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(54) Title: MODULAR DENTAL IMPLANT

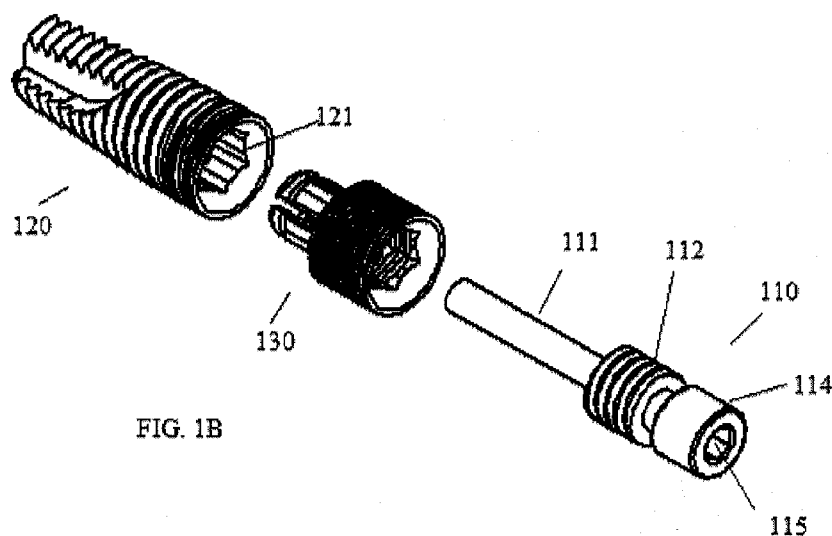


FIG. 1B

(57) Abstract: The present invention relates to a dental modular implant (100) for insertion into a borehole arranged in bone tissue, said implant having a cancellous portion (101), and a cortical portion (102). The modular implant comprises an implant body (120) and at least one removable implant segment (130), said removable implant segment (130) is configured to be coupled to said implant body (120).



MODULAR DENTAL IMPLANT

BACKGROUND OF THE INVENTION

1. Technical Field

The present invention relates generally to the field of endosseous dental implants and more specifically to the field of endosseous screw type dental implants.

2. Description of the Related Art

Screw type implants are implants having threaded outer surfaces and used as anchoring members for different prostheses, such as dental and orthopedic prostheses. This type of implant is screwed into a borehole arranged in the bone tissue of a bone tissue structure at a site where a prosthesis is required. The borehole may be formed into a shape generally corresponding to the shape of the implant, although slightly smaller in size. These implants may be provided with self-cutting edges to cut one or more internal threads in the inner wall of the borehole during the screwing in of the implant. If there are no self-cutting edges, the bore must be internally threaded before insertion of the implant.

Bone tissue has two components, cancellous bone tissue and cortical bone tissue. The major part of a bone usually is built up with the cancellous bone tissue, which is a relatively soft tissue in the interior of the bone. The cortical bone tissue is harder and normally forms a relatively thin layer surrounding the cancellous bone. Thus, in their final position, screw implants of the type described would typically be in contact with cancellous bone tissue along a larger part of its length, and with cortical bone tissue only at a shorter portion at one end of the implant.

When a screw type implant is in anchored position in the bone tissue, a superstructure for carrying a prosthetic part may be secured to the implant. In the case when a screw implant is

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used to secure a dental prosthesis, the superstructure will typically comprise an abutment or transmucosal component, which engages the implant to bridge the gingiva overlaying the maxilla or mandible at the implant site. The prosthetic part, e.g. a crown, a bridge or a denture is then secured to the abutment. The implant could also be formed integrally with a superstructure, such as a transgingival component, on which for example a crown is directly secured. A problem occurring when using many prior art screw type implants is referred to as the bone resorption problem. Bone resorption is a term used for a process in which, once an implant is installed in the bone tissue, the bone surrounding the implant tends to degenerate. This is highly undesired, since a diminished amount of bone surrounding the implant will lead to diminished stability and sometimes result in failure of the prosthesis. This is particularly the case because bone resorption primarily occurs in the cortical bone, which, as mentioned above, is the hardest part of the bone. Once bone resorption exists, secondary problems may also appear. Such secondary problems, particularly related to dental implants, are for example deposition of plaque, resulting in inflammation in the gingival tissue surrounding the implant, or down-growth of gingival tissue along the exposed end of the implant. Also, the aesthetic appeal of the implant is undermined by bone tissue resorption, which is an important drawback in particular when the implant is intended for dental applications since dental prosthesis form part of the field of cosmetic surgery.

