(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
16 June 2011 (16.06.2011)

PCT

(10) International Publication Number
WO 2011/069226 A1

(51) International Patent Classification:
A61C 13/225 (2006.01) *A61C 13/30* (2006.01)
A61C 13/265 (2006.01)

(21) International Application Number:
PCT/CA2009/001798

(22) International Filing Date:
11 December 2009 (11.12.2009)

(25) Filing Language: English

(26) Publication Language: English

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to the identity of the inventor (Rule 4.17(i))*

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

(54) Title: APPARATUS, METHOD, AND SYSTEM FOR HOLDING A DENTURE

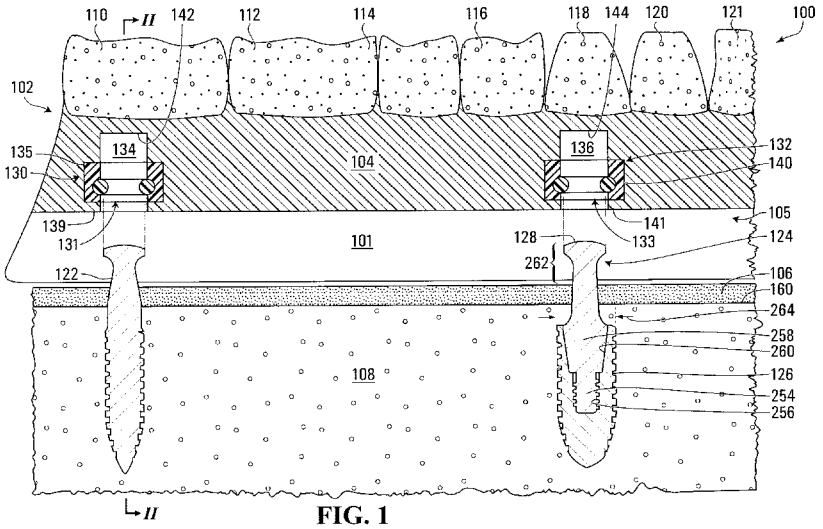

FIG. 1

(57) Abstract: An apparatus for holding a denture having a denture connector in a mouth of a patient is disclosed. The apparatus includes an elongate body having affixing means for affixing the apparatus in the mouth of the patient, and denture engaging means for engaging the denture. The denture engaging means include guiding means for guiding the denture connector in longitudinal movement along the elongate body. The guiding means is dimensioned to enable the denture connector to move and be guided in longitudinal movement along the elongate body in response to a load on the denture, to locate the denture connector in a position to facilitate transfer of the load to soft tissue adjacent the apparatus in the mouth of the patient and reduce vertical loading on the apparatus. The elongate body also has retaining means for receiving and retaining the denture connector on the guiding means.

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APPARATUS, METHOD, AND SYSTEM FOR HOLDING A DENTURE

BACKGROUND OF THE INVENTION

1. Field of Invention

This invention relates generally to dentures, and more particularly to apparatuses, methods, and systems for holding a denture in a mouth of a patient.

2. Description of Related Art

A denture is a prosthetic device for replacing lost natural teeth in the mouth of a patient. Some conventional dentures are held in the mouth by suction or by adhesives, for example. These dentures generally transfer loads from biting or chewing, for example, to gums or soft tissue in the mouth of the patient.

Alternatively, a denture may be held in place by one or more dental implants that are affixed to jaw bone in the mouth of a patient. A denture of this type is commonly referred to as an "overdenture", and generally has cavities for receiving abutment portions of the dental implants. These dental implants are generally implanted in the jaw bone, and attached to the bone either through scar tissue in the bone or by a process known as osseointegration. The abutment portions of these dental implants are often received within resilient connectors such as flexible O-rings, plastic devices, or resilient soft lining materials, for example, in the cavities of the overdenture. The resilient connectors engage the abutment portions to facilitate holding the overdenture in place. These abutment portions are therefore often referred to as "O-ring abutments".

One conventional O-ring abutment has a peripheral channel that holds an O-ring of an overdenture in a generally fixed longitudinal position relative to the dental implant. As such, when the overdenture receives a load from biting or chewing, for example, the overdenture transfers at least a significant portion of that load to the O-ring, and the O-ring transfers the load to the implant.

