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(54) **FABRICATION AND INSTALLATION OF A DENTAL IMPLANT**

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See application file for complete search history.

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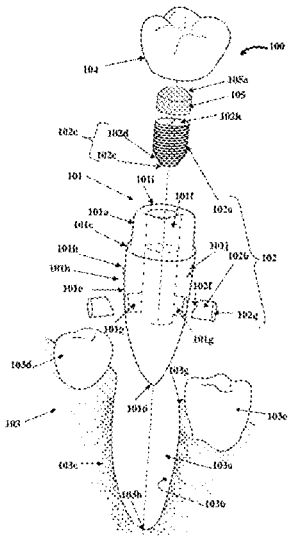
(57) **ABSTRACT**

A dental implant for supporting periodontal tissue and the supporting bone is provided. The dental implant includes an implant member for insertion into a periodontal bone socket, and an anchoring assembly. The anchoring assembly includes a fastening element and radially equidistant cylindrical members. The fastening element engages the implant member within the hollow axial cavity. The root section includes through-holes for radially and forcibly sliding the cylindrical members through them. When the fastening element apically advances within the hollow axial cavity, the cylindrical members generate an anchoring force to anchor the dental implant.

10 Claims, 12 Drawing Sheets



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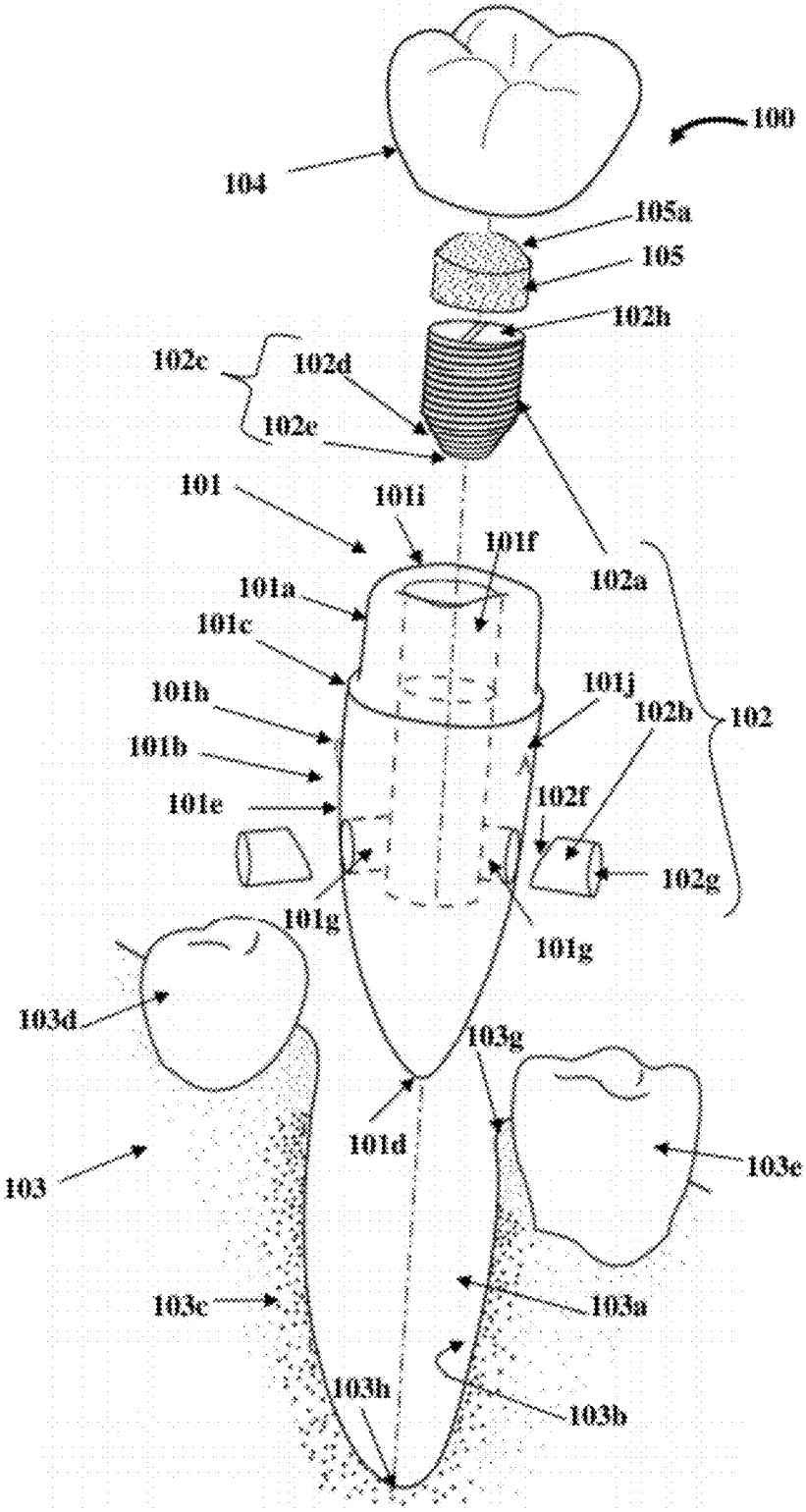
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101b
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103b

FIG. 1A

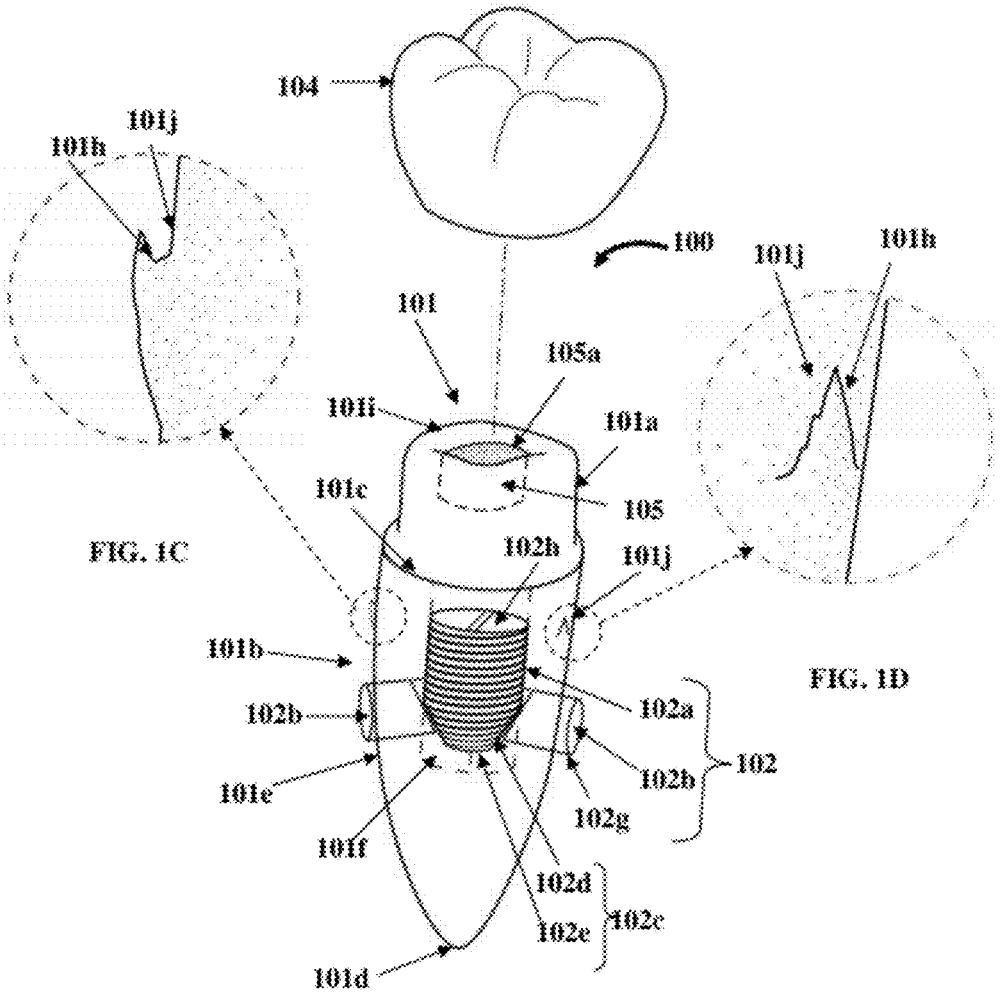
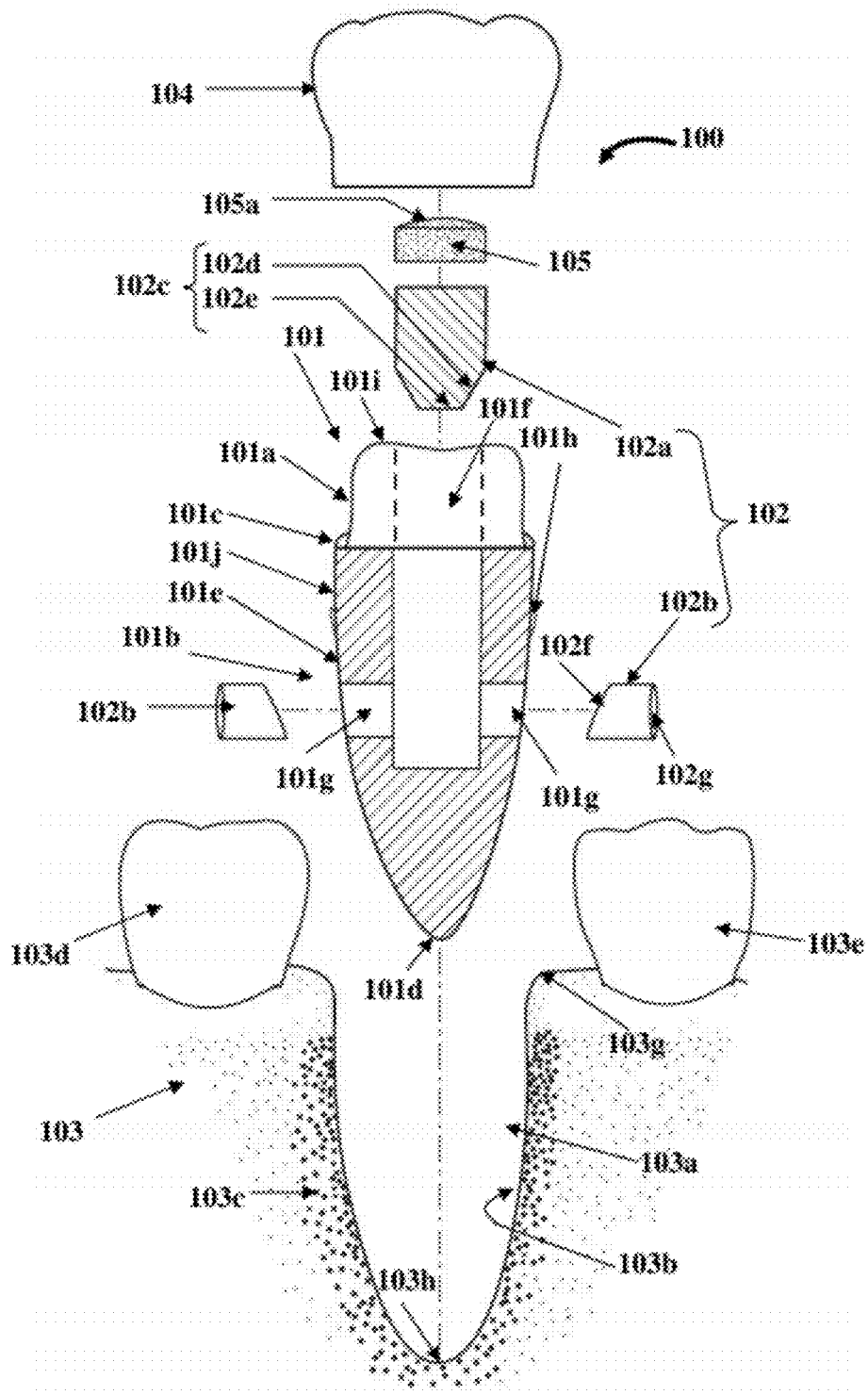


