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(54) **BONE SCREW**

(71) Applicant: **INDUSTRIAL TECHNOLOGY RESEARCH INSTITUTE**, HSINCHU (TW)

(72) Inventors: **Hsin-Hsin SHEN**, Zhudong Township (TW); **Pei-I TSAI**, Hsinchu City (TW); **Kuo-Yi YANG**, Hsinchu City (TW); **Fang-Jie JANG**, Keelung City (TW); **An-Li CHEN**, Tainan City (TW); **Shih-Ping LIN**, Kaohsiung City (TW); **Chih-Chieh HUANG**, Zhunan Township (TW); **Yi-Hung WEN**, Hsinchu City (TW); **Wei-Lun FAN**, Zhunan Township (TW); **Shin-I HUANG**, Hsinchu City (TW)

(73) Assignee: **INDUSTRIAL TECHNOLOGY RESEARCH INSTITUTE**, HSINCHU (TW)

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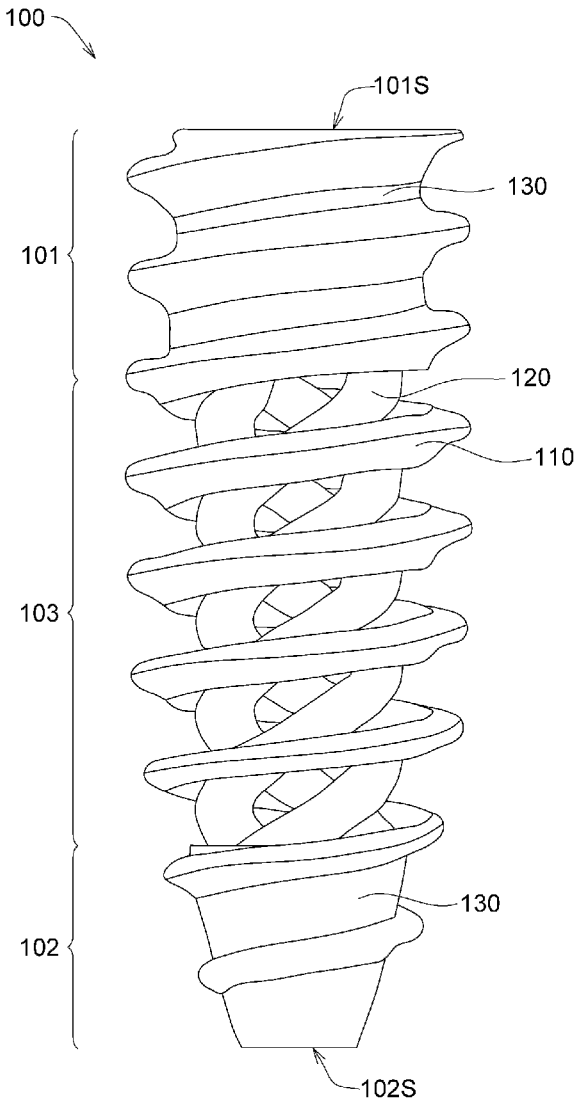
(57) **ABSTRACT**

A bone screw includes an external screw thread, an internal supporter structure and a porous layer. The internal supporter structure is inside the external screw thread. The internal supporter structure includes a screw thread supporter or a polygonal wall supporter. The porous layer is on a surface of the internal supporter structure. Therefore, the bone screw has an increased strength and also provides postoperative healing effect.