Load transfer from an overdenture to a dental implant may be referred to as "vertical loading". Vertical loading can damage the connection between the dental implant and bone in the mouth of the patient, which may damage osseointegration or other connections between the dental implant and the bone, and thus weaken the connection of the implant to the bone.

SUMMARY OF THE INVENTION

In accordance with one aspect of the invention, there is provided an apparatus for holding a denture having a denture connector in a mouth of a patient. The apparatus includes an elongate body having affixing means for affixing the apparatus in the mouth of the patient, and denture engaging means for engaging the denture. The denture engaging means includes guiding means for guiding the denture connector in longitudinal movement along the elongate body, the guiding means dimensioned to enable the denture connector to move and be guided in longitudinal movement along the elongate body in response to a load on the denture to locate the denture connector in a position to facilitate transfer of the load to soft tissue adjacent the apparatus in the mouth of the patient. The denture engaging means also includes retaining means for receiving and retaining the denture connector on the guiding means.

In accordance with another aspect of the invention, there is provided a denture system. The denture system includes the affixing means of each of the at least one apparatus affixed in bone in a mouth of a patient, and a denture having at least one connector. Each connector is held by a corresponding denture engaging means of a respective apparatus.

In accordance with another aspect of the invention, there is provided an apparatus for holding a denture having a denture connector in a mouth of a patient. The apparatus includes an elongate body having an affixing portion operably configured to affix the apparatus in the mouth of the patient, and a denture engaging portion operably configured to engage the denture. The denture engaging portion includes a guide operably configured to guide the

denture connector in longitudinal movement along the elongate body, the guide dimensioned to enable the denture connector to move and be guided in longitudinal movement along the elongate body in response to a load on the denture to locate the denture connector in a position to facilitate transfer of the load to soft tissue adjacent the apparatus in the mouth of the patient. The denture engaging portion also includes a stop operably configured to receive and retain the denture connector on the guide.

In accordance with another aspect of the invention, there is provided a denture system. The denture system includes at least one of the apparatus, the affixing portion of each apparatus affixed in bone in a mouth of a patient, and a denture having at least one connector, each connector being held by a corresponding denture engaging portion of a respective apparatus.

In accordance with another aspect of the invention, there is provided a method of holding a denture having a denture connector in a mouth of a patient. The method involves retaining the denture connector on a guiding portion of an elongate body affixed in the mouth of the patient, and guiding the denture connector in longitudinal movement along the guiding portion in response to a load on the denture to locate the denture connector in a position on the guiding portion that facilitates transfer of the load to soft tissue adjacent the apparatus in the mouth of the patient.

Other aspects and features of the present invention will become apparent to those ordinarily skilled in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

In drawings that illustrate embodiments of the invention,

Figure **1** is a fragmented cross-sectional view of a denture system in accordance with a first embodiment of the invention, in a separated arrangement,

Figure **2** is a cross-sectional view of the denture system of Figure **1** in the separated arrangement, taken along the line II-II in Figure **1**,

Figure **3** is a fragmented cross-sectional view of the denture system of Figure **1** in the separated arrangement, showing a first dental implant of the denture system of Figure **1**,

Figure **4** is an elevation view of the dental implant shown in Figure **3**,

Figure **5** is a plan view of the dental implant shown in Figure **3**,

Figure **6** is a side cross-sectional view of a dental implant in accordance with a second embodiment of the invention,

Figure **7** is a plan view of the dental implant shown in Figure **6**,

Figure **8** is an elevation view of a dental implant in accordance with a third embodiment of the invention,

Figure **9** is an elevation view of a dental implant in accordance with a fourth embodiment of the invention,

Figure **10** is an elevation view of a dental implant in accordance with a fifth embodiment of the invention,

Figure **11** is an elevation view of an abutment of the denture system of Figure **1**,

Figure **12** is a side cross-sectional view of an abutment assembly in accordance with a sixth embodiment of the invention, and

Figure **13** is a fragmented cross-sectional view of the denture system of Figure **1**, in an assembled arrangement.