FIG. 1B

FIG. 1C

FIG. 1D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101b
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103g
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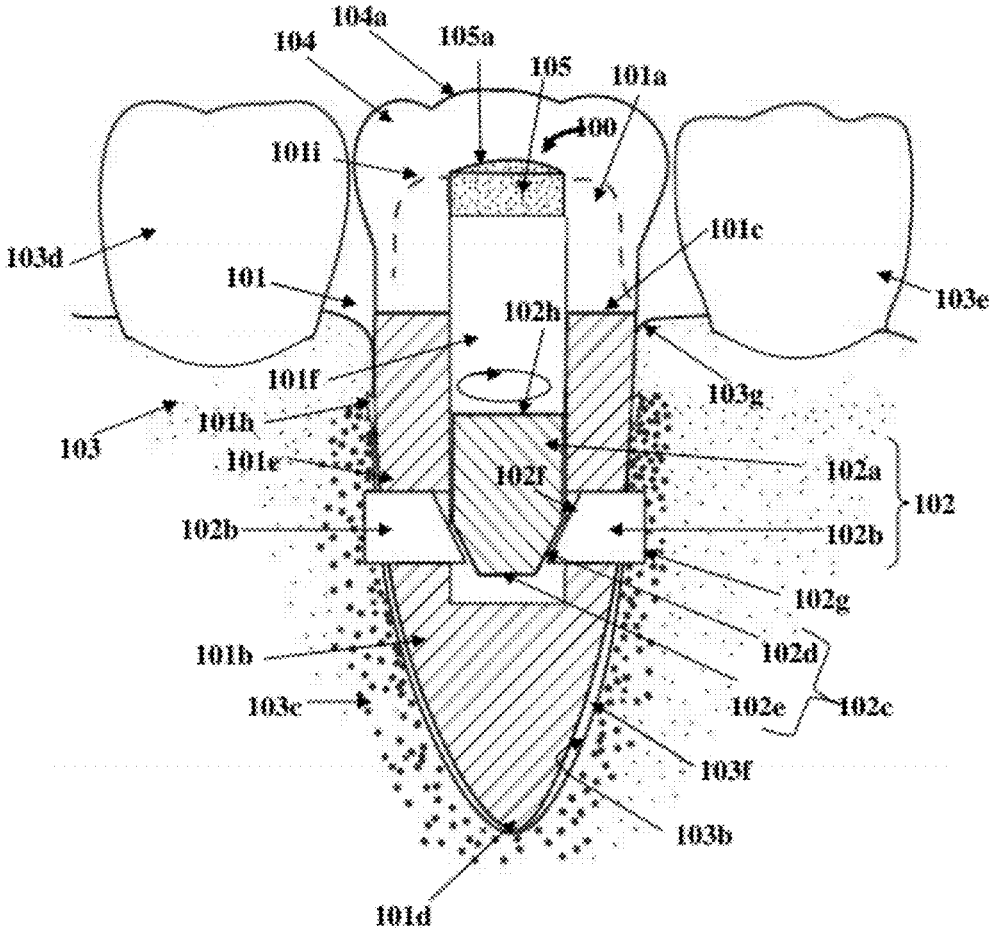
103a
103c
103b
103h

FIG. 1E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103c
102e
102c
103f
103b
101d

FIG. 1F

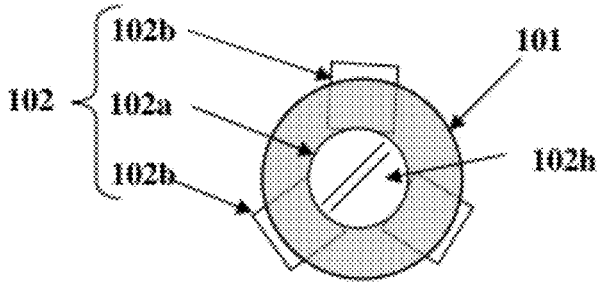


FIG. 1G

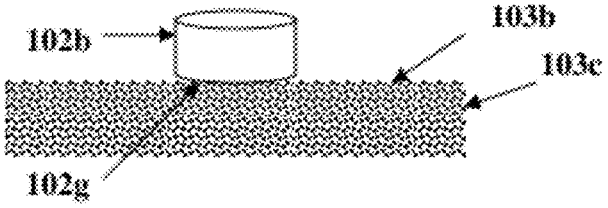


FIG. 2

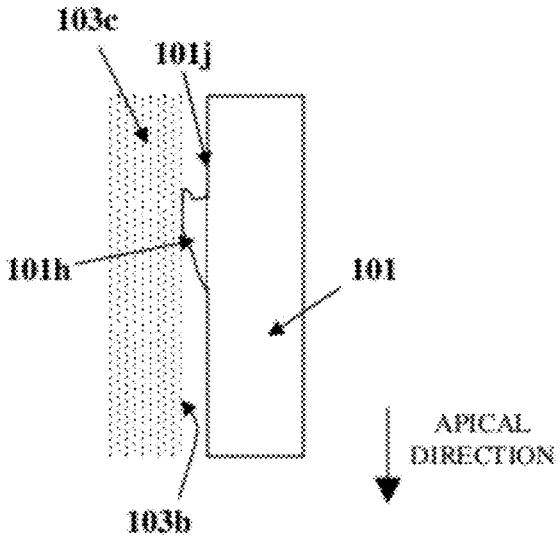


FIG. 3A

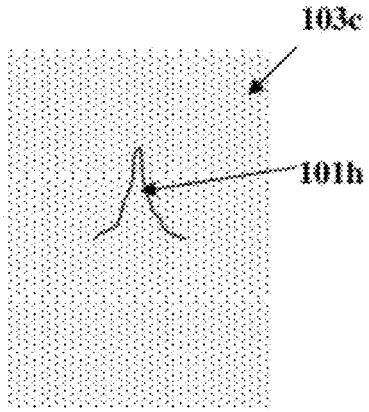


FIG. 3B

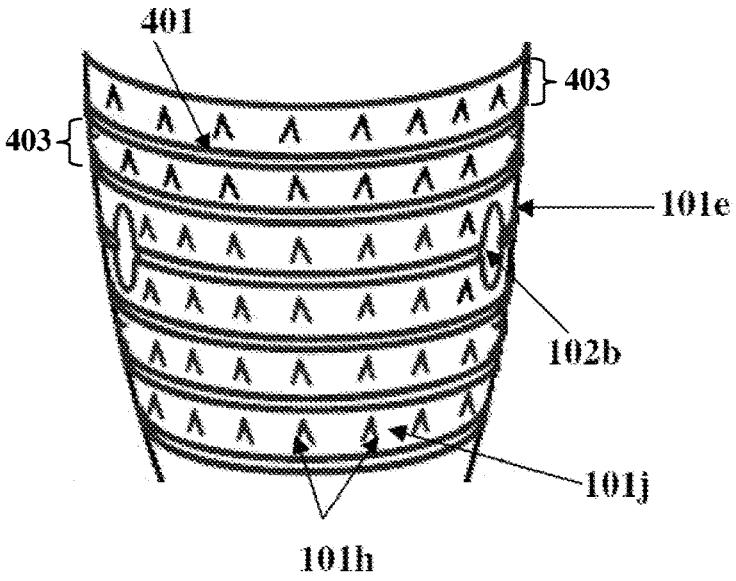


FIG. 4A

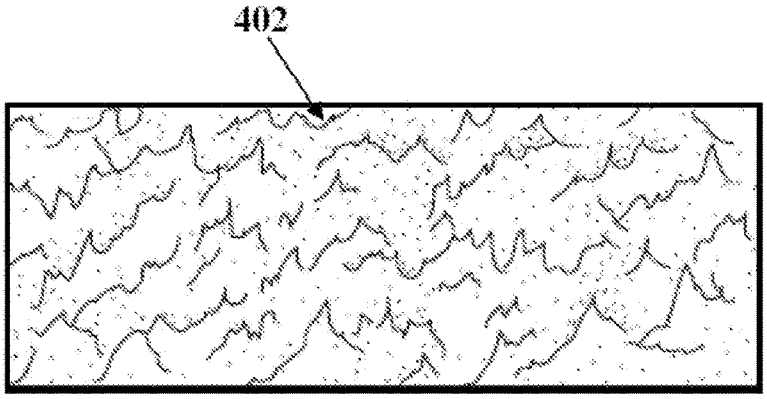
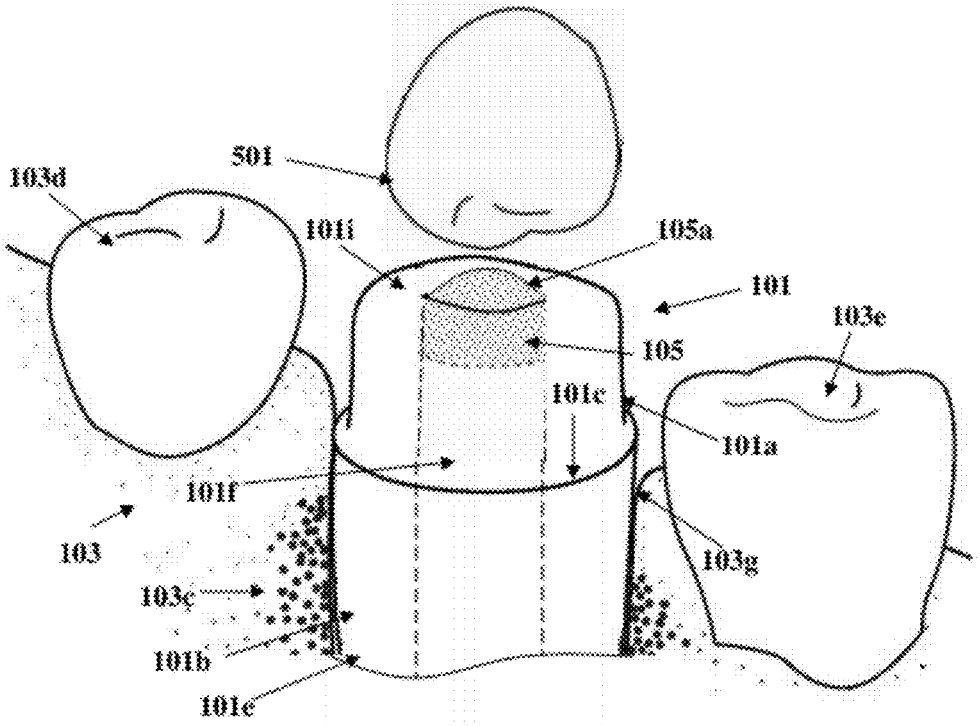