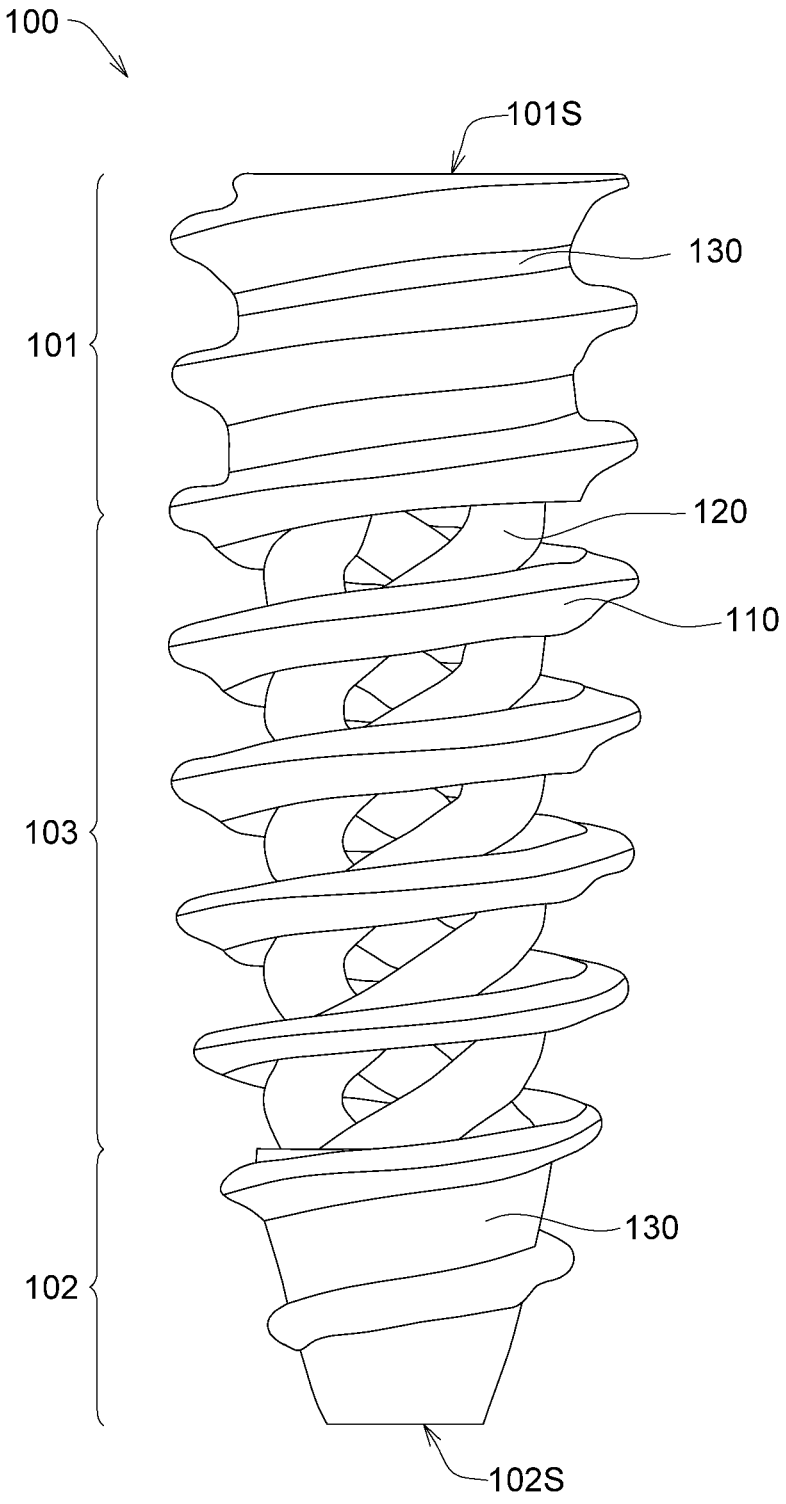


FIG. 1

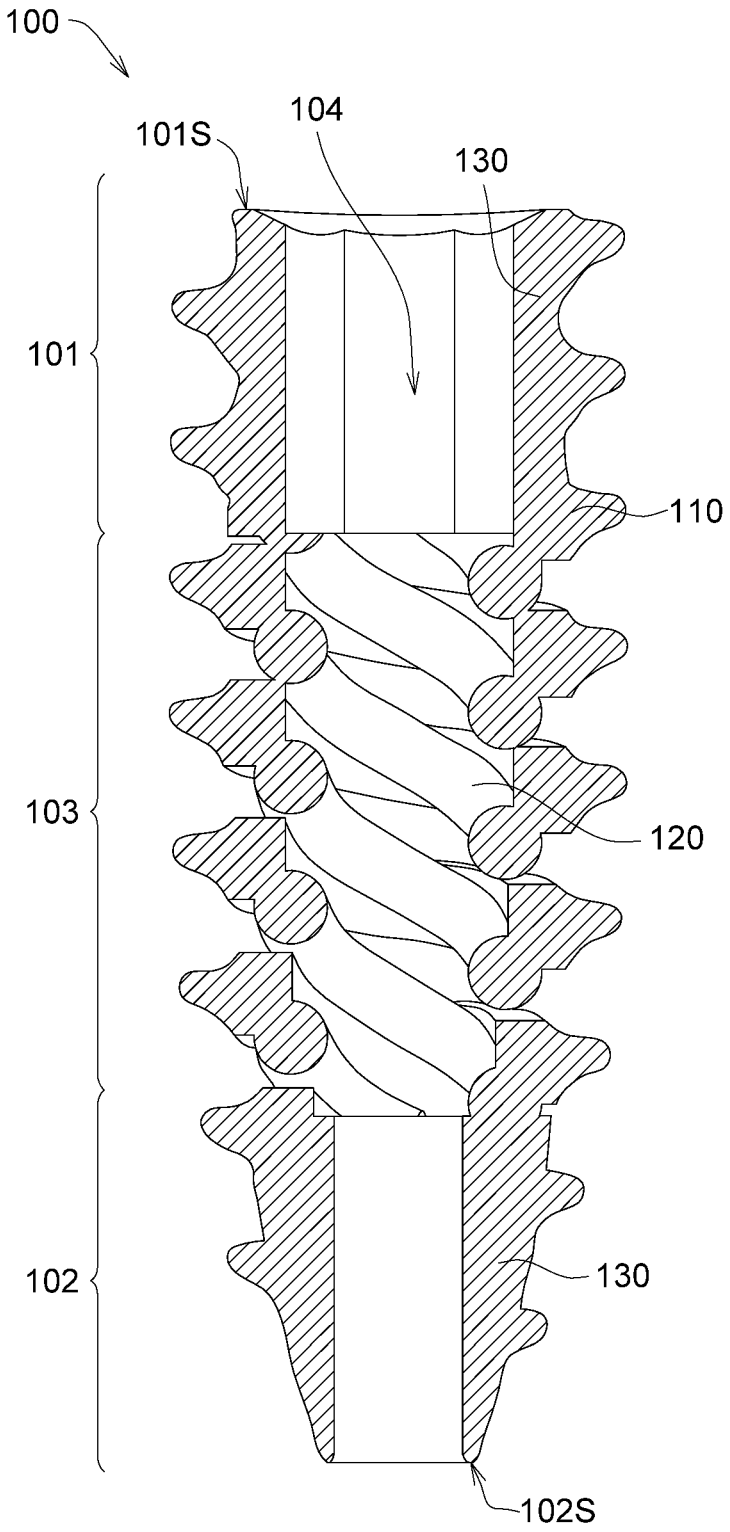


FIG. 2

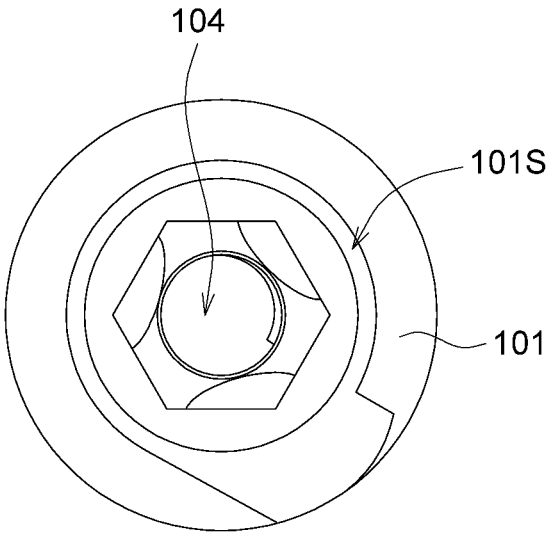


FIG. 3

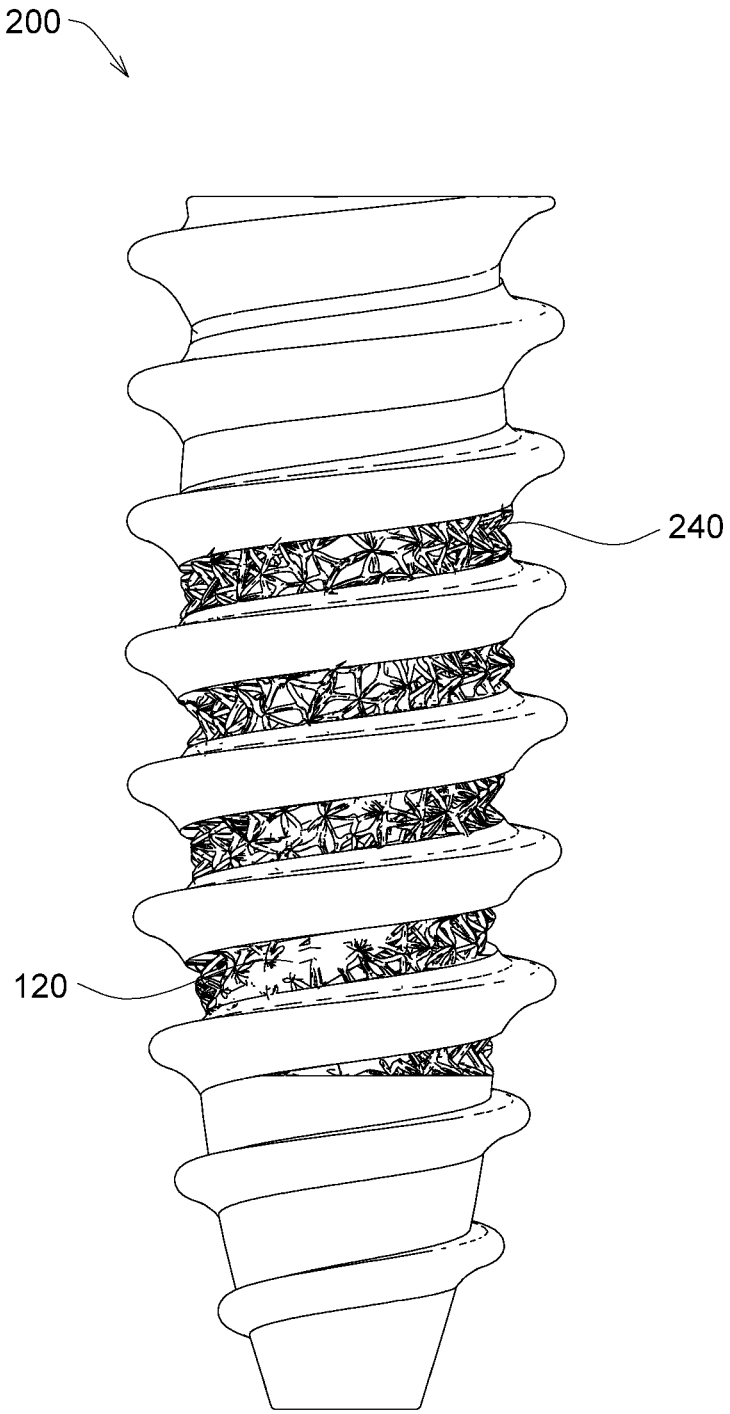


FIG. 4

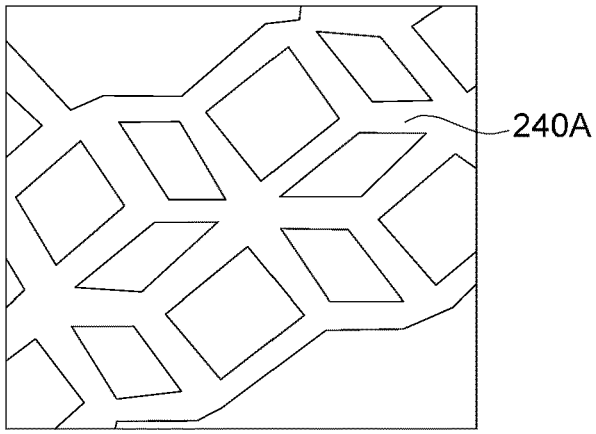


FIG. 5

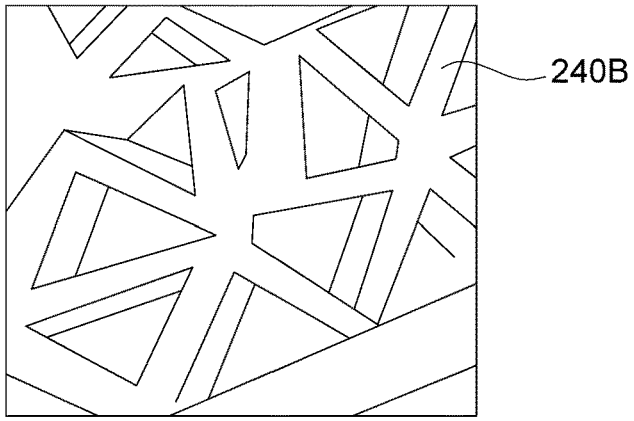


FIG. 6

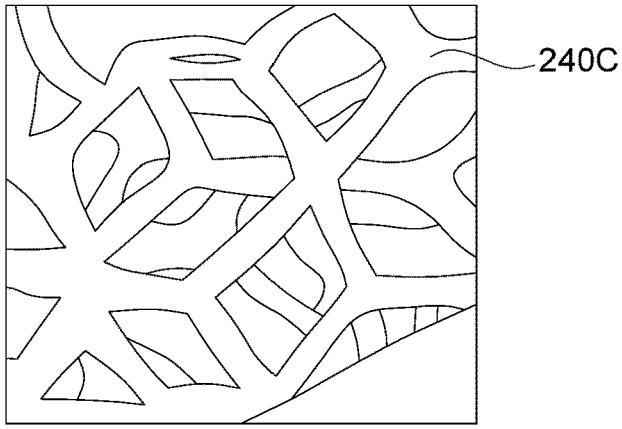


FIG. 7

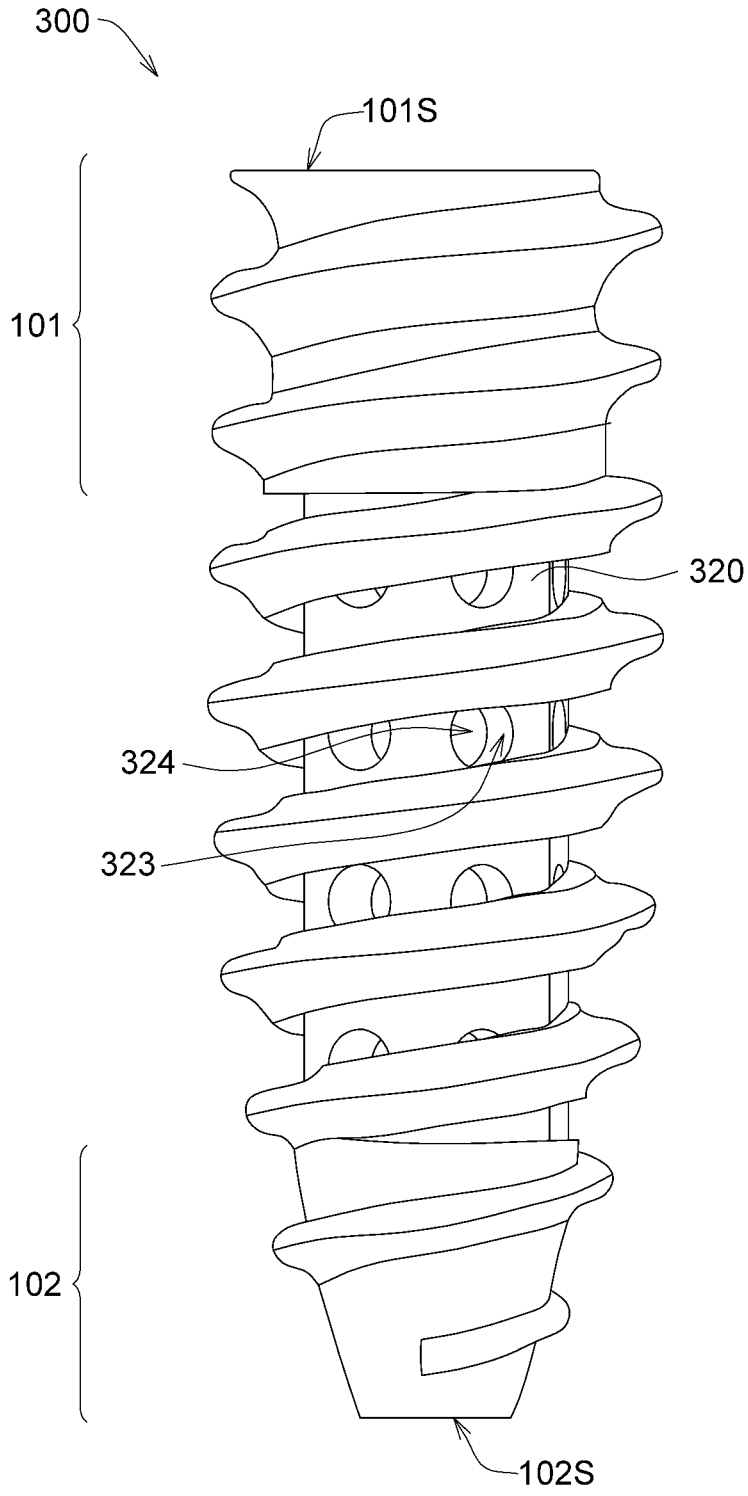


FIG. 8

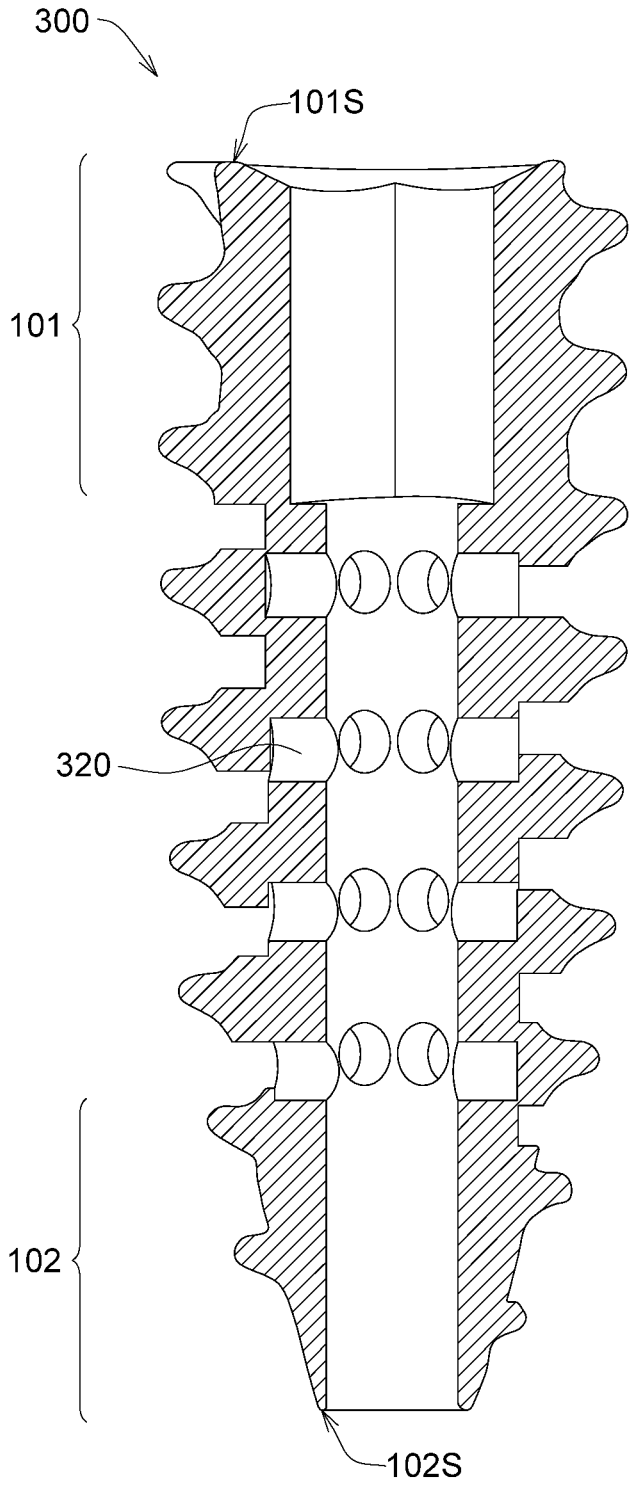


FIG. 9

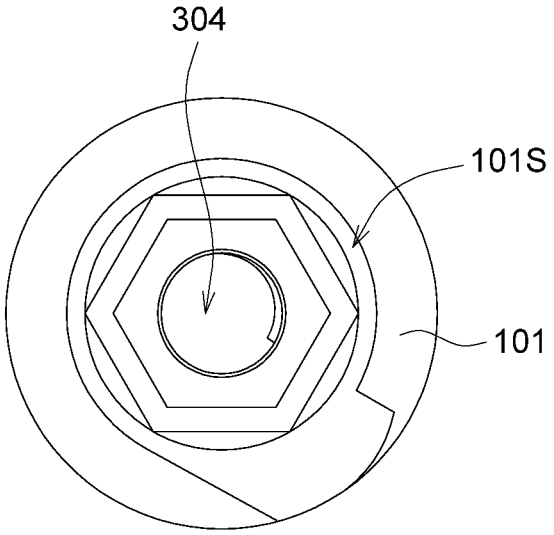


FIG. 10

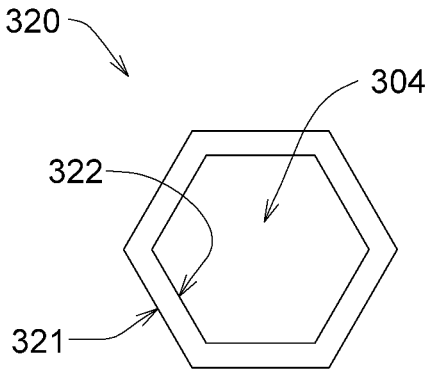


FIG. 11

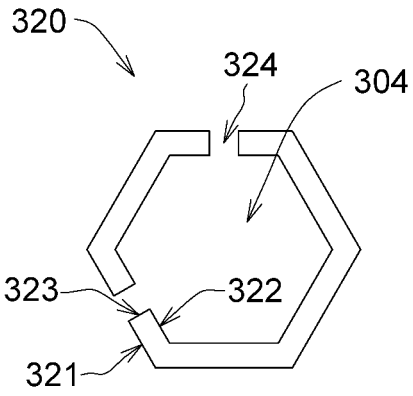


FIG. 12

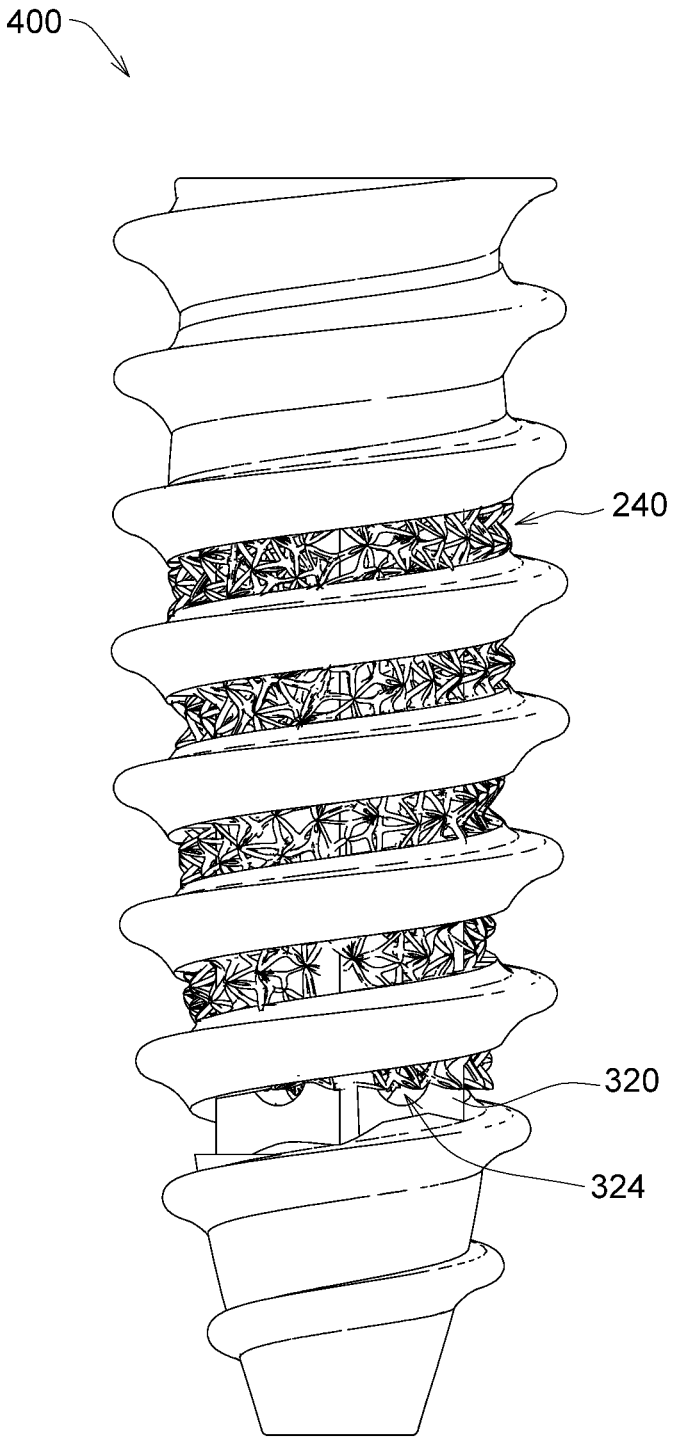


FIG. 13

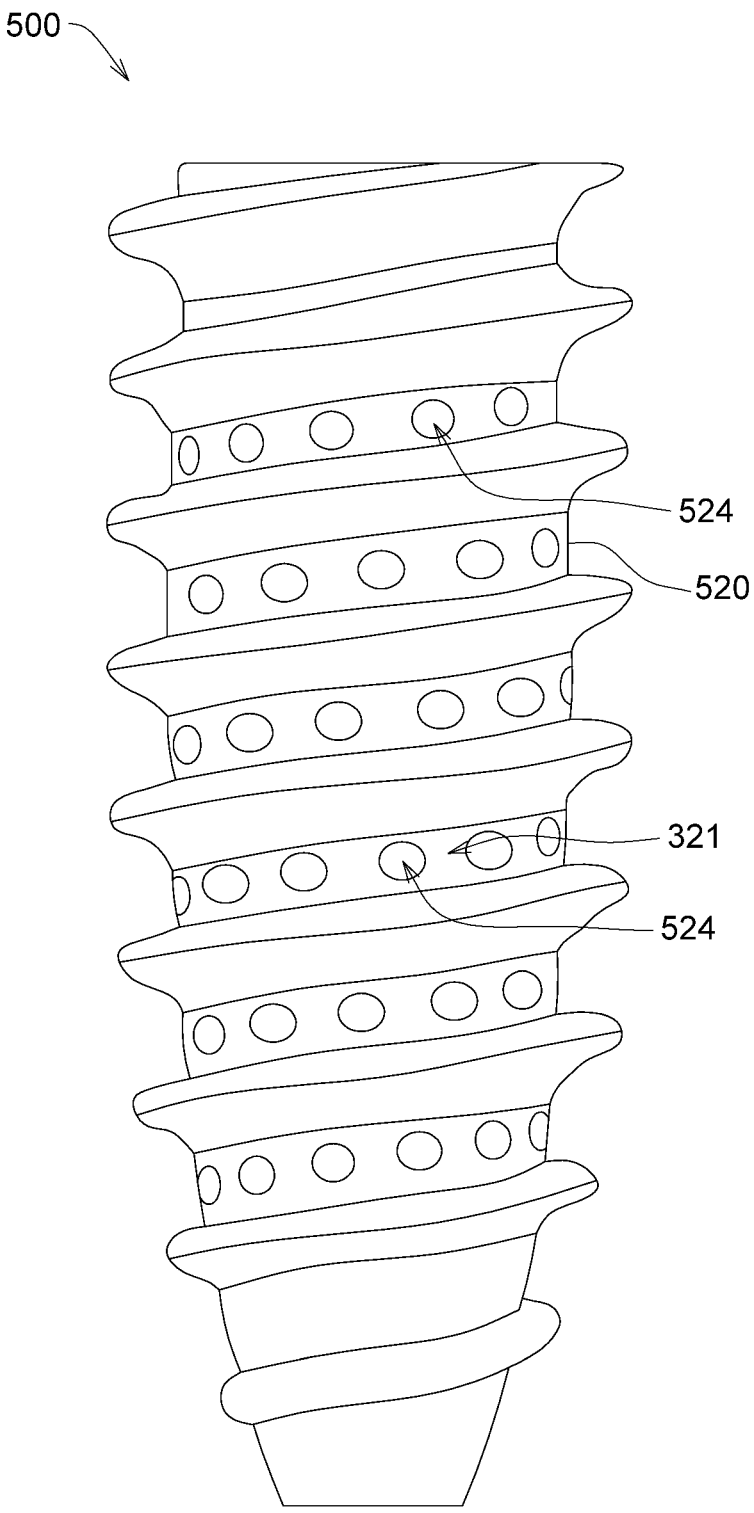


FIG. 14

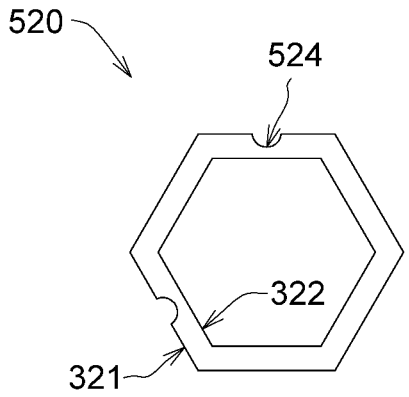


FIG. 15

BONE SCREW

TECHNICAL FIELD

[0001] The disclosure relates in general to a bone screw, and more particularly to a bone screw having an internal supporter structure.

BACKGROUND