SUMMARY OF THE INVENTION

The objective of the invention is to provide a well-functioning implant in a number of important aspects, such as providing stable primary fixation, initial stability and proper loading of the bone tissue.

The above mentioned object is achieved by a modular implant for insertion into a borehole arranged in bone tissue. Said implant having a cancellous portion, and a cortical portion having an axial length such that, when installed in the borehole, the engagement of said cortical portion with the bone tissue will generally be confined to the cortical bone tissue layer. Said cortical portion comprise one or more removable segments and presents an outer surface that is threaded for accomplishing said engagement, and has an outer design such that, when being screwed into

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said borehole under the action of a screwing torque, said cortical portion acts to increase the compression of the cortical bone tissue only.

A modular implant comprises an implant body and one or more removable implant segments, wherein said removable segments are adapted to be engaged or coupled with the implant body and with each other, by a snap lock mechanism. This modular implant has been previously unknown in the art and its manufacturing was not technically feasible up to date.

In a case when an upper part of the cortical portion of the implant is exposed due to bone resorption, the removable implant segment is removed, thus leaving a shorter implant inside the bone, without any exposed portions.

The term "cortical bone engagement portion" is used to define a portion of the implant that, in an implanted state, would mainly be engaged with the cortical bone tissue layer. For simplicity, the term will hereinafter in the description and in the claims be referred to as "cortical portion". Similarly, the term "cancellous bone engagement portion" will be referred to as "cancellous portion" and refers to a portion of the implant that is engaged mainly with cancellous bone tissue.

For accomplishing the engagement of the cortical portion with cortical bone, the cortical portion is provided with a threaded outer surface. With "threaded" is meant a surface allowing the portion to function as a screw. Thus, any surface having a helical arrangement fulfilling this purpose would be confined in the term "threaded", for example a surface having a series of discontinuous protrusions, subsequently following ribs or a conventional thread. At present, a surface presenting a conventional thread seems to be the most advantageous alternative.

The threaded surface is useful in that its engagement with the cortical bone tissue will increase the friction between the cortical bone and the implant, thus contributing to the distinct rise in screwing torque needed when the cortical portion is screwed into the borehole. Owing to this effect, the compression of cortical bone tissue can be held smaller than what would be necessary if a smooth surface was used, which is advantageous as discussed above. Furthermore, during screwing in of the implant, the threaded surface urges the cortical portion down into the

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borehole, compressing the cortical tissue in essentially radial directions. Without the threaded surface, there might be an increased risk that forces from the bone tissue that counteract the screwing in of the cortical portion overcoming the forces urging the cortical portion downwardly. In that case, the screwing torque applied to the implant would act only to rotate the implant, but not to advance it in a longitudinal direction, whereby internal threads cut in the borehole may be damaged.

Another advantage with threaded surfaces is that they have been shown to be beneficial to bone tissue ingrowth and are useful to enable proper load distribution to the surrounding bone tissue. Due to the load distribution function, they are useful to stimulate bone growth and inhibit marginal bone resorption. Also, the threaded outer surface of the cortical portion will contribute to the primary fixation and initial stability of the implant.

Returning to the definition of the cortical and cancellous portions of the implant, normally, an implanted screw implant is in contact with both cancellous bone tissue and cortical bone tissue. However, since the cortical bone tissue constitutes a relatively thin layer around the bone, the major part of the length of a screw implant is in contact with the cancellous bone. Thus, the length of the cortical portion of an implant is relatively short in relation to the implant length, as it should largely correspond to the thickness of the cortical bone tissue layer. Said thickness varies with the type of bone, the implantation site, and individually from patient to patient. A normal thickness would be around 0.5-1 mm. to 3 mm.

When discussing cortical and cancellous tissue in this application, reference is made to normal cases of bone tissue structures, as described above. There are however unusual cases, where the bone comprises almost only cortical tissue. The unusual cases are the result of a process of transformation of the bone tissue, which might occur in particular regarding the lower jaw in patients that have used loose overdentures for a long time. The implant of the invention primarily is designed to be useful for the normal cases, although it may also function when used for the unusual cases.

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Throughout the description and the claims, any reference to directional terms as "up" and "down" and related terms such as top, bottom, below etc. referring to the implant should be interpreted as "up" meaning towards the head end or trailing end, i. e. the coronal end of the implant, and "down" meaning towards the insertion end, i. e. the apical end of the implant. Thus, the "lower part" of the implant would refer to the part that would first be introduced into a borehole. Obviously, this does not constitute any restriction regarding in what actual directions the implant may be implanted and used.

