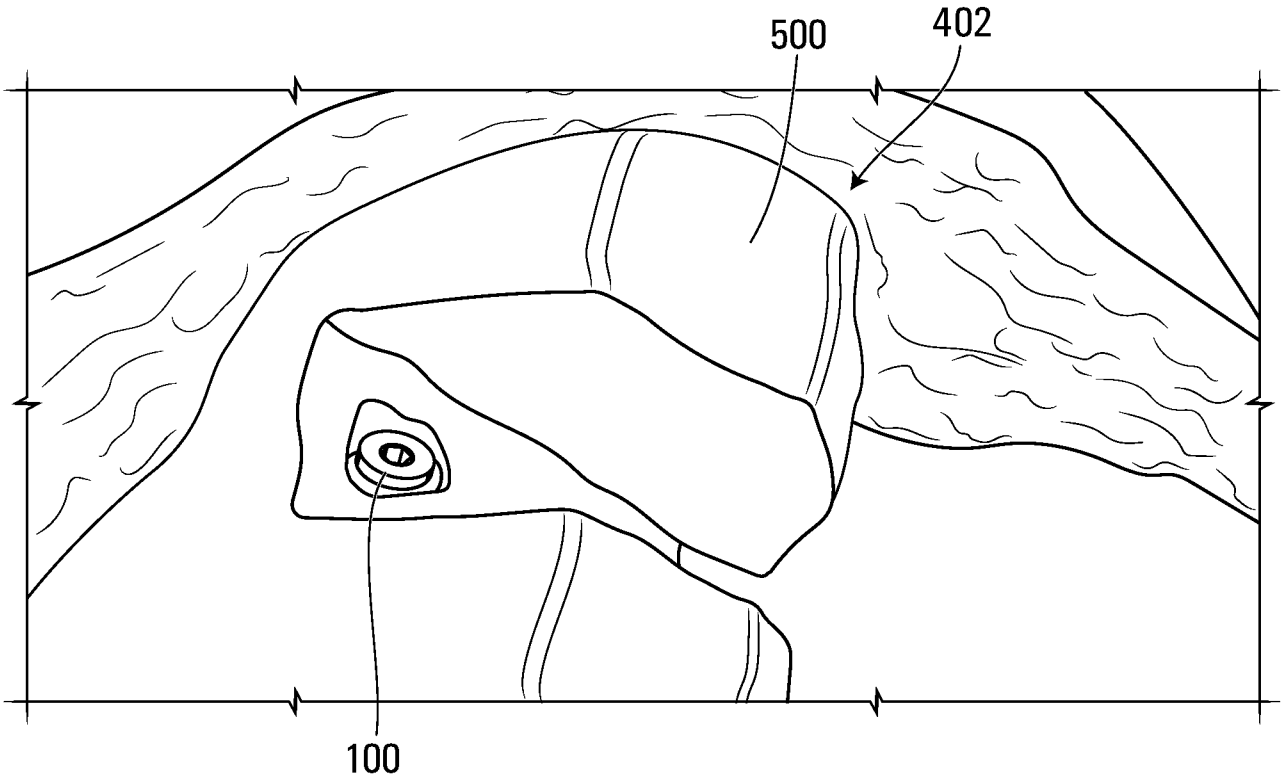
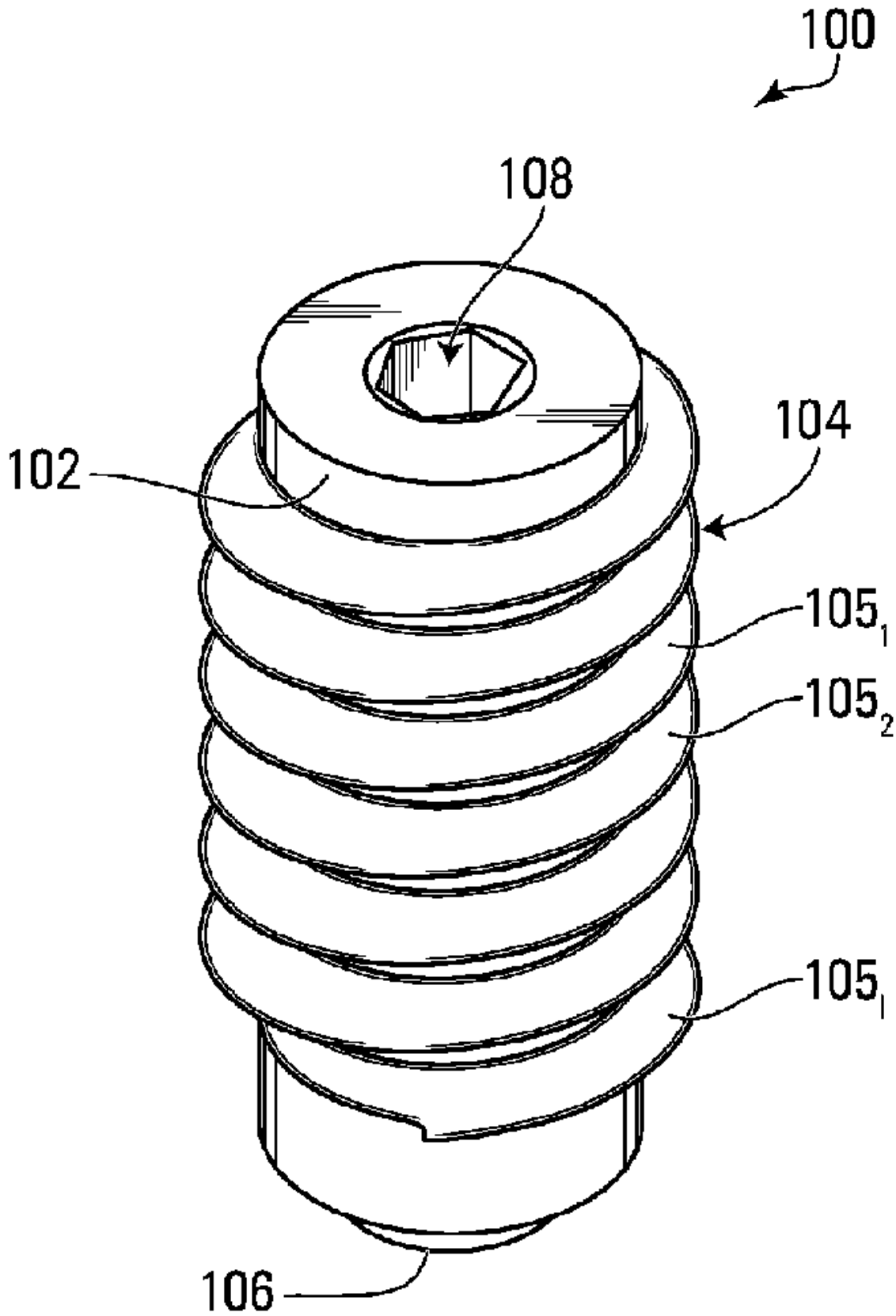


FIG. 5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