FIG. 4B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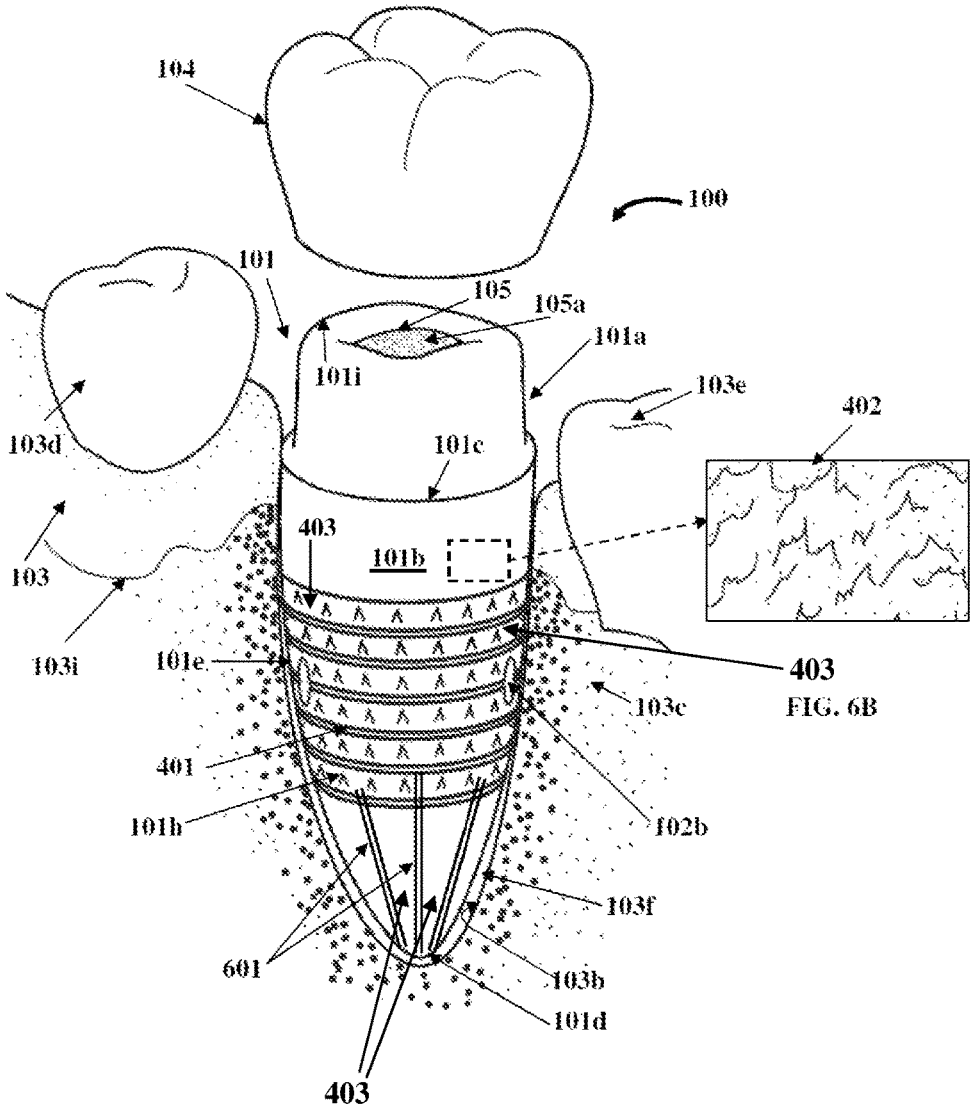
103c
101b
101e

FIG. 5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103d
101c
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101b
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403
103c
401
101h
102b
103f
601
103b
101d
403

FIG. 6B

FIG. 6A

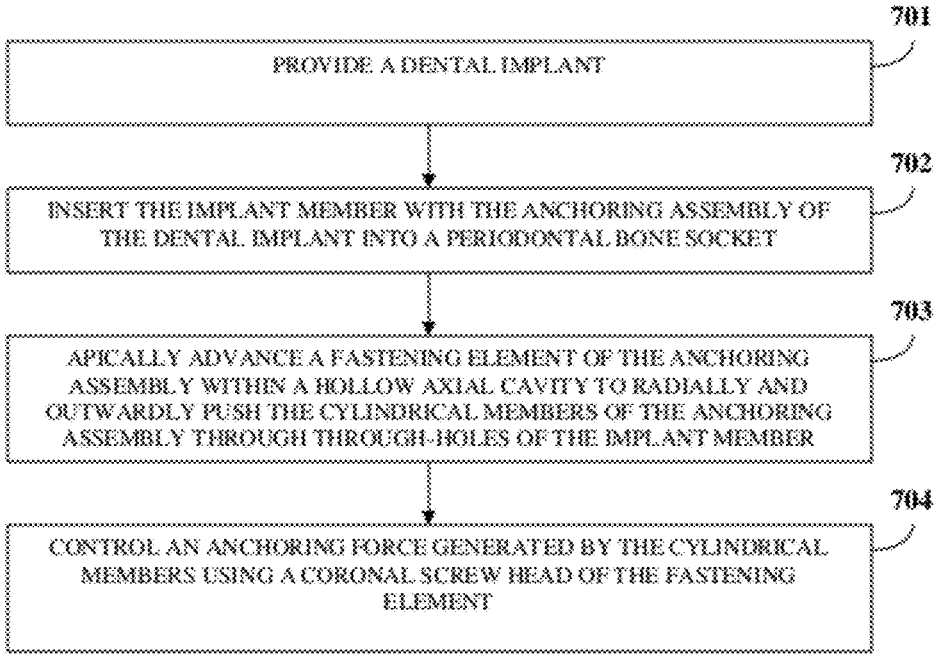
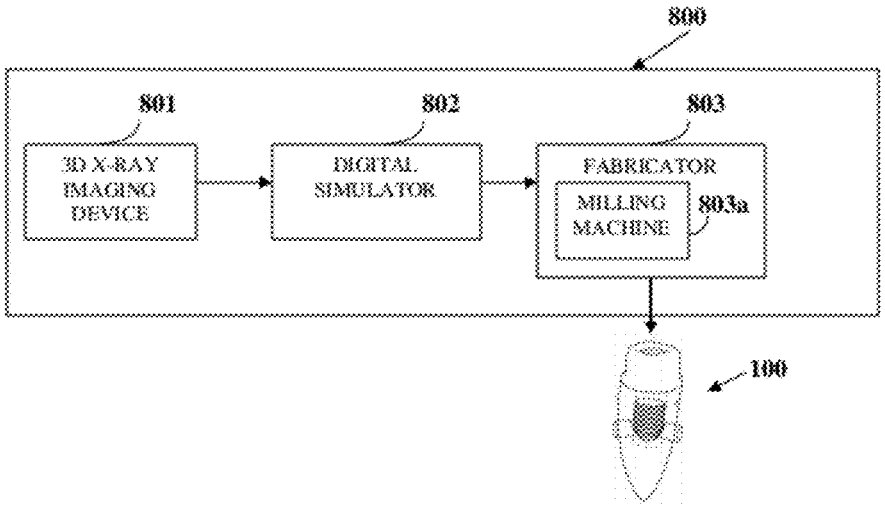

701
PROVIDE A DENTAL IMPLANT
702
INSERT THE IMPLANT MEMBER WITH THE ANCHORING ASSEMBLY OF THE DENTAL IMPLANT INTO A PERIODONTAL BONE SOCKET
703
APICALLY ADVANCE A FASTENING ELEMENT OF THE ANCHORING ASSEMBLY WITHIN A HOLLOW AXIAL CAVITY TO RADIALLY AND OUTWARDLY PUSH THE CYLINDRICAL MEMBERS OF THE ANCHORING ASSEMBLY THROUGH THROUGH-HOLES OF THE IMPLANT MEMBER
704
CONTROL AN ANCHORING FORCE GENERATED BY THE CYLINDRICAL MEMBERS USING A CORONAL SCREW HEAD OF THE FASTENING ELEMENT

FIG. 7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801
802
803
3D X-RAY IMAGING DEVICE
DIGITAL SIMULATOR
FABRICATOR
MILLING MACHINE
803a
100

FIG. 8

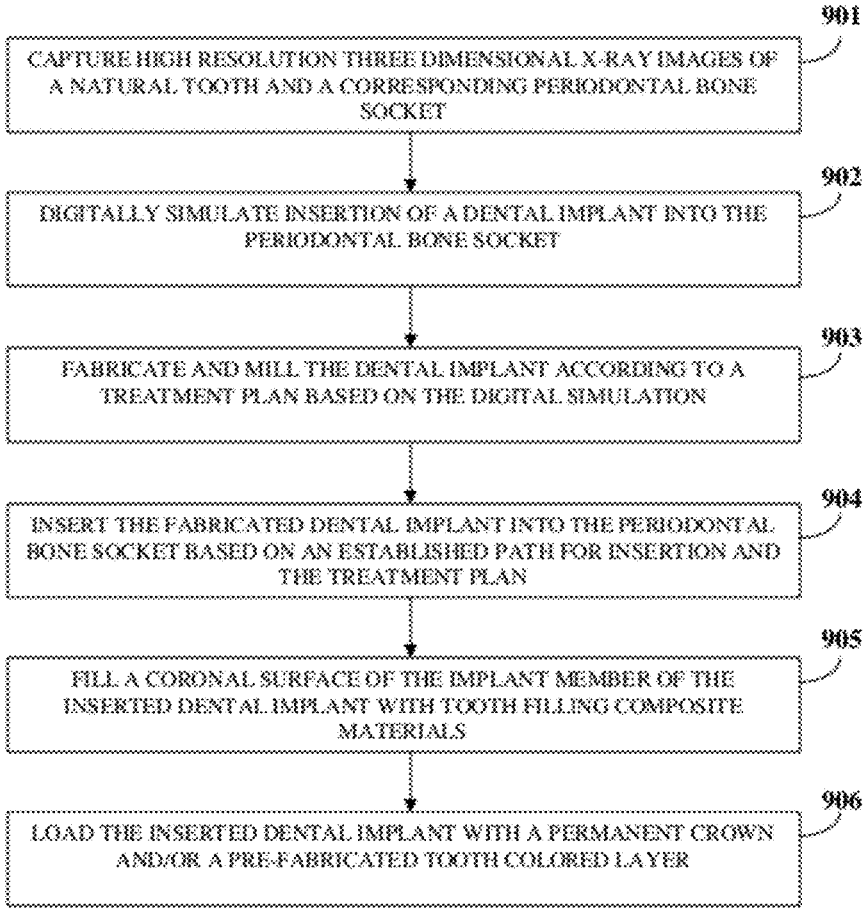
901
CAPTURE HIGH RESOLUTION THREE DIMENSIONAL X-RAY IMAGES OF A NATURAL TOOTH AND A CORRESPONDING PERIODONTAL BONE SOCKET
902
DIGITALLY SIMULATE INSERTION OF A DENTAL IMPLANT INTO THE PERIODONTAL BONE SOCKET
903
FABRICATE AND MILL THE DENTAL IMPLANT ACCORDING TO A TREATMENT PLAN BASED ON THE DIGITAL SIMULATION
904
INSERT THE FABRICATED DENTAL IMPLANT INTO THE PERIODONTAL BONE SOCKET BASED ON AN ESTABLISHED PATH FOR INSERTION AND THE TREATMENT PLAN
905
FILL A CORONAL SURFACE OF THE IMPLANT MEMBER OF THE INSERTED DENTAL IMPLANT WITH TOOTH FILLING COMPOSITE MATERIALS
906
LOAD THE INSERTED DENTAL IMPLANT WITH A PERMANENT CROWN AND/OR A PRE-FABRICATED TOOTH COLORED LAYER

FIG. 9

FABRICATION AND INSTALLATION OF A DENTAL IMPLANT

BACKGROUND

Dental implant therapy offers a method for restoring non-restorable teeth and endentulous dental sites in patients. Most dental implant systems hitherto require surgeries to drill precise pre-designed implant space such that an identically shaped prefabricated dental implant can be inserted into the implant space. Surgically preparing the implant space requires extensive diagnostic planning, invasive surgery, and an extended healing time. If the planned implant sites are close to the sinus or the nerve canal, the placement of the dental implant is unsuitable, and extensive bone graft surgery is generally required to build a suitable implant site before the dental implant can be inserted. Moreover, the invasive surgery may damage the periodontal tissue and supporting bone, and may occasionally result in the potential loss of stability and retention of the dental implant.