[0002] When one's issues, such as bones, tendons or ligaments, are damaged to a certain degree, doctors may decide that one's damaged part may need a surgery. Normally, the surgery is to move one's tissues to the pre-damage position and fix the tissues using surgical sutures and bone implants such as bone screws. Then, one's damaged part will be recovered through one's self-repair ability. Or, some man-made tissues can be fixed inside the body using sutures and bone implants to assist or replace the damaged tissues. Most of the tissues, such as shoulders, knees and adjacent tissues, have mobility requirement. The bone implants need to have excellent biological compatibility and suitable mechanical function and possess physical and chemical properties, such that the bone implants despite being used under a long duration of stress cycle still can match the needs of organism.

[0003] The bone implants can be formed of metallic or nonmetallic materials. Metallic materials, such as stainless steel or titanium alloy, have better mechanical properties and can sustain the load received by the bone implants. However, metallic bone implants have a hardness much larger than a hardness of the bone and may easily generate a stress shielding effect over the long run, causing discomfort to the surgical part, making the surrounding tissues of the implanted part loose and delaying bone healing. To the worse, osseointegration may fail and the affected part may need another surgery, which increases further surgical risk and medical costs.

SUMMARY

[0004] The disclosure is directed to a bone screw.

[0005] According to one embodiment, a bone screw is provided. The bone screw includes an external screw thread, an internal supporter structure and a porous layer. The internal supporter structure is disposed inside a middle part of the external screw thread. The internal supporter structure includes one of a screw thread supporter and a polygonal wall supporter. The porous layer is disposed on a surface of the internal supporter structure.