The cortical portion of an implant according to the invention would be positioned at the uppermost end of the implant, so to be in engagement with the cortical bone tissue when the implant is in its final position.

BRIEF DESCRIPTION OF THE DRAWINGS

By way of example, embodiments of the present invention will now be described with reference to the accompanying figures of drawings in which:

FIG. 1A is a perspective view of an embodiment of the modular dental implant of the invention.

FIG. 1B is an exploded view of an embodiment of the modular dental implant of the invention.

FIG. 1C is a cross-sectional view of an embodiment of the modular dental implant of the invention.

FIG. 2A is a perspective view of an implant segment of an embodiment of the modular dental implant of the invention.

FIG. 2B is a cross-sectional view of an implant segment of an embodiment of the modular dental implant of the invention.

FIG. 2C is a cross-sectional view of an embodiment of the modular dental implant of the invention.

FIG. 2D is a cross-sectional view of a snap lock latching mechanism of the modular dental implant of the invention.

FIG. 3A is a cross-sectional exploded view of another embodiment of the modular dental implant of the invention.

FIG. 3B is an exploded view of another embodiment of the modular dental implant of the invention.

FIG. 4 is a flowchart illustrating a method for adjusting the length of the modular dental implant according to some embodiments of the invention.

DETAILED DESCRIPTION

In the following detailed description of the invention, numerous specific details are set forth in order to provide a thorough understanding of the invention. However, it will be obvious to one skilled in the art that the invention may be used without these specific details. In other instances well-known methods, procedures, components, and elements are not described here in detail so as not to unnecessarily obscure aspects of the invention. It will be readily understood that the components of the present invention, as generally described and illustrated in the figures, may be arranged and designed in a wide variety of different configurations. Thus, the following more detailed description of the embodiments of the apparatus and methods of the present invention, as represented in the figures, is not intended to limit the scope of the invention, but is merely representative of selected embodiments of the invention.

FIG. 1A is a perspective view of a modular dental implant **100**, according to an embodiment of the invention. The modular dental implant **100** includes an implant body **120** and one or more implant segments **130** connected to the cortical portion of the implant body **120**. The multiple implant segments **130** can be connected to each other in a coaxial manner wherein an upper portion of one segment is located above an upper portion of the other.

The modular dental implant **100** has a generally tapered or conic like shape. It may include a plurality of cutting recesses or grooves **103** circumferentially distributed about the circumference of the apical end of the modular dental implant **100** for self-tapping of the modular dental implant **100** when being screwed into the borehole drilled in the bone tissue of a maxilla or mandible. If the modular dental implant **100** is not provided with cutting recesses **103**, the borehole may be internally threaded before the implant is inserted.

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The modular dental implant **100** also contains a threaded cancellous portion **101** having an axial length such that, when installed in the borehole, the engagement of the threaded cancellous portion **101** with the bone tissue will generally be confined to the cancellous bone tissue layer. It also has a threaded cortical portion **102** having an axial length such that, when installed in the borehole, the engagement of the threaded cortical portion **102** with the bone tissue will generally be confined to the cortical bone tissue layer.

The threaded portions **101** and **102** may comprise a single thread or preferably multiple threads, for example double, triple or quadruple threads. Threads **105** are sometimes called "micro-threads" and have been shown to be particularly advantageous when provided on the upper part of dental implants, where their presence inhibits marginal bone resorption.

The external threads **104** and **105** include a progressively changing profile. At the apical end of the modular dental implant **100**, the thread **104** is sharp and narrow in order to facilitate cutting and self-tapping into the bone. As the thread **104** progresses toward the implant's cortical portion **102**, it becomes increasingly broader or wider in its cross-sectional profile. Similarly, at the start of the cortical portion, the thread **105** is sharp and narrow in order to facilitate cutting and self-tapping into cortical bone. As the thread **105** progresses toward the implant's coronal end, it becomes increasingly broader or wider in its cross-sectional profile. The increasing breadth of threads **104** and **105** facilitates compression of cortical and cancellous bone that was previously tapped by the sharp coronal thread profiles. Bone compression increases the stability of the implant.

According to an embodiment of the invention, the implant segment **130** includes a polygonal (which may be a hexagonal) connector **131**, positioned on the base **140** of the implant segment **130**. The polygonal connector **131** tightly fits into a corresponding polygonal socket **121** of the implant body **120**, the socket **121** has the same cross-section as the connector **131**. The connector **131** and the socket **121** however may have a shape other than a polygonal shape.