Hence, there is a long felt but unresolved need for a method and system for fabricating and installing a dental implant that allows preservation of the supporting periodontal tissue and the supporting bone while maximizing retention and stability of the dental implant.

SUMMARY OF THE INVENTION

This summary is provided to introduce a selection of concepts in a simplified form that are further described in the detailed description of the invention. This summary is not intended to identify key or essential inventive concepts of the claimed subject matter, nor is it intended for determining the scope of the claimed subject matter.

The method and system for a dental implant disclosed herein addresses the above stated need for fabricating and installing the dental implant that preserves periodontal tissue and the supporting bone in implant sites during installation and that maximizes the retention and stability of the installed dental implant. The method and system disclosed herein enables fabrication and non-invasive installation and restoration of the dental implant, preferably in one clinical appointment in a single patient visit, and thus also avoids extensive planning, invasive surgery, and long healing time.

The dental implant disclosed herein comprises an implant member for insertion into a periodontal bone socket of an extracted natural tooth, and an anchoring assembly. The implant member substantially resembles a natural tooth. The implant member comprises a coronal section and a root section. The root section of the implant member comprises a coronal end, a mid portion, and a conical apical end. The coronal section axially extends from the coronal end of the root section. The implant member further comprises multiple hook shaped extensions circumferentially disposed around the root section of the implant member. The anchoring assembly is positioned within a hollow axial cavity of the implant member. The anchoring assembly anchors the implant member within the periodontal bone socket. The anchoring assembly comprises a fastening element and one or more radial and equidistant cylindrical members. The fastening element is engaged with the implant member and positioned within the hollow axial cavity. The fastening element comprises an apical section having a conical shaft and a truncated end. The radial and equidistant cylindrical members of the anchoring assembly are positioned proximal to the root section of the implant member. The root section of the implant member comprises one or more through-holes for radially and forcibly sliding the cylindrical members through the through-holes. Each of the cylindrical members comprises a first end that interfaces with the conical shaft of the fastening element, and a second end that interfaces substantially uniformly against a surface of the periodontal bone socket, for example, the surface of the surrounding bone socket, herein referred to as the "periodontal bone surface".

In an embodiment, the fastening element is threaded to screwably engage the hollow axial cavity of the implant member. The fastening element further comprises a coronal screw head for tightening or releasing the fastening element within the hollow axial cavity. The fastening element apically advances within the hollow axial cavity when the fastening element is tightened by turning the coronal screw head. When the fastening element is apically advanced within the hollow axial cavity of the implant member, the conical shaft of the fastening element radially and outwardly pushes the cylindrical members through the through-holes, whereby the second end of each of the cylindrical members presses substantially uniformly against the periodontal bone surface to generate an anchoring force to anchor the implant member within the periodontal bone socket. After installation, the fastening element thus enables a dentist to precisely control the anchoring force generated by the cylindrical members using the coronal screw head of the fastening element.

The hook shaped extensions circumferentially disposed around on an outer surface of the root section of the implant member anchor the periodontal bone surface for impeding coronal movement of the inserted implant member within the periodontal bone socket. The outer surface of the implant member is a sandblasted micro-textured surface. The outer surface of the implant member further comprises retentive grooves along a mid portion of the root section of the implant member to increase contact area between the implant member and the periodontal bone surface. New bone tissue can be formed into the space between the retentive grooves to permanently secure the implant member inside the periodontal bone socket. In an embodiment, the implant member further comprises one or more longitudinal grooves parallel to the periodontal bone socket for allowing debris to escape out of the periodontal bone socket during the insertion of the implant member within the periodontal bone socket.

The dental implant disclosed herein further comprises a composite packing filled with tooth filling composite materials. The composite packing is disposed on a coronal surface of the coronal section of the implant member. The composite packing avoids direct occlusal contact of the implant member with the opposing teeth to reduce parafunctional interferences during an osseointegration period of the dental implant. The inserted dental implant is loaded with a permanent crown and/or a pre-fabricated tooth colored layer after the osseointegration period of the dental implant. In an embodiment, temporary crowns are placed during the healing period before the dental implant is bio-integrated with the supporting periodontal bone structure, and thereafter replaced by a permanent crown by either cementation or screws. In case of the temporary crowns, the biting surface is designed to avoid occlusal contact with the opposing teeth surface. An interstitial space is defined between the periodontal bone surface and the outer surface of the implant member after the insertion of the implant member within the periodontal bone socket. This interstitial space is filled, for example, with a bone filler material, an osteogenic material, and antibiotic agents to ensure bone

regeneration and long term stability of the dental implant. The osteogenic material in the interstitial space and the retentive grooves induce bone into the retention grooves of the implant member and ensure long term stability and longevity of the dental implant.

In the method and system disclosed herein for fabricating and installing the dental implant and restoration for a patient, high resolution three dimensional (3D) X-ray images of a natural tooth and a corresponding periodontal bone socket of the natural tooth are captured, for example, before the extraction of the natural tooth. These three dimensional X-ray images of the periodontal bone socket are used to digitally simulate the insertion of the dental implant into the periodontal bone socket to establish a path for inserting the dental implant. The dental implant is fabricated and milled according to a treatment plan based on the digital simulation. The fabricated dental implant is inserted into the periodontal bone socket based on the established path for insertion and the treatment plan. A coronal surface of the coronal section of the implant member of the inserted dental implant is filled with tooth filling composite materials for the osseointegration period of the dental implant. The inserted dental implant is loaded with a permanent crown and/or one or more pre-fabricated tooth colored layers at the end of the osseointegration period of the dental implant.

The dental implant is designed using the high resolution 3D X-ray images of the original shape of the tooth to be extracted and the periodontal bone socket with resolutions of about 30 μm/pixel. This eliminates the need for traumatic surgery to prepare the implant space. The selection of the implant site and the path for insertion of the dental implant are based on the high resolution 3D X-ray images of the periodontal bone socket and the simulation of the insertion of the dental implant into the periodontal bone socket. Human errors in pre-surgical site selection are eliminated, because the odds of encountering a nerve, sinus or a major blood vessel in the socket of the tooth are excluded. The digital simulation also eliminates errors in implant design, site selection, and injury to nerves or blood vessels. If the implant member of the dental implant disclosed herein is positioned within 1000 μm to 2000 μm from the nerve canal, a separation space is planned to place the bone filler materials to maintain a distance of about 1000 μm to 2000 μm between the implant member and the nerve canal. The method and system disclosed herein enables direct placement of implants at implant sites heretofore determined to be unsuited for implants due to insufficient bone thickness such as the upper molar near the sinus floor, etc. The method and system disclosed herein enables the insertion of the dental implant without requiring any bone graft or sinus lift procedures. These and other advantages lead to a dramatic reduction of patient discomfort and clinical cost of the implant procedure. Furthermore, at the completion of the implant procedure according to the method and system disclosed herein, the periodontal bone socket is surrounded by a thicker cortical bone which provides stronger bone support for the dental implant, as opposed to the spongy bone structure supporting traditional implants.

The dental implant is inserted into the periodontal bone socket of the extracted tooth immediately after the atraumatic extraction of the tooth. In an embodiment, the coronal section of the implant member of the dental implant is restored immediately following the implant procedure, for example, at the same appointment without the need to wait for soft tissue healing. The method and system disclosed herein enables placement of the dental implant into a multi-rooted tooth socket. The unfilled undercut spaces are filled with the proper amount of bone filler material. The dental implant and the method and system disclosed herein for installing and restoring the dental implant can be standardized to reduce the clinical cost of implant therapies. With onsite 3D X-ray imaging, computer aided design (CAD)/computer aided manufacturing (CAM) milling machines, and a pre-machined implant block for the implant member, the diagnosis, treatment planning, implant and restoration fabrication, atraumatic extraction, implant placement and restoration may be accomplished in a single clinical appointment.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing summary, as well as the following detailed description of the invention, is better understood when read in conjunction with the appended drawings. For the purpose of illustrating the invention, exemplary constructions of the invention are shown in the drawings. However, the invention is not limited to the specific methods and instrumentalities disclosed herein.

FIG. **1**A illustrates an exploded perspective view of a dental implant for a patient.

FIG. **1**B exemplarily illustrates a perspective view of the dental implant.

FIGS. **1**C-**1**D exemplarily illustrate enlarged views of hook shaped micro-extensions disposed on a root section of an implant member of the dental implant.

FIG. **1**E exemplarily illustrates an exploded front view of the dental implant.

FIG. **1**F exemplarily illustrates an assembled front view of the dental implant.

FIG. **1**G exemplarily illustrates a top sectional view of the dental implant.

FIG. **2** exemplarily illustrates a cylindrical member of an anchoring assembly of the dental implant interfacing with a periodontal bone surface.

FIGS. **3**A-**3**B exemplarily illustrate hook shaped micro-extensions on an outer surface of the implant member of the dental implant.

FIG. **4**A exemplarily illustrates retentive grooves on the outer surface of the implant member along a root section of the implant member.

FIG. **4**B exemplarily illustrates a sandblasted micro-textured outer surface of the implant member.

FIG. **5** exemplarily illustrates a coronal surface of the implant member of the dental implant, showing a composite packing.

FIG. **6**A exemplarily illustrates loading of a permanent crown and/or a pre-fabricated tooth colored layer over the coronal surface of the implant member of the dental implant.

FIG. **6**B exemplarily illustrates an enlarged view of the sandblasted micro-textured outer surface of the implant member.

FIG. **7** illustrates a method for installing a dental implant.

FIG. **8** exemplarily illustrates a system for fabricating and installing a dental implant and restoration for a patient.

FIG. **9** exemplarily illustrates a method for fabricating and installing a dental implant and restoration for a patient.