DETAILED DESCRIPTION

Referring to Figures **1** and **2**, a denture system in accordance with a first embodiment of the invention is shown generally at **100**. The denture system **100** includes an overdenture (or more generally, a "denture") shown generally

at **102**, a first dental implant **122**, and a second dental implant shown generally at **124**.

Referring to Figure **2**, the overdenture **102** includes a denture base **104** comprised of acrylic or methyl methacrylate, for example, and the denture base **104** includes lateral projections **101** and **103** that are shaped to define a channel **105** that fits over soft tissue (or gum tissue) **106** that surrounds bone **108** in the mouth of a patient. In the embodiment shown, the bone **108** is a mandible or lower jaw bone from which natural teeth of the patient have been removed to allow the denture base **104** to fit in a complementary fashion over the soft tissue **106**.

Referring back to Figure **1**, the overdenture **102** includes prosthetic molars **110** and **112**, prosthetic bicuspids **114** and **116**, a prosthetic canine tooth **118**, a prosthetic lateral incisor **120**, and a prosthetic central incisor **121** secured to the denture base **104** to project away from the channel **105** to replace corresponding natural teeth of the patient. In alternative embodiments, the overdenture may be formed to fit over a maxilla or upper jaw, and may include prosthetic teeth to replace natural maxillary or upper-jaw teeth. Also, in alternative embodiments, the overdenture may replace all of the upper or lower natural teeth in the mouth of a patient, or the overdenture may replace only certain natural teeth that have been removed.

The denture base **104** includes first and second denture connector assemblies, shown generally at **130** and **132**, secured therein when the denture base **104** is formed. The first and second denture connector assemblies **130** and **132** include first and second inserts **135** and **140** respectively, which are annular in the embodiment shown. The first and second inserts **135** and **140**, together with the denture base **104**, define first and second cavities **134** and **136** respectively. The denture base **104** also defines first and second openings **131** and **133** in communication with the first and second cavities **134** and **136** respectively. In the embodiment shown, the first and second openings **131** and **133** are generally circular, the first and second cavities **134** and **136** are generally cylindrical, and the first and

second openings **131** and **133** are axially aligned with the first and second cavities **134** and **136** respectively. The first and second cavities **134** and **136** are bounded by respective end surfaces **142** and **144** of the denture base **104**. In the embodiment shown, the denture base **104** includes first and second shoulder portions **139** and **141**, which surround the first and second openings **131** and **133** respectively and contact the first and second inserts **135** and **140** respectively. The first and second shoulder portions **139** and **141** facilitate holding the first and second denture connector assemblies **130** and **132** respectively in the first and second cavities **134** and **136** respectively.

Referring to Figure **3**, the insert **135** has an inner wall **137** having an inner diameter **143**. In the embodiment shown, the first opening **131** also has an inner diameter **146** approximately equal to the inner diameter **143**. The inner wall **137** defines a groove **145**, which holds a denture connector **138** in the first cavity **134**. In this embodiment, the denture connector **138** includes a compressible and resilient rubber ring (or O-ring). Alternatively, however, the denture connector **138** may include silicone or plastic or other resilient materials, for example. When the denture connector **138** is not compressed, an inner surface **147** of the denture connector **138** has an uncompressed diameter **149**, which is less than the inner diameter **143**. The second denture connector assembly **132** (shown in Figure **1**) substantially resembles the first denture connector assembly **130**.

Referring to Figure **4**, the first dental implant **122** includes an elongate body shown generally at **150**. The elongate body **150** has an affixing portion **152** for affixing the first dental implant **122** in the mouth of a patient, a denture engaging portion **154** for engaging the first denture connector assembly **130** (shown in Figure **3**), and a transition portion **153** disposed between the affixing portion **152** and the denture engaging portion **154**.

The affixing portion **152** is connected directly to the bone **108** (shown in Figures **1** to **3**), and in this embodiment is made with an alloy including titanium or another biocompatible material such as zirconium, for example, to facilitate osseointegration with the bone (**108**). In this embodiment, the affixing

portion **152** includes a threaded portion **156** of the elongate body **150** for threadedly engaging the bone **108** (shown in Figures **1** to **3**). The affixing portion **152** thus functions as a bone connector and is used to affix the first dental implant **122** in the mouth of a patient.