[0006] According to another embodiment, a bone screw is provided. The bone screw includes an external screw thread and an internal supporter structure. The internal supporter structure is disposed inside a middle part of the external screw thread. The internal supporter structure is a polygonal wall supporter with several.

[0007] The above and other aspects of the invention will become better understood with regard to the following detailed description of the preferred but non-limiting embodiment (s). The following description is made with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. **1** is a 3D appearance diagram of a bone screw according to an embodiment.

[0009] FIG. **2** is a longitudinal cross-sectional view of a bone screw according to an embodiment.

[0010] FIG. **3** is a top view of a top pin portion a bone screw according to an embodiment.

[0011] FIG. **4** is a 3D appearance diagram of a bone screw according to another embodiment.

[0012] FIG. **5** is a schematic diagram of a porous layer according to an embodiment.

[0013] FIG. **6** is a schematic diagram of a porous layer according to another embodiment.

[0014] FIG. **7** a schematic diagram of a porous layer according to yet another embodiment.

[0015] FIG. **8** is a 3D appearance diagram of a bone screw according to another embodiment.

[0016] FIG. **9** is a longitudinal cross-sectional view of a bone screw according to another embodiment.

[0017] FIG. **10** is a top view of a top pin portion of a bone screw according to another embodiment.

[0018] FIG. **11** is a lateral cross-sectional view of a portion of a polygonal wall supporter without apertures.

[0019] FIG. **12** is a lateral cross-sectional view of a portion of a polygonal wall supporter with apertures.