DETAILED DESCRIPTION OF THE INVENTION

FIG. **1**A illustrates an exploded perspective of a dental implant **100** for a patient. The dental implant **100** comprises an implant member **101**, substantially resembling a natural tooth, for insertion into a periodontal bone socket **103***a* of an

extracted natural tooth. The extracted tooth, for example, lies adjacent to natural teeth **103***d* and **103***e*. As used herein, the term "periodontal bone socket" or "periodontal socket" refers to the socket(s) of the tooth/teeth **103***d* and **103***e*, also referred to as the dental alveolus in the maxillary and mandibular bones **103**, surrounded by supporting bone and tissues of the periodontium or periodontal bone structure **103***c*. The implant member **101** comprises a coronal section **101***a* and a root section **101***b*. The root section **101***b* of the implant member **101** comprises a coronal end **101***c*, a mid portion **101***e*, and a conical apical end **101***d*. The coronal section **101***a* axially extends from the coronal end **101***c* of the root section **101***b*. As used herein, the "coronal end" refers to an end **101***c* of the root section **101***b* of the implant member **101** or an end section of any other component that is disposed in the direction towards the crown **104** of a tooth **103***d* or **103***e*. As used herein, the "apical end" refers to an end **101***d* of the root section **101***b* of the implant member **101** or an end section of any other component that is disposed in the direction towards the root tip **101***d* of a tooth **103***d* or **103***e*.

The dental implant **100** disclosed herein further comprises an anchoring assembly **102** positioned within a hollow axial cavity **101***f* of the implant member **101**. The anchoring assembly **102** anchors the implant member **101** within the periodontal bone socket **103***a*. The anchoring assembly **102** comprises a fastening element **102***a* that engages the implant member **101** from within the hollow axial cavity **101***f* of the implant member **101**. The fastening element **102***a* comprises a coronal screw head **102***h* and an apical section **102***c* having a conical shaft **102***d* and a truncated end **102***e*. The coronal screw head **102***h* is used for tightening or releasing the fastening element **102***a* within the hollow axial cavity **101***f* of the implant member **101**. The coronal screw head **102***h* can be accessed from the coronal section **101***a* of the implant member **101**. The anchoring assembly **102** further comprises one or more radial and equidistant cylindrical members **102***b* positioned near the root section **101***b* of the implant member **101**, for example, on the mid portion **101***e* of the root section **101***b* of the implant member **101**. The root section **101***b* of the implant member **101** comprises one or more through-holes **101***g* for radially and forcibly sliding the cylindrical members **102***b* through the through-holes **101***g*. The hollow axial cavity **101***f* of the implant member **101** is in fluid communication with each of the through-holes **101***g* in the root section **101***b* of the implant member **101**. Each of the cylindrical members **102***b* comprises a first end **102***f* that contacts and interfaces with the conical shaft **102***d* of the fastening element **102***a*, and a second end **102***g* that contacts and interfaces substantially uniformly against a surface **103***b* of the periodontal bone socket **103***a*, herein referred to as the "periodontal bone surface". The first end **102***f* of each of the cylindrical members **102***b* is concaved and beveled to make a flush contact with the conical shaft **102***d* of the fastening element **102***a*. A temporary crown **104** and/or a composite packing **105** may be placed over a coronal surface **101***i* of the coronal section **101***a* of the implant member **101** to reduce para-functional interferences during an osseointegration period of the dental implant **100**.

FIG. **1**B exemplarily illustrates a perspective view of the dental implant **100**. As illustrated in FIGS. **1**A-**1**B, the implant member **101** further comprises multiple hook shaped micro-extensions **101***h* circumferentially disposed around the root section **101***b* of the implant member **101**. In an embodiment, a temporary crown **104** is optionally placed on the dental implant **100** during the healing period when the dental implant **100** is bio-integrated with the periodontal bone structure **103***c* illustrated in FIG. **1**A, and thereafter replaced by a permanent crown **104**. The temporary crown **104** is loaded on the coronal section **101***a* of the implant member **101**, abutting the coronal surface **101***i* of the coronal section **101***a* of the dental implant **100**.

FIG. **1**C exemplarily illustrates an enlarged view of the hook shaped micro-extension **101***h* disposed on the root section **101***b* of the implant member **101** of the dental implant **100**. The hook shaped micro-extension **101***h* provides a retentive function during the initial stages of the dental implant **100**.

FIG. **1**D exemplarily illustrates an enlarged view if another hook shaped micro-extension **101***h* disposed on the root section **101***b* of the implant member **101** of the dental implant **100**. The hook shaped micro-extension **101***h* provides a retentive function during the initial stages of the dental implant **100**.

FIG. **1**E exemplarily illustrates an exploded front view of the dental implant **100**. As seen in the unassembled view of the dental implant **100** in FIG. **1**E, the hollow axial cavity **101***f* of the implant member **101** is in fluid communication with each of the radial through-holes **101***g* in the implant member **101**. Unlike a conventional implant design, where the dental implant **100** and the coronal section **101***a* are originally separate but are connected to each other at a later stage through a screw retained abutment, the root section **101***b* of the dental implant **100** disclosed herein and the coronal section **101***a* are directly connected to each other as exemplarily illustrated in FIG. **1**E. The components, for example, the composite packing **105**, the fastening element **102***a* and the cylindrical members **102***b* of the anchoring assembly **102** are disclosed in the detailed description of FIG. **1**A.

FIG. **1**F exemplarily illustrates an assembled front view of the dental implant **100**. The fastening element **102***a* of the anchoring assembly **102** comprises a coronal screw head **102***h* and a frustoconical apical section **102***c* having a truncated end **102***e* that allows the fastening element **102***a* to be advanced down or retracted up the hollow axial cavity **101***f* of the implant member **101** to generate an appropriate anchoring force of the cylindrical members **102***b* against the periodontal bone surface **103***b*. In an embodiment, the fastening element **102***a* is threaded to screwably engage the hollow axial cavity **101***f* of the implant member **101**. As illustrated in FIG. **1**B and FIG. **1**F, the fastening element **102***a* apically advances within the hollow axial cavity **101***f* when turned by the coronal screw head **102***h*. When the fastening element **102***a* is apically advanced within the hollow axial cavity **101***f* of the implant member **101**, the conical shaft **102***d* of the fastening element **102***a* radially and outwardly pushes the cylindrical members **102***b* through the through-holes **101***g*, whereby the second end **102***g* of each of the cylindrical members **102***b* abuts and evenly presses against the periodontal bone surface **103***b* to substantially uniformly contact the periodontal bone surface **103***b* and to generate an anchoring force to anchor the implant member **101** to the periodontal bone surface **103***b* within the periodontal bone socket **103***a*. The fastening element **102***a* enables a dentist to precisely control the anchoring force generated by the cylindrical members **102***b* against the periodontal bone surface **103***b* by turning the coronal screw head **102***h* of the fastening element **102***a*. In an embodiment, the amount of anchoring force is determined based on the type of bone of the patient and the bone density around the periodontal bone socket **103***a* illustrated

in FIG. **1**A and FIG. **1**E, which can be estimated using three dimensional X-ray image data captured during the treatment planning stages.

FIG. **1**G exemplarily illustrates a top sectional view of the dental implant **100**. A dentist turns the coronal screw head **102***h* of the fastening element **102***a*, as illustrated in FIG. **1**G, for controlling the anchoring force generated by the cylindrical members **102***b* against the periodontal bone surface **103***b* as exemplarily illustrated in FIG. **1**F. As seen in FIG. **1**F, the anchoring assembly **102** of the dental implant **100** disclosed herein functions as an inner-lock structure near the mid portion **101***e* of the root section **101***b* of the implant member **101** to provide strong initial stability to the dental implant **100**. The contact areas of the cylindrical members **102***b* with the periodontal bone surface **103***b* illustrated in FIG. **1**F are roughened to provide friction and prevent slippage of the cylindrical members **102***b* over the periodontal bone surface **103***b*.

As illustrated in FIG. **1**F, an interstitial space **103***f* defined between the outer surface **101***j* of the implant member **101** and the periodontal bone surface **103***b* is pre-planned using the X-ray images of the periodontal bone socket **103***a* illustrated in FIG. **1**A and FIG. **1**E to allow for the proper insertion of the dental implant **100** and to maintain the initial stability of the dental implant **100**. The implant member **101** is designed such that the resulting interstitial space **103***f* after the insertion of the dental implant **100** is narrow, for example, about 30 μm at the coronal end **101***c* and the apical end **101***d* of the root section **101***b*, and wider, for example, about 90 μm at the mid portion **101***e* of the root section **101***b*, which is about one-third the area of the interstitial space **103***f*. The narrow interstitial space **103***f* at the coronal end **101***c* and the apical end **101***d* of the root section **101***b* does not interfere with the insertion of the dental implant **100** until the final seating of the dental implant **100** in the periodontal bone socket **103***a*. The wider middle interstitial area **103***f* allows proper and trouble-free insertion of the dental implant **100**. The insertion of the conical apical end **101***d* of the root section **101***b* terminates at the base **103***h* of the periodontal bone socket **103***a* as illustrated in FIG. **1**A and FIG. **1**E. The tighter coronal end **101***c* establishes a coronal seal that stabilizes the dental implant **100** at the final seating position of the dental implant **100** within the periodontal bone socket **103***a* illustrated in FIG. **1**A and FIG. **1**E and provides a tight seal between the dental implant **100** and the soft tissue of the periodontal bone socket **103***a* near the gum line **103***g*.

FIG. **2** exemplarily illustrates a cylindrical member **102***b* of the anchoring assembly **102** of the dental implant **100** interfacing with the periodontal bone surface **103***b*. The second end **102***g* of three equidistant cylindrical members **102***b* illustrated in FIG. **1**G abut against and substantially uniformly contact the periodontal bone surface **103***b* on the periodontal bone structure **103***c*. The second end **102***g* of the equidistant cylindrical member **102***b* does not penetrate the periodontal bone structure **103***c*. The amount of anchoring force exerted by the cylindrical members **102***b* against the supporting periodontal bone structure **103***c* is controlled by the coronal screw head **102***h* of the fastening element **102***a*, as illustrated in FIG. **1**G. Controlling the anchoring force exerted by the cylindrical members **102***b* against the supporting periodontal bone structure **103***c* prevents uneven pressure and uncontrolled forces on the supporting periodontal bone structure **103***c* which may damage the supporting periodontal bone structure **103***c* or cause necrosis of the bone, resulting in loss of tightness and retention of the dental implant **100**.

FIGS. **3**A exemplarily illustrates a hook shaped micro-extension **101***h* on an outer surface **101***j* of the implant member **101** of the dental implant **100**. The hook shaped micro-extension **101***h* is circumferentially disposed on the outer surface **101***j* of the root section **101***b* of the implant member **101** as exemplarily illustrated in FIGS. **1**A-**1**B.

FIG. **3**B exemplarily illustrates another hook shaped micro-extension **101***h* on an outer surface **101***j* of the implant member **101** of the dental implant **100**. The hook shaped micro-extension **101***h* is circumferentially disposed on the outer surface **101***j* of the root section **101***b* of the implant member **101** as exemplarily illustrated in FIGS. **1**A-**1**B. These hook shaped micro-extensions **101***h* provide a retentive function during the initial stages of the dental implant **100**. Typically, the hook shaped micro-extensions **101***h* are, for example, about 300 μm long, about 100 μm wide, and about 60 μm high. The hook shaped micro-extensions **101***h* are bent upwardly and therefore allow the initial movement and insertion of the implant member **101** towards the periodontal bone structure **103***c* without resistance. This requires that the height of the hook shaped micro-extensions **101***h* establishes an implant diameter slightly wider than the diameter of the periodontal bone socket **103***a*, for example, less than about 30 μm to about 60 μm wider than the diameter of the periodontal bone socket **103***a* illustrated in FIG. **1**A and FIG. **1**E. As these hook shaped micro-extensions **101***h* are disposed along the mid portion **101***e* of the root section **101***b* of the implant member **101**, the resistance to the initial apical movement at the start of the insertion of the implant member **101** in the periodontal bone socket **103***a* is minimal.