In the embodiment shown, the affixing portion **152** also includes a shoulder portion **158** adjacent the denture engaging portion **154**. Referring to Figures **3** and **4**, the first dental implant **122** in this embodiment is positioned in the bone **108** such that the shoulder portion **158** is submerged approximately one to two millimeters below a gum-contacting surface **160** of the bone **108** such that the bone **108** may grow over the shoulder portion **158** to retain the affixing portion **152** in the bone **108**, particularly against longitudinal movement of the first dental implant **122** relative to the bone **108**. This process may be referred to as "platform switching". In general, platform switching advantageously strengthens the connection of the first dental implant **122** in the bone **108**.

Still referring to Figure **4**, the denture engaging portion **154**, which may also be referred to as an "abutment portion", includes a guide **162** and a stop **164**. The guide **162** in the embodiment shown is disposed adjacent the transition portion **153** and the stop **164** is disposed adjacent the guide **162**. The guide **162** includes an elongate surface portion **175** on the elongate body **150**. In the embodiment shown, the elongate surface portion **175** has a first width **176** adjacent the stop **164**, and a second width **177** adjacent the affixing portion **152**. The first width **176** is less than the second width **177**, such that the elongate surface portion **175** tapers inwardly in a direction away from the affixing portion **152**.

The stop **164** in the embodiment shown has an annular concaved stop surface **166** generally facing the guide **162**, an end surface **168** generally opposite the stop surface **166**, and a peripheral region **170** between the stop surface **166** and the end surface **168**. The end surface **168** in this embodiment is gently curved convex, and forms a truncated spherical cap in the embodiment shown. The stop **164** has a diameter **172** defined by the peripheral region **170**, and the end surface **168** rises a height **174** above the

peripheral region **170**. In the embodiment shown, the height **174** is less than half of the diameter **172**.

Referring to Figures **4** and **5**, the peripheral region **170** in the embodiment shown also includes a peripheral torque transfer surface **178** which is generally hexagonal (or more generally, generally polygonal) in the embodiment shown. More particularly, the peripheral torque transfer surface **178** includes six generally planar faces **180**, **182**, **184**, **186**, **188**, and **190**, and six rounded edges **192**, **194**, **196**, **198**, **200**, and **202**. The rounded edges **192**, **194**, **196**, **198**, **200**, and **202** advantageously avoid sharp edges between the generally planar faces, as such sharp edges could cause damage to tissue in the mouth, for example. The peripheral torque transfer surface **178** facilitates engagement by a tool (not shown) for applying a torque to the first dental implant **122** to cause the first dental implant **122** to rotate, thereby causing the threaded portion **156** to threadedly engage with the bone **108** (shown in Figures **1** to **3**) to a desired depth in the bone (**108**). In the embodiment shown, torque is applied to the peripheral torque transfer surface **178** until the shoulder portion **158** is approximately one to two millimetres below the gum-contacting surface **160** (shown in Figures **1** to **3**) to facilitate platform switching as described above.

Referring to Figure **6**, a dental implant in accordance with a second embodiment of the invention is shown generally at **300**. The dental implant **300** is substantially the same as the first dental implant **122**, except that an end surface **302** of a stop **304** defines a recessed torque transfer surface **306**. Referring to Figures **6** and **7**, the recessed torque transfer surface **306** in the embodiment shown is centrally located and generally hexagonal (or more generally, generally polygonal) and includes six generally planar faces **308**, **310**, **312**, **314**, **316**, and **318**. It will be appreciated that dental implants may include one or both of a peripheral torque transfer surface (such as the peripheral torque transfer surface **178** shown in Figures **4** and **5**) and a recessed torque transfer surface such as the recessed torque transfer surface **306**, and it will be appreciated that the recessed torque transfer surface **306**

facilitates engagement by a tool (not shown) to accomplish substantially the same functions as the peripheral torque transfer surface (**178**).