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The polygonal connector **131** is comprised of a plurality of bendable sections **133**, separated from each other by a slot **138**. The sections **133** create the polygonal shape of the connector **131**.

Upon the insertion of the connector **131** into the socket **121**, the implant segment **130** is secured to the implant body **120** by a snap lock mechanism activated between the socket **121** and the connector **131**. The snap lock mechanism comprises an annular protrusion **123** located inside the implant body bore **122** and below the socket **121**, and an annular groove **134** located on the outer surface of the connector **131**, near its end. The annular protrusion **123** is configured to be fitted into the annular groove **134** of the connector **131**.

The snap lock mechanism is also used to connect the implant segments **130** to each other. In this case a snap connection is made between an annular groove **134** of the polygonal connector **131** and an annular protrusion **136** located below a threaded socket **139**, upon insertion of the polygonal connector **131** into the corresponding threaded polygonal socket **139** of another implant segment **130**.

The implant segment **130** also includes a threaded bore **135** located below the threaded polygonal socket **139**. The threaded bore **135** is used for connecting a healing screw **140** to the implant **100**. The threaded polygonal socket **139** is used for insertion of a driver key **110**. The driver key **110** is used for extraction of the implant segment **130** from the implant body **120**. The rotation of the threaded portion **112** of the driver key **110** inside the socket thread **137** forces the driver key shaft against the bottom surface of the implant body bore **122**, thus creating an opposite force acting upon the implant segment **130** and causing its extraction from the implant body **120**.

FIG. 3B is a perspective view of a modular dental implant **300** comprising an implant body **310** and an implant segment **320**, according to another embodiment of the invention. According to an embodiment of the invention the implant **300** comprises an annular seal **330** (for example O-ring) which could be manufactured from biocompatible material, such as (but not limited to) biocompatible polymer, medical silicone rubber or fluoropolymer.

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The seal **330** is positioned in an annular depression **321** of the implant segment **320**. When the implant segment **320** is fastened to the implant body **310**, the seal **330** is compressed against a sealing surface **311** of the implant body **310**, thus creating a sealing between the implant body **310** and the implant segment **320**.

If however the implant segment **320** is fastened to another implant segment **320**, the seal **330** is compressed against a sealing surface **322** of the implant segment **320**, thus creating a sealing between the first and the second implant segments **320**.

The seal **330** prevents entry of foreign matter into the interior of the implant **300**.

The present invention also comprises a method **400** for adjusting the length of the modular dental implant, when it already positioned in the bone tissue.

The method **400** starts with a stage **410** of conducting visual/X-ray/CT examination of the implant site.

Stage **410** is followed by stage **420** of detecting a bone resorption. If bone resorption is detected, the stage **420** is followed by stage **430** of removing the prosthesis and the abutment from the examined implant. If bone resorption is not detected, the stage **420** is followed by stage **460** of moving to the next implant site for conducting an examination. Stage **430** is followed by stage **440** of removing one or more implant segments until the most of the remaining implant length is covered with a bone tissue. Stage **440** is followed by stage **450** of fitting an abutment and a prosthesis to the remaining implant.

The implants **100**, **300** may be manufactured from commercially pure titanium, a titanium alloy, another biocompatible metal or metal alloy, or a ceramic to promote osseointegration of the implants with the bone tissue of the boundary walls of the borehole.

The length of the implants **100**, **300** is preferably between 6-16 mm. and the width is preferably between 3-6 mm. The distance between each thread of the cancellous portion is 0.6-1.6 mm. The distance between each thread of the micro-thread is 0.3 mm. or lower.

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Although illustrative embodiments have been shown and described, a wide range of modification change and substitution is contemplated in the foregoing disclosure and in some instances, some features of the embodiments may be employed without a corresponding use of other features. Accordingly, it is appropriate that the appended claims are construed broadly and in a manner consistent with the scope of the embodiments disclosed herein.