The hook shaped micro-extensions **101***h* are positioned on the outer surface **101***j* of the implant member **101**. After the insertion of the dental implant **100** into the periodontal bone socket **103***a* illustrated in FIG. **1**A and FIG. **1**E, the hook shaped micro-extensions **101***h* anchor onto the periodontal bone surface **103***b* for impeding coronal movement of the inserted implant member **101** within the periodontal bone socket **103***a* as exemplarily illustrated in FIG. **1**F. This allows the dental implant **100** to snap onto the periodontal bone socket **103***a* after the insertion to maximize the retention of the dental implant **100** in the periodontal bone socket **103***a* and to establish the initial stability of the dental implant **100**. After the insertion of the dental implant **100**, the tips of these hook shaped micro-extensions **101***h* reach very close, for example, about 30 μm to the supporting periodontal bone structure **103***c*, thereby providing resistance to backward coronal movement of the implant member **101**. Hence, during the initial stages of the dental implant **100**, the hook shaped micro-extensions **101***h* prevent the dental implant **100** from dislodging out of the periodontal bone socket **103***a*. On the other hand, when a patient applies an apical biting force towards the base **103***h* of the periodontal bone socket **103***a*, the hook shaped micro-extensions **101***h* do not interfere with such apical forces. In an embodiment, isolated or contiguous groups of these hook shaped micro-extensions **101***h* are added over the root section **101***b* of the implant member **101**. In another embodiment, the hook shaped micro-extensions **101***h* are much smaller and are etched over the ridges **403** of grooves **401** and **601** on the root section **101***b* of the implant member **101** as exemplarily illustrated in FIG. **4**A and FIG. **6**A respectively.

FIG. **4**A exemplarily illustrates retentive grooves **401** on the outer surface **101***j* of the implant member **101** along the root section **101***b* of the implant member **101**. The outer surface **101***j* of the implant member **101** is a sandblasted

micro-textured surface **402**. FIG. **4**B exemplarily illustrates a sandblasted micro-textured outer surface **402** of the implant member **101**. Although, initially the periodontal bone structure **103***c* illustrated in FIG. **1**A and FIGS. **1**E-**1**F are not integrated with the dental implant **100**, the interstitial space **103***f* of about 30 μm to about 90 μm is filled, for example, with micro bone filler materials. These bone filler materials are gradually replaced by real bone tissues, when the dental implant **100** is bio-integrated with the supporting periodontal bone structure **103***c*. Hence, the dental implant **100** incorporates the sandblasted surface structure **402** and the retentive grooves **401** on the implant member **101** to increase the contact area between the implant member **101** and the periodontal bone surface **103***b* illustrated in FIG. **1**A and FIGS. **1**E-**1**F, and to engage the dental implant **100** in the periodontal bone socket **103***a* of the periodontal bone structure **103***c*. The retentive grooves **401** illustrated in FIG. **4**A ensure the long term stability and longevity of the dental implant **100**. The retentive grooves **401** are provided along the mid portion **101***e* of the root section **101***b* of the implant member **101** to increase the contact area between the implant member **101** and the periodontal bone surface **103***b* as exemplarily illustrated in FIG. **4**A and FIG. **6**A. The retentive grooves **401** are disposed either parallel to each other or spirally wound around the mid portion **101***e* of the root section **101***b* of the implant member **101**. The deep retentive grooves **401** illustrated in FIG. **4**A derive support from the periodontal bone structure **103***c* against biting forces and prevent the dental implant **100** disclosed herein from dislodging out of the periodontal bone socket **103***a*. As the bone filler materials in the retentive grooves **401** are replaced by natural bone structures, the retentive grooves **401** provide the same support as a conventional implant design. In an embodiment, the ridges **403** of the retentive grooves **401** provided over the mid portion **101***e* of the root section **101***b* of the implant member **101** are etched with the hook shaped micro-extensions **101***h*, as illustrated in FIG. **4**A and FIG. **6**A. As illustrated in FIG. **4**B and FIG. **6**B, the outer surface **101***j* of the implant member **101**, specifically those areas in contact with the periodontal bone surface **103***b* are sandblasted to produce the sandblasted micro-textured surface **402** on the implant member **101**. The sandblasted micro-textured surface **402** further increases the contact area between the dental implant **100** and the periodontal bone surface **103***b*, and allows the periodontal bone structure **103***c*, tissue and fibers such as Sharpie's fibers to grow and anchor onto the sandblasted micro-textured surface **402** of the implant member **101**.

In order to ensure bone growth around the dental implant **100**, agents that encourage bone growth, for example, osteogenic materials and antibiotic agents that prevent infection are mixed with the bone filler material. The interstitial space **103***f* illustrated in FIG. **1**F is filled with the bone filler material, the osteogenic material, and the antibiotic agents to ensure bone regeneration and long term stability of the dental implant **100**. The osteogenic materials in the interstitial space **103***f* and in the retentive grooves **401** of the implant member **101** induce bone into the retentive grooves **401** and ensure long term stability of the dental implant **100**.

Proper soft tissue health around the dental implant **100** is important in preventing infections in and around the periodontal bone socket **103***a*. The areas of the dental implant **100** that are in contact with soft periodontal tissues are polished and smoothed to prevent plaque and calculus accumulation. The depth of the soft periodontal tissue layer can be determined from X-ray imaging, and is typically around 2 mm from the underline bone level **103***i* illustrated in FIG. **6**A. In case of esthetically prominent teeth such as incisors and canines, a dark surface of the implant member **101** may produce a visible dark halo through the gingiva. In such a case, a white coating can be provided in the soft periodontal tissue layer to produce an esthetic result. Compared to the diameter of the natural tooth, the cross-sectional area of the implant member **101** is made slightly larger, about 20 μm larger, to provide a tight seal and prevent foreign bodies from entering into the interstitial space **103***f* between the implant member **101** and the periodontal bone surface **103***b*.

FIG. **5** exemplarily illustrates a coronal surface **101***i* of the implant member **101** dental implant **100**, showing a composite packing **105**. During the first several months, in order to provide an optimal environment for the periodontal bone structure **103***c* to bio-integrate with the implant member **101**, the coronal section **101***a* is designed to avoid direct contact with the opposing teeth **501**, especially para-functional interferences. The composite packing **105** is provided to avoid direct contact of the coronal section **101***a* of the implant member **101** with the opposing teeth **501**. As illustrated in FIG. **1**F, either a temporary crown or a permanent crown **104** may be placed over the composite packing **105**. The temporary or permanent crown **104** will not be in contact with the opposing teeth **501** so that the dental implant **100** is not subjected to any forces during bio-integration. At the completion of the bio-integration between the dental implant **100** and the periodontal bone structure **103***c*, the biting surface of the coronal section **101***a* of the dental implant **100**, herein referred to as the coronal surface **101***i* can be modified to restore the proper contact between the opposing upper and lower teeth **501**. As illustrated in FIG. **5**, the coronal surface **101***i* of the implant member **101**, where the opposing upper and lower teeth **501** make contact, comprises the composite packing **105** that is filled with tooth filling composite materials. The composite packing **105** is a pre-designed cartridge that avoids direct occlusal contact of the implant member **101** with the opposing teeth **501** to reduce para-functional interferences during the osseointegration period of the dental implant **100**. The composite packing **105** can be removed and refilled to a higher surface level **105***a* to contact the opposing tooth surface **501** at a later stage.

In many cases, where the opposite teeth **501** are natural teeth, the natural teeth **501** tends to shift down and contact the coronal surface **101***i* or the composite packing **105** over a period of time, corresponding to the period of bio-integration of the dental implant **100**. In such cases, occlusal modifications at the end of the bio-integration may be eliminated.

In an embodiment, areas of the coronal surface **101***i* of the coronal section **101***a* of the implant member **101** that are exposed to the oral cavity are coated with tooth colored materials such as porcelain or high density composites. The shade or color of the surface coating on the coronal surface **101***i* is chosen to match the original shade or color of the natural teeth. Layers of translucent and opaque material may be overlaid on top of each other to ensure a natural tooth appearance.

In some cases, a tooth colored layer **104** is fabricated separately similar to a conventional crown, and cemented or screw-retained to the dental implant **100**. In these cases, the coronal section **101***a* of the implant member **101** projecting over the gum line **103***g* is designed and prepared similar to a prepared tooth surface for loading a dental crown **104**, as illustrated in FIG. **6**A. FIG. **6**A exemplarily illustrates loading of a permanent crown **104** and/or a pre-fabricated tooth

colored layer over the coronal surface **101***i* of the implant member **101** of the dental implant **100**. In another embodiment, temporary crowns **104** are placed during the healing period before the dental implant **100** is bio-integrated with the supporting periodontal bone structure **103***c*, and thereafter replaced by a permanent crown **104**. These crowns **104** can be retained, for example, using dental cement or screws that can be accessed from the occlusal surface **104***a* of the crowns **104** and filled with a composite. As used herein, the occlusal surface **104***a* refers to the surface of the crown **104** that makes occlusal contact with the opposing teeth **501**. In case of temporary crowns **104**, the coronal surface **101***i* is designed to avoid occlusal contact with the opposing teeth surface.

In an embodiment, the implant member **101** further comprises one or more longitudinal grooves **601** as illustrated in FIG. **6**A. The longitudinal grooves **601** are provided on the implant member **101** substantially parallel to the periodontal bone socket **103***a* for allowing debris to escape out of the periodontal bone socket **103***a* during the insertion of the implant member **101** within the periodontal bone socket **103***a*. FIG. **6**B exemplarily illustrates an enlarged view of the sandblasted micro-textured outer surface **402** of the implant member **101**.

FIG. **7** illustrates a method for installing a dental implant **100**. The dental implant **100**, as disclosed in the detailed description of FIGS. **1**A-**1**E, is provided **701**. Before the insertion of the dental implant **100**, atraumatic extraction is performed to minimize the damages to the surrounding periodontal bone structure **103***c* and soft tissue. All infected and inflamed tissues in the periodontal bone socket **103***a* are removed before the insertion of the dental implant **100**. The implant member **101** with the anchoring assembly **102** of the dental implant **100** is inserted **702** into the periodontal bone socket **103***a* of the patient. A proper initial orientation of the dental implant **100** is important to ensure that the dental implant **100** follows the correct insertion path in the first attempt, such that the dental implant **100** need not be removed and reinserted again. Due to a resistance mechanism along the outer surface **101***j* of the implant member **101**, if the dental implant **100** is inserted in the wrong orientation, the dental implant **100** may lock itself in the periodontal bone socket **103***a* after insertion and may be difficult to extract, without damaging the periodontal bone surface **103***b*. The anatomy of the crown **104** of the teeth should properly guide an experienced dentist to place the dental implant **100** in the correct initial orientation. Once the dental implant **100** is correctly and fully seated in the periodontal bone socket **103***a*, the fastening element **102***a* of the anchoring assembly **102** is apically advanced **703** within the hollow axial cavity **101***f* of the implant member **101**. The conical shaft **102***d* of the fastening element **102***a* radially and outwardly pushes the cylindrical members **102***b* of the anchoring assembly **102** through the through-holes **101***g* and presses the second end **102***g* of each of the cylindrical members **102***b* substantially uniformly against the periodontal bone surface **103***b* to generate an anchoring force to anchor the implant member **101** within the periodontal bone socket **103***a*.