Referring to Figure **8**, a dental implant in accordance with a third embodiment of the invention is shown generally at **210**. The dental implant **210** includes an elongate body shown generally at **212**. The elongate body **212** has an affixing portion **214** for affixing the dental implant **210** in the mouth of a patient, and a denture engaging portion (or "abutment portion") **216** for engaging a denture such as the overdenture **102** (shown in Figure **1**). The denture engaging portion **216** is substantially the same as the denture engaging portion **154** shown in Figure **4**. Although only a peripheral torque transfer surface (such as the peripheral torque transfer surface **178** shown in Figures **4** and **5**) is shown, it will be appreciated that the dental implant **210** may additionally or alternatively include a recessed torque transfer (such as the recessed torque transfer surface **306** shown in Figures **6** and **7**). Alternatively, the denture engaging portion **216** may not include any torque transfer surface, as the dental implant **210** may be positioned in bone by applying an axial force to the dental implant **210** without necessarily applying any torque. In such alternative embodiments, the denture engaging portion **216** may instead include a smooth peripheral region around the stop.

The affixing portion **214**, has a shape similar to that of the affixing portion **152** (shown in Figure **4**), although in this embodiment the affixing portion **214** includes a wedge portion **218** of the elongate body **212** for connecting directly to bone (such as the bone **108** shown in Figures **1** to **3**) by frictionally engaging the bone. To facilitate osseointegration, the wedge portion **218** in this embodiment is made with an alloy including titanium or another biocompatible material such as zirconium, for example, and may be coated with hydroxyl appetite (not shown) to produce a rougher surface, or the surface of the wedge portion **218** may otherwise be roughened. In this embodiment, the affixing portion **214** includes a shoulder portion **220** adjacent the denture engaging portion **216** to facilitate platform switching as described

above. The affixing portion **214** thus functions as a bone connector and is used to affix the dental implant **210** in the mouth of a patient.

Referring to Figure **9**, a dental implant in accordance with a fourth embodiment of the invention is shown generally at **230**. The dental implant **230** includes an elongate body shown generally at **232**. The elongate body **232** has an affixing portion **234** for affixing the dental implant **230** in the mouth of a patient, and a denture engaging portion (or "abutment portion") **236** for engaging a denture such as the overdenture **102** (shown in Figure **1**).

The affixing portion **234** includes a wedge portion **238** of the elongate body **232** for connecting directly to bone in the mouth of a patient (such as the bone **108** shown in Figures **1** to **3**) by frictionally engaging the bone. Again, to facilitate osseointegration, the wedge portion **238** in this embodiment is made with an alloy including titanium or another biocompatible material such as zirconium, for example, and may be coated with hydroxyl appetite (not shown) or otherwise roughened. However, the wedge portion **238** in this embodiment includes longitudinal projections (or "fins") **240** and **242** for engaging bone in the mouth of a patient (such as the bone **108** shown in Figures **1** to **3**) to prevent rotation of the dental implant **230**. Alternative embodiments may include one or more projections and recesses (such as grooves or indentations, for example) and the projections and/or recesses may be longitudinal, peripheral, or otherwise oriented to engage the bone and prevent movement of the dental implant **230** relative to the bone. Although two longitudinal projections **240** and **242** are shown, a greater or lesser number of projections and/or recesses may be used. The affixing portion **234** also includes a shoulder portion **244** adjacent the denture engaging portion **236** to facilitate platform switching as described above. The affixing portion **234** thus functions as a bone connector and is used to affix the dental implant **230** in the mouth of a patient.

In the embodiment shown, the denture engaging portion **236** is substantially the same as the denture engaging portions **154** (shown in Figure **4**) and **216** (shown in Figure **8**). Again, only a peripheral torque transfer surface (such as

the peripheral torque transfer surface **178** shown in Figures **4** and **5**) is shown, although it will be appreciated that the dental implant **230** may additionally or alternatively include a recessed torque transfer surface (such as the recessed torque transfer surface **306** shown in Figures **6** and **7**). Alternatively, the denture engaging portion **236** may not include any torque transfer surface, and may instead include a smooth peripheral region around the stop, particularly in embodiments where one or more projections or recesses are configured to prevent rotation of the dental implant relative to bone.