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WHAT IS CLAIMED IS:

1. A modular dental implant having a cancellous portion and a cortical portion, and comprising:
 - a. an implant body having a bore and a polygonal socket;
 - b. a plurality of implant segments, wherein each implant segment comprises a polygonal socket located in the upper part of the implant segment and a polygonal connector positioned on the base of the implant segment; and wherein the polygonal connector is comprised of at least two bendable sections separated from each other by a slot; and wherein said implant segments are connected to each other and to said implant body by a snap lock mechanism.
2. A modular dental implant of claim 1, additionally comprising an annular seal positioned between the implant body and the implant segment.
3. A modular dental implant of claim 2, additionally comprising an annular seal positioned between each successive implant segment.
4. A modular dental implant of claim 3, wherein said annular seal is made from biocompatible polymer.
5. A modular dental implant of claim 3, wherein said annular seal is made from silicone rubber.
6. A modular dental implant of claim 3, wherein said annular seal is made from fluoropolymer.
7. A modular dental implant of any one of the previous claims, wherein the cortical portion is a threaded cortical portion, and wherein at the start of the cortical portion the thread is sharp and narrow and as the thread progresses towards the implant's coronal end it becomes increasingly wider in cross-sectional profile.
8. A modular dental implant of claim 7, wherein the threaded cortical portion is a multiple threaded portion.
9. A modular dental implant of any one of the previous claim, wherein the snap lock mechanism comprises an annular protrusion and an annular groove, and wherein the annular protrusion is configured to be fitted into the annular groove.

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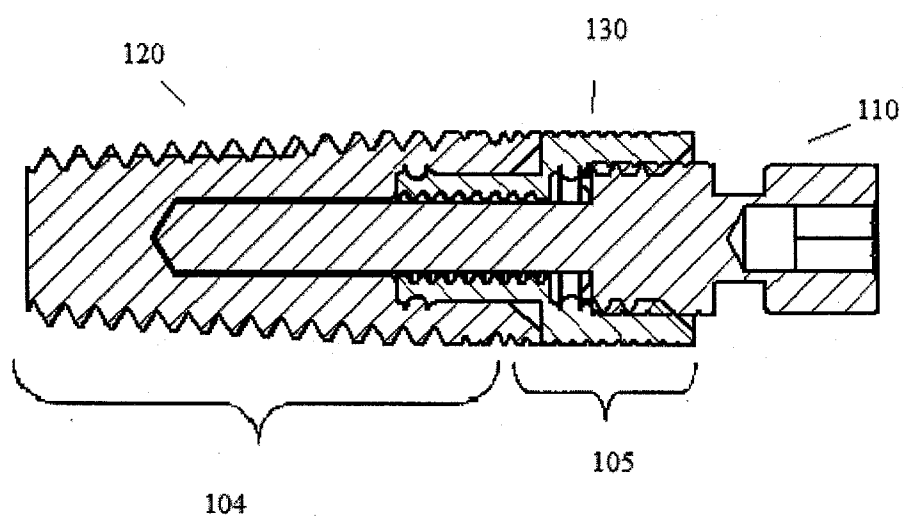
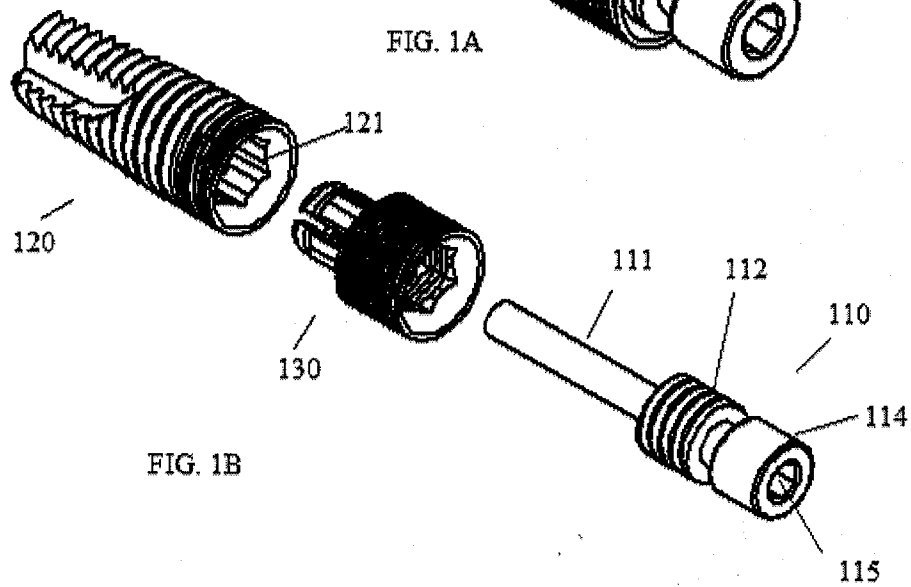
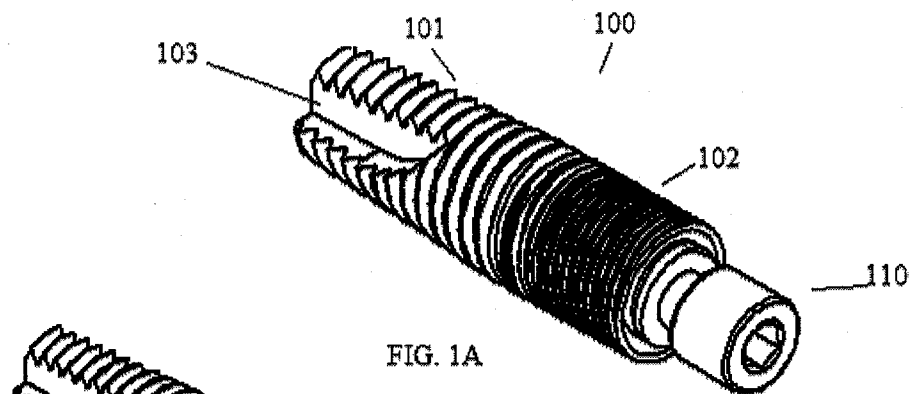
10. Method for adjusting the length of the modular dental implant comprising steps of:

- a. detecting a bone resorption from the implant site;
- b. removing one or more of the implant segments from the dental implant till the most of the remaining implant length is covered with the bone tissue.

11. Method for adjusting the length of the modular dental implant comprising steps of:

- a. detecting a bone resorption from the implant site;
- b. removing the prosthesis and the abutment from the implant;
- c. removing one or more of the implant segments from the dental implant till the most of the remaining implant length is covered with the bone tissue;
- d. fitting a prosthesis and an abutment to the remaining implant.

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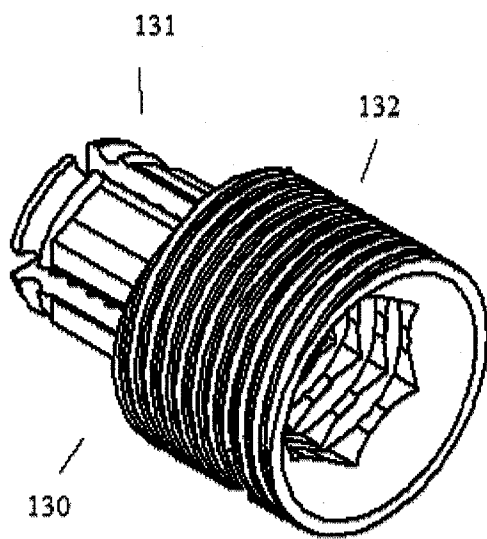