In an embodiment, the fastening element **102***a* is threaded to screwably engage the hollow axial cavity **101***f* of the implant member **101**. The fastening element **102***a* comprises a coronal screw head **102***h* for tightening or releasing the fastening element **102***a* within the hollow axial cavity **101***f*. The fastening element **102***a* is apically advanced within the hollow axial cavity **101***f* by turning the coronal screw head **102***h* of the fastening element **102***a*. The method disclosed herein enables a dentist to precisely control **704** the anchoring force generated by the cylindrical members **102***b* using the coronal screw head **102***h* of the fastening element **102***a*.

As exemplarily illustrated in FIGS. **1**A-**1**E, multiple hook shaped micro-extensions **101***h* are circumferentially disposed around the root section **101***b* of the implant member **101** for impeding coronal movement of the inserted implant member **101** within the periodontal bone socket **103***a*. As illustrated in FIG. **4**B, an outer surface **101***j* of the implant member **101** is sandblasted to obtain a sandblasted micro-textured surface **402**. The outer surface **101***j* is also provided with retentive grooves **401** along the root section **101***b* of the implant member **101** to increase the contact area between the implant member **101** and the periodontal bone surface **103***b*. As illustrated in FIG. **6**A, one or more longitudinal grooves **601** are provided on the implant member **101** parallel to the periodontal bone socket **103***a* for allowing excess bone filler material and debris to escape out of the periodontal bone socket **103***a* during the insertion of the implant member **101** within the periodontal bone socket **103***a*. After the insertion, an interstitial space **103***f* defined between the periodontal bone surface **103***b* and the outer surface **101***j* of the implant member **101** is filled, for example, with a bone filler material, an osteogenic material, antibiotic agents, etc. to ensure bone regeneration and long term stability of the dental implant **100**. A coronal surface **101***i* of the implant member **101** is provided with a composite packing **105** filled with tooth filling composite materials. The composite packing **105** avoids direct contact of the implant member **101** with the opposing teeth **501** as exemplarily illustrate in FIG. **5** to reduce para-functional interferences during the osseointegration period of the dental implant **100**. The inserted dental implant **100** is optionally loaded with a temporary crown **104**, and loaded with a permanent crown **104** after the osseointegration period. In an embodiment, the coronal surface **101***i* of the dental implant **100** is overlaid with one or more pre-fabricated tooth colored layers.

FIG. **8** exemplarily illustrates a system **800** for fabricating and installing a dental implant **100** and restoration for a patient. The system **800** disclosed herein comprises a three dimensional (3D) X-ray imaging device **801**, a digital simulator **802**, and a fabricator **803**. The 3D X-ray imaging device **801** captures high resolution three dimensional X-ray images of a natural tooth and a corresponding periodontal bone socket **103***a* of the natural tooth before extraction of the natural tooth. The digital simulator **802** digitally simulates insertion of the dental implant **100** into the periodontal bone socket **103***a* using the three dimensional X-ray images to establish a path for inserting the dental implant **100**. The fabricator **803** fabricates and mills the dental implant **100** according to a treatment plan based on the digital simulation. The fabricator **803** comprises a computer-aided milling machine **803***a* that produces the fine details of the implant member **101** of the dental implant **100**.

FIG. **9** exemplarily illustrates a method for fabricating and installing a dental implant **100** and restoration for a patient. High resolution three dimensional (3D) X-ray images of a natural tooth and a corresponding periodontal bone socket **103***a* of the natural tooth are captured **901**, for example, before the extraction of the natural tooth. In cases where there is severe tooth infection, the periodontal bone structure **103***c* around the tooth root may undergo resorption, in which case there may be a discrepancy between the X-ray image of the periodontal bone socket **103***a* and the root structure of the tooth. If the dental implant **100** is designed based on the shape of the tooth root alone and inserted into

the periodontal bone socket **103***a*, an open gap may be created between the implant member **101** and the periodontal bone surface **103***b* due to the resorption, and the inserted dental implant **100** may be wobbly. Hence, the dental implant **100** is configured to a shape of the image of the periodontal bone socket **103***a*, which accounts for both the root of the tooth and the resorbed portion. In order to secure the dental implant **100** firmly into the periodontal bone socket **103***a*, the shape of the dental implant **100** is configured to compensate for the discrepancy created by the resorption.

The interstitial space around a natural tooth is about 200 μm in width. This interstitial space is filled with periodontal tissue such as ligaments to permit limited tooth movement. In case of the dental implant **100**, if an interstitial space **103***f* of much over 200 μm is allowed between the periodontal bone surface **103***b* and the dental implant **100**, not only do micro-organisms such as bacteria access the interstitial space **103***f*, but the dental implant **100** will be mobile and may dislodge from the periodontal bone socket **103***a*. Thus, it is important to define and allow a much narrower interstitial space **103***f* between the dental implant **100** and the periodontal bone surface **103***b*, especially near the coronal end **101***c* of the root section **101***b* of the implant member **101** where the dental implant **100** is exposed to the oral cavity. The narrow interstitial space **103***f* between the dental implant **100** and the periodontal bone surface **103***b* firmly anchors the dental implant **100** inside the periodontal bone structure **103***c* in the long run. Accordingly, a high-resolution three dimensional X-ray of, for example, about 30 μm is acquired to determine the exact dimensions of the tooth and the periodontal bone socket **103***a* in designing the dental implant **100**.

A tooth shade or color scan is also obtained from the natural tooth/teeth. The digital information comprising the high resolution X-ray images and the color scan is sent to a dental lab to custom build a customized dental implant **100** for the yet-to-be replaced tooth. Using this digital information, the root section **101***b* of the implant member **101** of the dental implant **100** is made to resemble the shape of the root of the natural tooth. The shade of the coronal section **101***a* of the implant member **101** of the dental implant **100** is made to match the natural shade of the tooth. A few considerations in the customized construction of the dental implant **100** and the restoration include proper insertion, initial stability, long-term stability, and functional and esthetic considerations.

The three dimensional X-ray images are used to digitally simulate **902** the insertion of the dental implant **100** into the periodontal bone socket **103***a* to establish a path for inserting the dental implant **100**. The pre-surgical three dimensional (3D) image simulation is performed to ensure the proper insertion of the dental implant **100** into the periodontal bone socket **103***a*. The path of insertion of the dental implant **100** is established to avoid any undercuts that may block the insertion of the dental implant **100**. If the implant member **101** of the dental implant **100** is to be positioned within 1000 μm to 2000 μm from a nerve canal, a separation space is planned to place the bone filler materials to maintain a distance of about 1000 μm to 2000 μm between the implant member **101** and the nerve canal. The unfilled area will be filled with flowable bone filler materials. Along the implant member **101**, one or more longitudinal grooves **601** are designed to allow debris such as blood and excess bone filler material to escape from the periodontal bone socket **103***a* during the insertion of the dental implant **100** into the periodontal bone socket **103***a*. For teeth with multiple roots, the dental implant **100** is designed to ensure proper insertion into all the roots at the same time. For the unfilled undercut area that the dental implant **100** is unable to reach, bone filler graft materials can be added before the insertion of the dental implant **100**.

The dental implant **100**, as disclosed in the detailed description of FIGS. **1**A-**1**E, is fabricated and milled **903** according to a treatment plan formulated based on the digital simulation. In fabricating the dental implant **100**, the design features and structures, for example, the shape of the implant member **101**, the anchoring assembly **102**, the hook-shaped micro-extensions **101***h*, the sandblasted micro-textured surface **402**, the retentive grooves **401**, the composite packing **105**, other retentive and anti-rotational features, etc. that account for initial stability, long-term stability, soft tissue management, functional and esthetic requirements of the dental implant **100** are planned and/or incorporated. The implant member **101** is made from or coated with titanium alloys that are bio-compatible with human tissues. In an embodiment, the anchoring assembly **102** comprising the fastening element **102***a* and the cylindrical members **102***b* is machined in the center of a preformed cylinder or a block of titanium alloys that constitute the implant member **101**. These prefabricated cylinders or blocks can be manufactured in large numbers. Images of the implant member **101** are acquired and imported to a computer aided design (CAD)/computer aided manufacturing (CAM) milling machine **803***a* as exemplarily illustrated in FIG. **8**. The computer aided milling machine **803***a* analyzes the implant member **101** and the exact position and dimensions of the pre-machined anchoring assembly **102**, and is programmed to produce the fine details of the implant member **101**. In an embodiment, after measuring the screw pitch of the fastening element **102***a*, the apical movement of the fastening element **102***a* within the implant member **101** and the corresponding radial movement of the cylindrical members **102***b* may also be simulated using the digital simulator **802** to predetermine the amount of anchoring force required for the patient, and in turn predetermine the number of turns of the coronal screw head **102***h* of the fastening element **102***a* to precisely control the anchoring force thereabout. Also, the amount of anchoring force is determined based on the type of bone of the patient and the bone density around the periodontal bone socket **103***a*, which can be estimated using the captured three dimensional X-ray images data of the periodontal bone socket **103***a*. The second end **102***g* of each of the cylindrical members **102***b* that contacts the periodontal bone surface **103***b* are fabricated and milled to conform to the surface contour of the periodontal bone surface **103***b*, so that the second end **102***g* abuts against the periodontal bone surface **103***b* evenly as the cylindrical members **102***b* are radially advanced.

The bone contacting outer surface areas **101***j* of the implant member **101** are engraved, sandblasted and etched with the pre-designed retentive grooves **401**. The coronal surface areas **101***i* of the coronal section **101***a* of the implant member **101** that potentially contact the soft tissue are contoured to establish a tight closure with the soft tissue and smoothed and polished to avoid plaque accumulation. The coronal surface **101***i* of the coronal section **101***a* exposed to the oral cavity is coated with layers of tooth colored materials. The final product is sterilized, sealed and delivered to the dentist. With the pre-machined implant cylinders or blocks, the CAD/CAM milling machine **803***a*, etc. to fabricate the implant member **101**, and the loading of the crown

104 onto the dental implant 100, it is possible to diagnose, design, and deliver the dental implant 100 in a single clinical appointment.