[0020] FIG. **13** is a 3D appearance diagram of a bone screw according to yet another embodiment.

[0021] FIG. **14** is a 3D appearance diagram of a bone screw according to yet more another embodiment.

[0022] FIG. **15** is a lateral cross-sectional view of a portion of a polygonal wall supporter with apertures.

[0023] In the following detailed description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the disclosed embodiments. It will be apparent, however, that one or more embodiments may be practiced without these specific details. In other instances, well-known structures and devices are schematically shown in order to simplify the drawing.

DETAILED DESCRIPTION

[0024] A number of embodiments are disclosed below for explanatory purpose. It should be noted that although the present disclosure does not illustrate all possible embodiments, other embodiments not disclosed in the present disclosure are still applicable. Moreover, the dimension scales used in the accompanying drawings are not based on actual proportion of the product. Therefore, the specification and drawings are for explaining and describing the embodiment only, not for limiting the scope of protection of the present disclosure. Furthermore, descriptions of the embodiments, such as detailed structures, manufacturing procedures and materials, are for exemplification purpose only, not for limiting the scope of protection of the present disclosure. Suitable modifications or changes can be made to the structures and procedures of the embodiments to meet actual needs without breaching the spirit of the present disclosure. Designations common to the accompanying drawings are used to indicate identical or similar elements.

[0025] A bone screw **100** in an embodiment is disclosed with reference to FIG. **1**, FIG. **2** and FIG. **3**. FIG. **1** is a 3D appearance diagram of the bone screw **100**. FIG. **2** is a longitudinal cross-sectional view of the bone screw **100**. FIG. **3** is a top view of a top pin portion **101** the bone screw **100**.

[0026] The bone screw **100** includes an external screw thread **110** and an internal supporter structure. In the present

embodiment, the internal supporter structure includes a screw thread supporter **120**. The screw thread supporter **120** is inside a middle part of the external screw thread **110**. A spiral direction of the external screw thread **110** can be identical to or different from a spiral direction of the screw thread supporter **120**. The screw thread supporter **120** is not limited to a three-wire screw thread, and can comprise supporter structure of a one-wire screw thread, a two-wire screw thread, a four-wire screw thread, or a screw thread of other amounts of wires. A diameter of the screw thread supporter **120** may be 0.8 mm to 1.2 mm, for example, but the present disclosure is not limited thereto.

[0027] Parts of the bone screw **100** may include the top pin portion **101**, a bottom pin portion **102** and a middle pin portion **103**, for example. The middle pin portion **103** is between the top pin portion **101** and the bottom pin portion **102**. The top pin portion **101**, the bottom pin portion **102** and the middle pin portion **103** include the external screw thread **110**. Otherwise, the external screw thread **110** connects the top pin portion **101**, the bottom pin portion **102** and the middle pin portion **103**. Each of the top pin portion **101** and the bottom pin portion **102** includes an outer wall layer **130** connecting with the top and the bottom of the external screw thread **110**. The middle pin portion **103** includes the screw thread supporter **120** and a part of the external screw thread **110** (such as the middle part of the external screw thread **110**). The bone screw **100** includes a middle hole **104** passing through the interior of the bone screw **100**. The middle hole **104** can be inside the screw thread supporter **120**. The middle hole **104** can be extended to the bottom bone screw surface **102**S of the bottom pin portion **102** from the top bone screw surface **101**S of the top pin portion **101** along an axial direction. The hollowed middle hole **104** can be used for surgical guidance and micro-wound surgery.

[0028] In an embodiment, materials of the external screw thread **110**, the outer wall layer **130** and the screw thread supporter **120** can have a non-porous structure. The non-porous structure refers to a solid structure or material without pores connected with each other. The material of the internal supporter structure (the screw thread supporter **120**) has a solid structure (that is, non-porous structure), which provides the bone screw **100** with sufficient structural strength and hardness, reduces the probability of rupture during the implantation or use process and increases the lifespan of the bone screw **100**. In comparison to the bone screw of the comparison example without having an internal supporter structure, the bone screw **100** of the present embodiment having the screw thread supporter **120** having the material being a solid structure (that is, a non-porous structure) as an internal supporter structure can have larger torsional strength and pull-out strength. The external screw thread **110** can be used for increasing the stability of the bone screw **100** after implantation.

[0029] FIG. **4** is a 3D appearance diagram of a bone screw **200** according to another embodiment, which is different from the bone screw **100** of FIG. **1** with the following description. The bone screw **200** includes a porous layer **240**. The porous layer **240** is disposed on a surface of the screw thread supporter **120**. The porous layer **240** can also be formed on the roots of the external screw thread **110** and connected between the roots. The porous layer **240** has pores connected with each other and has a hardness lower than a hardness of the non-porous material. The porous layer **240** not only can avoid the stress shielding effect but can be used as a bionic porous structure with osseointegration effect, which induces the growth of bone cells and promotes bone ingrowth to achieve osseointegration and fixation and benefit the user from postoperative healing and recovery.

[0030] The porosity of the porous layer **240** can be 15% or higher, such as 30% to 60%. The pore size of the porous layer **240** can be 50 μm to 500 μm, such as 50 μm to 200 μm, or 300 μm to 500 μm, or 300 μm to 440 μm, or 170 μm to 440 μm, or 170 μm to 300 μm. In an embodiment, the porous layer **240** can be the porous layer **240**A as indicated in FIG. **5** having quadrangle pores whose pore size is 210 μm to 390 μm. In another embodiment, the porous layer **240** can be the porous layer **240**B as indicated in FIG. **6** having triangle pores whose pore size is 310 μm to 330 μm. In an alternate embodiment, the porous layer **240** can be the porous layer **2400** as indicated in FIG. **7** having amoeba-shaped pores whose pore size is 170 μm to 440 μm. However, the present disclosure is not limited thereto. The porous layer **240** can have other possible types of porous structure.

[0031] A bone screw **300** in another embodiment is disclosed with reference to FIG. **8** to FIG. **12**. FIG. **8** is a 3D appearance diagram of the bone screw **300**. FIG. **9** is a longitudinal cross-sectional view of the bone screw **300**. FIG. **10** is a top view of the top pin portion **101** of the bone screw **300**. The bone screw **300** is different from the bone screw **100** described with referring to FIG. **1** to FIG. **3** with the following description. In this embodiment, the internal supporter structure includes a polygonal wall supporter **320**. The polygonal wall supporter **320** can have apertures **324**.