Referring to Figure **10**, a dental implant in accordance with a fifth embodiment of the invention is shown generally at **330**. The dental implant **330** includes an elongate body shown generally at **332**. The elongate body **332** has an affixing portion **334** for affixing the dental implant **330** in the mouth of a patient, and a denture engaging portion (or "abutment portion") **336** for engaging a denture such as the overdenture **102** (shown in Figure **1**). The denture engaging portion **336** is substantially the same as the denture engaging portion **154** shown in Figure **4**. Again, only a peripheral torque transfer surface (such as the peripheral torque transfer surface **178** shown in Figures **4** and **5**) is shown, although it will be appreciated that the dental implant **330** may additionally or alternatively include a recessed torque transfer surface (such as the recessed torque transfer surface **306** shown in Figures **6** and **7**). Alternatively, the denture engaging portion **336** may not include any torque transfer surface, and may instead include a smooth peripheral region around the stop, particularly in embodiments where one or more projections or recesses are configured to prevent rotation of the dental implant relative to bone.

The affixing portion **334** includes a generally cylindrical portion **338** of the elongate body **332** for connecting directly to bone in the mouth of a patient (such as the bone **108** shown in Figures **1** to **3**) by frictionally engaging the bone. The affixing portion **334** also includes a rounded end portion **340**. Again, to facilitate osseointegration, the affixing portion **334** in this

embodiment is made with an alloy including titanium or another biocompatible material such as zirconium, for example, and may be coated with hydroxyl appetite (not shown) or otherwise roughened. The affixing portion **334** includes a shoulder portion **342** adjacent the denture engaging portion **336** to facilitate platform switching as described above. The affixing portion **334** thus functions as a bone connector and is used to affix the dental implant **330** in the mouth of a patient. The affixing portion **334** may further include one or more projections or recesses (such as the longitudinal projections **240** and **242** shown in Figure **9**, for example), to prevent movement of the dental implant **330** relative to the bone.

The first dental implant **122** (shown in Figures **3** to **5**), and the dental implants **300** (shown in Figures **6** and **7**), **210** (shown in Figure **8**), **230** (shown in Figure **9**), and **330** (shown in Figure **10**), are, in those embodiments, unitary dental implants that directly engage bone, such as the bone **108** (shown in Figures **1** and **2**), for example.

Referring to Figure **1**, as an alternative to the unitary implants shown in Figures **2** to **10**, a two piece dental implant may be employed, and the second dental implant **124** is an example of a two-piece dental implant. This type of implant includes a fixture **126** attached directly to the bone **108**, and an abutment **128** connected to the fixture **126**. In the embodiment shown, the fixture **126** is made with an alloy including titanium or another biocompatible material such as zirconium, for example, to facilitate osseointegration, and is submerged about one to two millimetres below the gum-contacting surface **160** (shown in Figure **1**) to facilitate platform switching as described above.

Referring to Figure **11**, the abutment **128** (also shown in Figure **1**) includes an elongate body shown generally at **250**. The elongate body **250** has an affixing portion **252**, which in this embodiment may be referred to as a "fixture connector", for connecting the abutment **128** to the fixture **126**, which is attached directly to the bone **108** (as shown in Figure **1**). The affixing portion **252** is thus used to affix the abutment **128** in the mouth of a patient.

Referring to Figures **1** and **11**, the affixing portion **252** includes a threaded portion **254** of the elongate body **250** for threadedly engaging a complementary portion **256** of the fixture **126**. The affixing portion **252** also includes a mating surface, which in the embodiment shown includes a tapered portion **258** of the elongate body **250** for engaging a complementary receptacle **260** of the fixture **126**. The tapered portion **258** of the elongate body **250** in the embodiment shown may be referred to as a "Morse taper", and the cooperation of the tapered portion **258** and the complementary receptacle **260** of the fixture **126** has been found to facilitate a secure connection between the affixing portion **252** of the abutment **128** to the fixture **126**.