The fabricated dental implant 100 is inserted 904 into the periodontal bone socket 103*a* based on the established path for the insertion and the treatment plan. At the clinical appointment, local anesthetics are administered before the procedure. Prior to the insertion, atraumatic extraction techniques are used to minimize damages such as the forced expansion of the bone plates, fractures of surrounding periodontal bones 103*c*, and laceration of the soft tissue. 3D X-ray images can be used to plan the path of extraction to avoid undercut area and the sectioning of multiple roots that may be flared to block the path of extraction. For multi-rooted teeth, surgical procedures can be used to section the roots before the atraumatic extraction of the teeth. Infections in the periodontal bone socket 103*a* are removed and treated with antibiotic agents. Mixtures of bone filler materials and antibiotic agents are filled into the apical area or base 103*h* of the periodontal bone socket 103*a*. The dental implant 100 is held from the coronal section 101*a* to avoid contamination and inserted into the periodontal bone socket 103*a* with the proper orientation until the entire implant member 101 is submerged into the periodontal bone socket 103*a*. A post-surgical X-ray is taken to ensure the full insertion of the dental implant 100 into the periodontal bone socket 103*a*. The fastening element 102*a* of the anchoring assembly 102 is tightened according to the digital simulation or according to the manufacturer's recommendations. The coronal surface 101*i* of the coronal section 101*a* of the implant member 101 of the inserted dental implant 100 is filled 905 with tooth filling composite materials for the osseointegration period of the dental implant 100. If temporary crowns 104 are indicated by the dentist, the coronal surface 101*i* of the coronal section 101*a* of the implant member 101 is loaded with the temporary crowns 104 using temporary dental cement. Occlusal contacts with the dental implant 100 are verified to ensure that no occlusal contacts are strongly marked. If abnormal contacts are expected to the implanted coronal surface 101*i* or a crown surface, a protective guard or a splint is placed on the coronal surface 101*i* to avoid such contacts with the coronal section 101*a* of the implant member 101. The dental implant 100 may be loaded 906 with a permanent crown 104 and/or a pre-fabricated tooth colored layer at the end of the osseointegration period of the dental implant 100.

The foregoing examples have been provided merely for the purpose of explanation and are in no way to be construed as limiting of the present invention disclosed herein. While the invention has been described with reference to various embodiments, it is understood that the words, which have been used herein, are words of description and illustration, rather than words of limitation. Further, although the invention has been described herein with reference to particular means, materials and embodiments, the invention is not intended to be limited to the particulars disclosed herein; rather, the invention extends to all functionally equivalent structures, methods and uses, such as are within the scope of the appended claims. Those skilled in the art, having the benefit of the teachings of this specification, may effect numerous modifications thereto and changes may be made without departing from the scope and spirit of the invention in its aspects.

We claim:

1. A dental implant, comprising:

an implant member adapted for insertion into a periodontal bone socket of an extracted natural tooth, said implant member comprising a coronal section and a root section comprising a coronal end and a conical apical end, said coronal section axially extending from said coronal end of said root section, said implant member further comprising:

a plurality of concentric retentive grooves disposed along an outer surface of a mid-portion of said root section, wherein adjacent retentive grooves define ridges formed therebetween;

a plurality of hook-shaped micro-extensions integrally formed on a circumference of each of said ridges in said mid-portion of said root section, wherein each of said hook-shaped micro-extensions are bent upwards, wherein each of said hook-shaped micro-extensions are about 300 microns in length, about 100 microns in width, and about 60 microns in height, and wherein said hook-shaped micro-extensions are configured to impede coronal movement of an inserted implant member within said periodontal bone socket;

an anchoring assembly positioned within a hollow axial cavity of said implant member, said anchoring assembly comprising:

a fastening element engaged with said implant member, said fastening element positioned within said hollow axial cavity, wherein said fastening element comprises an apical section comprising a conical shaft and a truncated end, wherein said fastening element is threaded to screwably engage said hollow axial cavity of said implant member, wherein said fastening element further comprises a coronal screw head for one of tightening and releasing said fastening element within said hollow axial cavity, and wherein said fastening element apically advances within said hollow axial cavity when said fastening element is tightened by turning said coronal screw head; and

one or more radial and equidistant cylindrical members positioned in said mid-portion of said root section, wherein said mid-portion of said root section of said implant member further comprises one or more through-holes for radially and forcibly sliding said cylindrical members through said one or more through-holes, wherein each of said cylindrical members comprises a first end that interfaces with said conical shaft of said fastening element, and a second end that abuts against an inner wall of said periodontal bone socket without penetrating said inner wall of said periodontal bone socket, wherein said conical shaft of said fastening element radially and outwardly pushes said cylindrical members through said through-holes when said fastening element is apically advanced within said hollow axial cavity, and wherein said second end of each of said cylindrical members evenly presses against said inner wall of said periodontal bone socket to generate an anchoring force to anchor said implant member within said periodontal bone socket.

2. The dental implant of claim 1, wherein said fastening element enables a dentist to control said anchoring force generated by said cylindrical members using said coronal screw head of said fastening element, and wherein said anchoring force is controlled based on a pre-determined anchoring force determined by a digital simulator.

3. The dental implant of claim 1, wherein the root section comprises one or more longitudinal grooves extending from said mid-portion of the root section to the conical apical end,

and wherein said one or more longitudinal grooves are parallel to said periodontal bone socket for allowing debris to escape out of said periodontal bone socket during said insertion of said implant member within said periodontal bone socket.

4. The dental implant of claim **1**, wherein said outer surface is a sandblasted micro-textured surface, wherein said retentive grooves are located along said mid-portion of said root section of said implant member, and wherein said retentive grooves increase contact area between said implant member and said surface of said periodontal bone socket.

5. The dental implant of claim **1**, further comprising a composite packing disposed on a coronal surface of said coronal section of said implant member, wherein said composite packing is filled with tooth filling composite materials, wherein said composite packing avoids direct contact of said implant member with opposing teeth to reduce parafunctional interferences during an osseointegration period.

6. The dental implant of claim **1**, wherein said inner wall of said periodontal bone socket and an outer surface of said implant member define an interstitial space therebetween after said insertion of said implant member within said periodontal bone socket, wherein said interstitial space is filled with one or more of a bone filler material, an osteogenic material, and antibiotic agents to ensure bone regeneration and long term stability of said dental implant.

7. The dental implant of claim **1**, wherein said inserted implant member is loaded with a permanent crown after an osseointegration period.

8. A dental implant comprising a plurality of implant members adapted for insertion into a multi-rooted periodontal bone socket, each of said plurality of implant members adapted for insertion into a corresponding root socket, each of said plurality of implant members comprising:

a coronal section and a root section comprising a coronal end and a conical apical end, said coronal section axially extending from said coronal end of said root section, said implant member further comprising:

a plurality of concentric retentive grooves disposed along an outer surface of a mid-portion of said root section, wherein adjacent retentive grooves define ridges formed therebetween;

a plurality of hook-shaped micro-extensions integrally formed on a circumference of each of said ridges in said mid-portion of said root section, wherein each of said hook-shaped micro-extensions are bent upwards, wherein each of said hook-shaped micro-extensions are about 300 microns in length, about 100 microns in width, and about 60 microns in height, and wherein said hook-shaped micro-extensions are configured to impede coronal movement of an inserted implant member within said periodontal bone socket;

an anchoring assembly positioned within a hollow axial cavity of said implant member, said anchoring assembly comprising:

a fastening element engaged with said implant member, said fastening element positioned within said hollow axial cavity, wherein said fastening element comprises an apical section comprising a conical shaft and a truncated end, wherein said fastening element is threaded to screwably engage said hollow axial cavity of said implant member, wherein said fastening element further comprises a coronal screw head for one of tightening and releasing said fastening element within said hollow axial cavity, and wherein said fastening element apically advances within said hollow axial cavity when said fastening element is tightened by turning said coronal screw head; and

one or more radial and equidistant cylindrical members positioned in said mid-portion of said root section, wherein said mid-portion of said root section of said implant member further comprises one or more through-holes for radially and forcibly sliding said cylindrical members through said one or more through-holes, wherein each of said cylindrical members comprises a first end that interfaces with said conical shaft of said fastening element, and a second end that abuts against an inner wall of said periodontal bone socket without penetrating said inner wall of said periodontal bone socket, wherein said conical shaft of said fastening element radially and outwardly pushes said cylindrical members through said through-holes when said fastening element is apically advanced within said hollow axial cavity, and wherein said second end of each of said cylindrical members evenly presses against said inner wall of said periodontal bone socket to generate an anchoring force to anchor said implant member within said periodontal bone socket.

9. A system for fabricating and installing a dental implant in a periodontal bone socket, said system comprising:

a three dimensional X-ray imaging device for capturing high resolution three dimensional X-ray images of a natural tooth and said periodontal bone socket of said natural tooth, before extraction of said natural tooth, wherein said three dimensional X-ray imaging device has a resolution of at least 30 microns per pixel;

a fabricator comprising:

a computer aided design and computer aided manufacturing (CAD/CAM) milling machine for designing and milling said dental implant by using said captured high resolution three dimensional X-ray images, said CAD/CAM milling machine configured to:

design said dental implant to maintain a distance of at least 1000microns between said dental implant and one or more of an adjacent nerve canal, an adjacent sinus, and an adjacent blood vessel;

design said dental implant to maintain an interstitial space of at least 30 microns between a coronal end of a root section of said dental implant and said periodontal bone socket, an interstitial space of at least 30 microns between an apical end of said root section of said dental implant and said periodontal bone socket, and an interstitial space of at least 90 microns between a mid-portion of said root section of said dental implant and said periodontal bone socket; and

fabricate and mill said designed dental implant, wherein said CAD/CAM milling machine is further configured for creating a plurality of concentric retentive grooves along an outer surface of said mid-portion of said root section of said designed dental implant, wherein adjacent grooves define ridges formed therebetween, wherein a plurality of hook-shaped micro-extensions are integrally formed on a circumference of each of said ridges, wherein each of said hook-shaped micro-extensions are bent upwards, and wherein each of said hook-shaped micro-exten-

sions are about 300 microns in length, about 100 microns in width, and about 60 microns in height;

a digital simulator for digitally simulating insertion of said designed dental implant into said periodontal bone socket using said three dimensional X-ray images to establish a path for inserting said designed dental implant; and

said digital simulator further configured for predetermining an anchoring force required for anchoring said designed dental implant within said periodontal bone socket.

10. A method for fabricating and installing a dental implant and restoration for a patient, comprising:

capturing high resolution three dimensional X-ray images of said natural tooth and said periodontal bone socket of said natural tooth using a three dimensional X-ray imaging device, before extraction of said natural tooth;

designing and fabricating said dental implant based on said captured high resolution three dimensional X-ray images, using a fabricator;

digitally simulating insertion of said designed dental implant into said periodontal bone socket, using a digital simulator based on said captured three dimensional X-ray images;

pre-determining an anchoring force for anchoring said designed dental implant to an inner wall of said periodontal socket, by said digital simulator, based on said captured three dimensional X-ray images;

extracting said natural tooth and installing said fabricated dental implant into said periodontal bone socket, wherein a plurality of hook-shaped micro-extensions integrally formed in a mid-portion of a root section of said fabricated dental implant help in guiding said dental implant into said periodontal bone socket and impede coronal movement of said inserted dental implant within said periodontal bone socket;

anchoring said inserted dental implant within said periodontal bone socket, wherein a plurality of radial and equidistant cylindrical members disposed in said mid-portion of said root section of said fabricated dental implant abut and evenly press against said inner wall of said periodontal bone socket, wherein said anchoring force between said plurality of radial and equidistant cylindrical members and said inner wall of said periodontal bone socket is set to said pre-determined anchoring force;

filling an interstitial space between said inserted dental implant and said periodontal bone socket with one or more of a bone filler material, an osteogenic material, and antibiotic agents, to ensure bone regeneration and long term stability of said dental implant;

filling a coronal surface of a coronal section of said dental implant with tooth filling composite materials for osseointegration of said dental implant; and

loading a permanent crown and/or one or more prefabricated tooth colored layers after completion of said osseointegration.

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