[0032] FIG. **11** is a lateral cross-sectional view of a portion of the polygonal wall supporter **320** without the apertures **324**. The polygonal wall supporter **320** is a hexagonal wall supporter. The outer wall surface **321** of the polygonal wall supporter **320** is a hexagonal wall surface. The inner wall surface **322** of the polygonal wall supporter **320** is a hexagonal wall surface.

[0033] FIG. **12** is a lateral cross-sectional view of a portion of the polygonal wall supporter **320** with the apertures **324**.

[0034] A material of the internal supporter structure (the polygonal wall supporter **320**) can have a non-porous structure, which provides the bone screw **300** with sufficient structural strength and hardness, reduces the probability of rupture during the implantation or use process and increases the lifespan of the bone screw **300**. In comparison to the bone screw of the comparison example without having an internal supporter structure, the bone screw **300** of the present embodiment having the screw thread supporter **320** having a material being a solid structure (that is, non-porous structure) as an internal supporter structure can have larger torsional strength and pull-out strength.

[0035] FIG. **8** to FIG. **12** are referred to. The polygonal all supporter **320** has a middle surface **323**. The middle surface **323** is between an outer wall surface **321** and an inner wall surface **322** opposite to the outer wall surface **321**. The apertures **324** are defined by the middle surface **323**. The apertures **324** are separated from each other by the polygonal wall supporter **320**. The bone screw **300** may include a middle hole **304** inside the polygonal wall supporter **320**. The middle hole **304** can be extended to the bottom bone screw surface **102**S of the bottom pin portion **102** from the top bone screw surface **101**S of the top pin portion **101** along an axial direction.

[0036] The lateral size, such as width, of the polygonal wall supporter **320** may be 0.9 mm to 2.9 mm. The size of

the aperture **324** may be 0.5 mm to 1.5 mm, such as 1.2 mm. But the present disclosure is not limited thereto.

[0037] FIG. **13** illustrates a 3D appearance diagram of a bone screw **400** according to yet another embodiment, which is different from the bone screw **300** of FIG. **8** with the following description. The bone screw **400** includes a porous layer **240**. The porous layer **240** is on a surface of the polygonal wall supporter **320**. The porous layer **240** can be on an outer wall surface of the polygonal wall supporter **320**. But the present disclosure is not limited thereto. In an embodiment, the porous layer **240** can be a middle surface of the polygonal wall supporter **320** exposed from the apertures **324**. The porous layer **240** can be on an inner wall surface of the polygonal wall supporter **320**.

[0038] A bone screw **500** in another embodiment is disclosed with reference to FIG. **14** to FIG. **15**, FIG. **14** is a 3D appearance diagram of the bone screw **500** according to yet another alternate embodiment, which is different from the bone screw **300** of FIG. **8** with the following description. The bone screw **500** includes a polygonal wall supporter **520** having apertures **524**. Fla **15** is a lateral cross-sectional view of a portion of the polygonal wall supporter **520** with the apertures **524**. In the present embodiment, the outer wall surface **321** of the polygonal wall supporter **520** has the apertures **524**. The holes **524** can be regarded as pits of the outer wall surface **321**. The size of the aperture **524** may be 300 μm to 500 μm, for example. The polygonal wall supporter **520** having the apertures **524** can be used as a bionic structure which provides osseointegration effect.

[0039] A material of the internal supporter structure (the polygonal wall supporter **520**) has a solid structure (i.e. non-porous structure), which provides the bone screw **500** with sufficient structural strength and hardness, reduces the probability of rupture during the implantation or use process and increases the lifespan of the bone screw **500**. In comparison to the bone screw of the comparison example without having an internal supporter structure, the bone screw **500** of the present embodiment with the screw thread supporter **520** having a material being a solid structure (that is, non-porous structure) as an internal supporter structure can have larger torsional strength and pull-out strength. In an embodiment, a porous layer (such as the porous layer **240**, not shown in FIG. **14**) can be disposed on a surface of the polygonal wall supporter **520** of the bone screw **500**.

[0040] The present disclosure is not limited to the above embodiments. For example, the polygonal wall supporter is not limited to a hexagonal shape, and can also have a square shape, a pentagonal shape, a hexagonal shape, a heptagonal shape, an octagonal shape, a nonagon shape, a decagon shape, a hendecagon shape, a dodecagon shape, a thirteen-sided shape, a fourteen-sided shape, etc.

[0041] In an embodiment, the bone screw can have a consistent material, such as a metal or a non-metallic material such as high polymer. The bone screw can be integrally formed in one piece. However, the present disclosure is not limited thereto, and the bone screw can be formed by a composite material. The bone screw may be formed by an ordinary method or a laminating method.

[0042] It will be apparent to those skilled in the art that various modifications and variations can be made to the disclosed embodiments. It is intended that the specification and examples be considered as exemplary only, with a true scope of the disclosure being indicated by the following claims and their equivalents.

What is claimed is:

1. A bone screw, comprising:
an external screw thread;
an internal supporter structure disposed inside a middle part of the external screw thread, wherein the internal supporter structure comprises one of a screw thread supporter and a polygonal wall supporter; and
a porous layer disposed on a surface of the internal supporter structure.

2. The bone screw according to claim **1**, wherein a spiral direction of the spiral supporter is identical to a spiral direction of the external screw thread.

3. The bone screw according to claim **1**, wherein the polygonal wall supporter comprises an outer wall surface having apertures.

4. The bone screw according to claim **1**; wherein a material of the external screw thread has a non-porous structure.

5. The bone screw according to claim **1**, wherein a material of the internal supporter structure has a non-porous structure.

6. The bone screw according to claim **1**, further comprising a middle hole passing through an interior of the bone screw.

7. A bone screw, comprising:
an external screw thread; and
an internal supporter structure disposed inside a middle part of the external screw thread, wherein the internal supporter structure is a polygonal wall supporter having apertures.

8. The bone screw according to claim **7**, wherein the polygonal wall supporter comprises an outer wall surface having the apertures.

9. The bone screw according to claim **7**, wherein a material of the external screw thread has a non-porous structure.

10. The bone screw according to claim **7**, wherein a material of the internal supporter structure has a non-porous structure.

11. The bone screw according to claim **7**, further comprising a middle hole passing through an interior of the bone screw.

* * * * *