The abutment **128** also includes a denture engaging portion **262** that is substantially the same as the denture engaging portions **154** (shown in Figure **4**), **216** (shown in Figure **8**), **236** (shown in Figure **9**), and **336** (shown in Figure **10**) although again, a stop **263** of the denture engaging portion **262** may include one or both of a peripheral torque transfer surface such as the peripheral torque transfer surface **178** (shown in Figures **4** and **5**) and a recessed torque transfer surface (such as the recessed torque transfer surface **306** shown in Figures **6** and **7**).

Referring to Figure **12**, an abutment assembly in accordance with a sixth embodiment of the invention is shown generally at **350**, and includes an abutment shown generally at **352** and a fastener shown generally at **360**. The abutment **352** includes an elongate body that has an affixing portion **354** having a fixture end **370**. The affixing portion **354** in the embodiment shown includes a mating surface **356** for contacting a complementary surface on a fixture, such as the complementary receptacle **260** of the fixture **126** shown in Figure **1**, for example. In the embodiment shown, the mating surface **356** is a tapered portion that may be referred to as a "Morse taper" to facilitate a secure connection between the affixing portion **354** of the abutment **352** to the fixture. Alternatively, the mating surface **356** may have an internal or external

polygonal cross-section, such as a triangular, square, or hexagonal cross-section, for example.

The abutment **352** also includes a denture engaging portion **358** that is substantially the same as the denture engaging portions **154** (shown in Figure **4**), **216** (shown in Figure **8**), **236** (shown in Figure **9**), **336** (shown in Figure **10**), and **262** (shown in Figure **11**). However, in the embodiment shown, a stop **359** of the denture engaging portion **358** may not include any torque transfer surface, and may instead include a smooth peripheral region around the stop, as the fastener **360** facilitates holding the abutment **352** in a fixture (such as the fixture **126** shown in Figure **1**, for example).

In the embodiment shown, the abutment **352** defines a through-channel **362** for receiving the fastener **360**. The fastener **360** includes a head **363** that defines a retaining surface **364** for contacting a complementary surface **366** of the abutment **352** in the through-channel **362**. When the fastener **360** is received within the through-channel **362**, the retaining surface **364** contacts the complementary surface **366**, and a threaded portion **368** of the fastener **360** protrudes through the fixture end **370** of the abutment **352**. The threaded portion **368** is threadedly received in a complementary threaded portion of a fixture (such as the complementary portion **256** of the fixture **126** shown in Figure **1**, for example), thereby holding the mating surface **356** against a complementary surface of the fixture (such as the complementary receptacle **260** of the fixture **126** shown in Figure **1**, for example). The affixing portion **354** is thus used to affix the abutment **352** in the mouth of a patient.

Unitary dental implants such as the first dental implant **122** (shown in Figures **3** to **5**), and the dental implants **300** (shown in Figures **6** and **7**), **210** (shown in Figure **8**), **230** (shown in Figure **9**), and **330** (shown in Figure **10**), for example, generally have a maximal diameter (shown respectively at **204** in Figure **4**, at **320** in Figure **6**, at **222** in Figure **8**, at **246** in Figures **9,** and at **344** in Figure **10**) of their respective bone-engaging portions that is less than about three millimeters, although some unitary dental implants may have maximal diameters of their bone-engaging portions in excess of three millimetres. In

contrast, a two-piece dental implant such as the second dental implant **124** (shown in Figure **1**) generally has a maximal diameter of its bone-engaging portion (shown at **264** in Figure **1**) of greater than about three millimetres.

Unitary dental implants such as the first dental implant **122** may thus be referred to as "minis". Generally, a suitable dental implant will have a bone-engaging portion having a maximal diameter that leaves at least about two millimeters of bone surrounding the bone-engaging portion. Therefore, unitary dental implants are more frequently used in regions of a mouth where bone is generally relatively narrow and deep, whereas two-piece dental implants such as the second dental implant **124** may be more suitable for use in regions of a mouth where bone is generally relatively thick and shallow. For example, bone width in the mouth of a patient is known to diminish over time in regions of the mouth where natural teeth are missing, and thus narrower unitary dental implants such as the first dental implant **122**, for example, may be more frequently used in such regions.