FIG. 2A

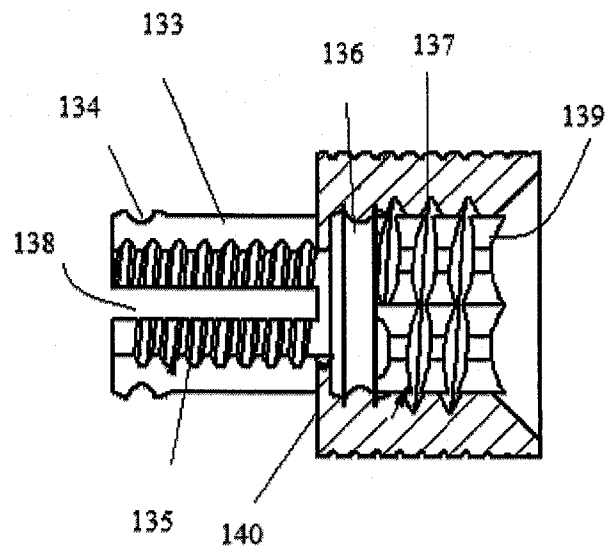


FIG. 2B

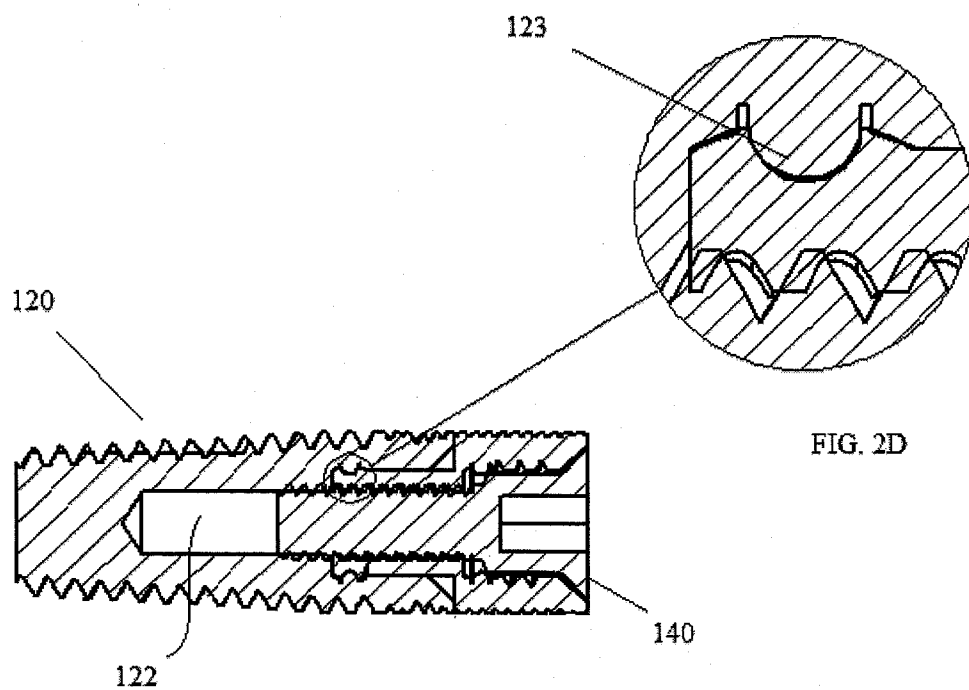
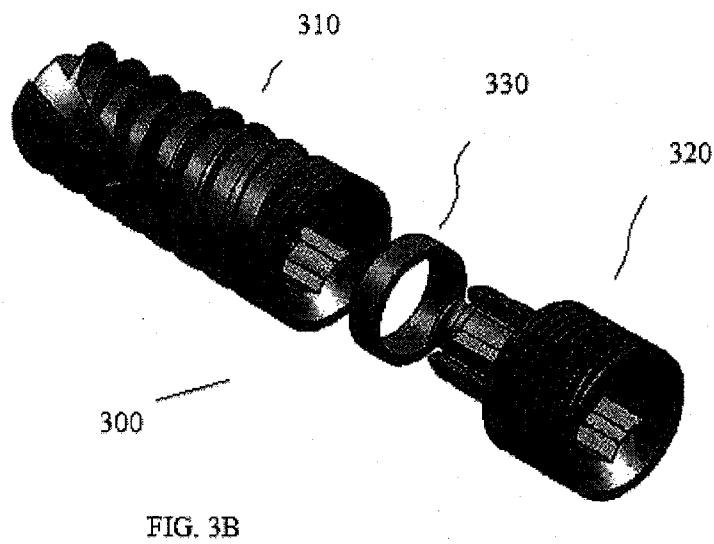
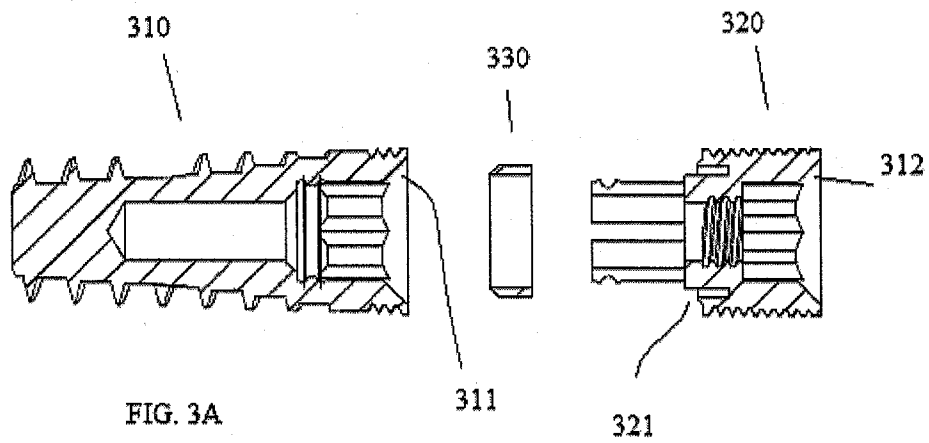


FIG. 2D

FIG. 2C



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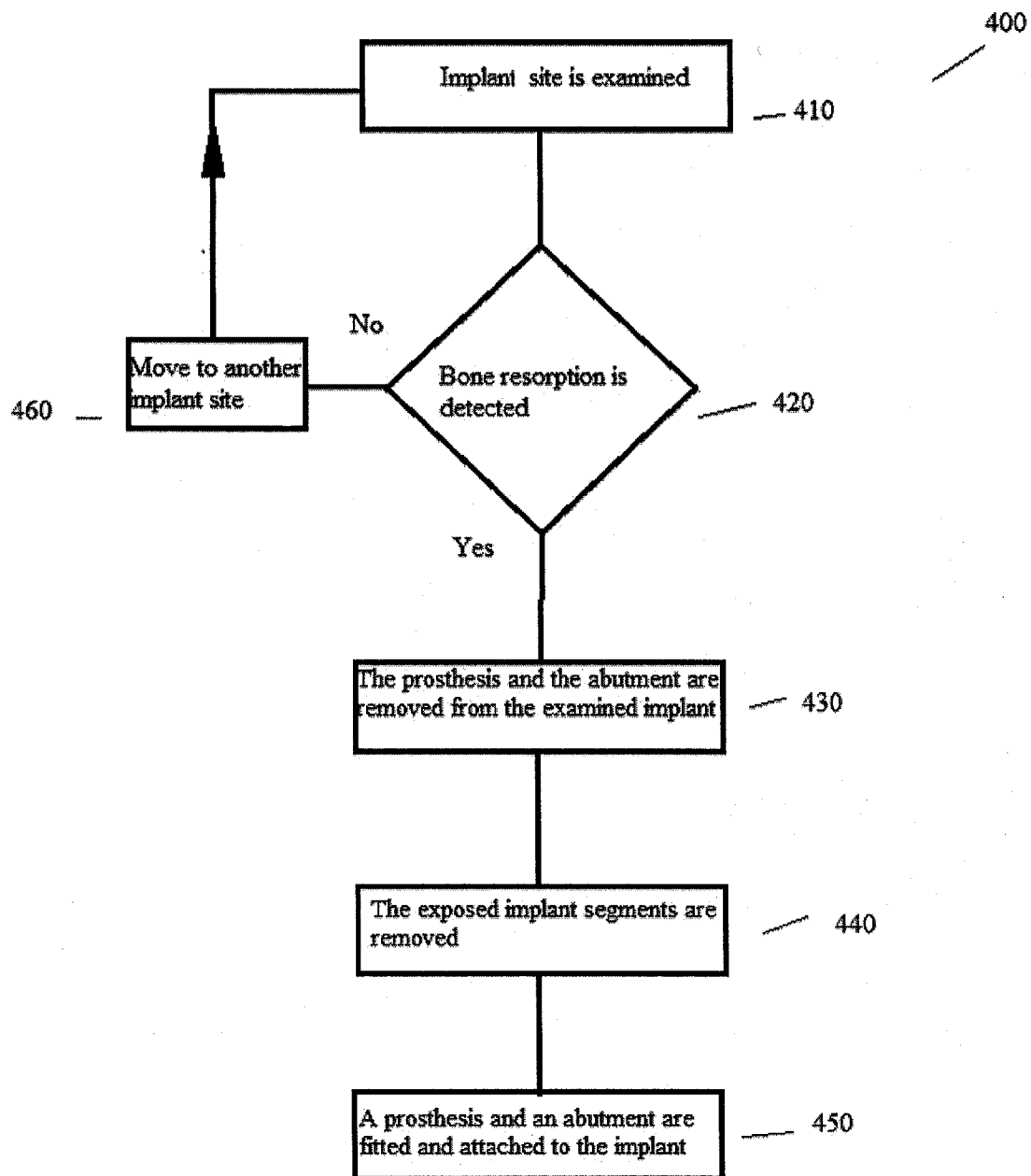


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IL2012/000227

A. CLASSIFICATION OF SUBJECT MATTER

IPC (2012.01) A61C 8/00

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)

IPC (2012.01) A61C

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 practicable, search terms used)

Databases consulted: THOMSON INNOVATION, Esp@cenet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2011/0189634 A1 KFIR P. 04 Aug 2011 (2011/08/04) paragraphs [0028], [0032]-[0036], [0039], [0043]; figures 1-4, 9-10, 14	1-11
Y	US 5782918 A KLARDIE R. M. et al. 21 Jul 1998 (1998/07/21) column 1, lines 46-55; column 2, lines 44-49; column 4, lines 22-31, 35-37; figures 1, 2	1-9
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A	US 7281926 B2 YAKIR M. 16 Oct 2007 (2007/10/16) whole document	1



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

12 Sep 2012

Date of mailing of the international search report

12 Sep 2012

Name and mailing address of the ISA:

Israel Patent Office

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INTERNATIONAL SEARCH REPORT
Information on patent family members

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