Referring to Figures **1** and **13**, the denture system **100** is shown in different arrangements. Figure **1** shows the denture system **100** in a separated arrangement, wherein the denture base **104** is spaced apart from the soft tissue **106**, and the first and second dental implants **122** and **124** are not received in the first and second cavities **134** and **136**. Figure **13** shows the denture system **100** in an assembled arrangement. In the assembled arrangement, the soft tissue **106** is received within the channel **105** (shown in Figure **1**), the denture base **104** is seated against the soft tissue **106**, the denture engaging portion **154** of the first dental implant **122** is received within the first cavity **134**, and the denture engaging portion **262** of the second dental implant **124** is received within the second cavity **136**. As shown, a mixture of different types of dental implants may be used in the mouth of one patient, depending upon the thickness and depth of available bone, for example, at various locations the mouth of the patient.

The second denture connector assembly **132** substantially resembles the first denture connector assembly **130**, and the denture engaging portion **262** of the

second dental implant **124** is substantially the same as the denture engaging portion **154** of the first dental implant **122**. Therefore, for simplicity, the functions of the first denture connector assembly **130** and the denture engaging portion **154** of the first dental implant **122** are described below, although it will be appreciated that the second denture connector assembly **132** and the denture engaging portion **262** of the second dental implant **124** function in substantially the same way.

Referring back to Figure **3**, the diameter **172** of the stop **164** is less than the inner diameter **146** of the first opening **131**, and less than the inner diameter **143** of the inner wall **137**, so that the stop **164** can pass through the first opening **131** and into the first cavity **134**, as shown in Figure **13**.

In order to configure the denture system **100** in the assembled arrangement shown in Figure **13**, the overdenture **102** is positioned in the mouth of a patient as shown in Figure **1**, such that the first dental implant **122** is generally aligned with the first opening **131**, and the denture engaging portion **262** of the second dental implant **124** is generally aligned with the second opening **133**. The overdenture **102** is then pressed onto the soft tissue **106** such that the denture engaging portion **154** of the first dental implant **122** is received within the first cavity **134**, and the denture engaging portion **262** of the second dental implant **124** is received within the second cavity **136**.

Referring to Figure **3**, in response to an increase in force on the overdenture **102** towards the soft tissue **106**, the denture connector **138** is urged against the convex end surface **168**, which bears on the inner surface **147** of the denture connector **138**. This force on the overdenture **102** causes the convex end surface **168** to deform the resilient denture connector **138**, expanding the inner surface **147** from the uncompressed diameter **149** to at least the diameter **172** of the stop **164**, thus urging the denture connector **138** over the peripheral region **170**. The convex shape for the end surface **168** thus advantageously facilitates positioning the denture connector **138** in the retained position on the guide **162**. When the denture engaging portion **154** is

received within the first cavity **134**, as shown in Figure **13**, the denture connector **138** is positioned on the guide **162**.

Still referring to Figures **3** and **13**, the diameter **172** of the stop **164** is greater than the uncompressed diameter **149** of the inner surface **147** of the denture connector **138**, so that the stop surface **166** retains the denture connector **138** in the assembled arrangement on the guide **162**, as shown in Figure **13**. The first dental implant **122** thus functions as an apparatus to hold the overdenture **102** in the mouth of a patient.

Although in the embodiment shown, the denture connector **138** includes a resilient ring, it will be appreciated that alternatively, the denture connector **138** may include a silicone lining, or plastic or other resilient materials, for example, that function as a cushion and that can be resiliently deformed or compressed as the denture connector **138** is positioned against the guide **162** and thereby retained by the stop **164**.

Referring back to Figure **3**, the first width **176** of the elongate surface portion **175** in the embodiment shown is approximately equal to, or slightly greater than, the uncompressed diameter **149** of the inner surface **147** of the denture connector **138**, and thus the elongate surface portion **175** is dimensioned to slidably contact the denture connector **138** to enable the denture connector **138** to move longitudinally along the elongate surface portion **175** between the stop **164** and the affixing portion **152**.

When the denture system **100** is in the assembled arrangement shown in Figure **13**, the overdenture **102** is pressed against the soft tissue **106** in response to a load on the overdenture **102** resulting from biting or chewing, for example, and the denture connector **138** is therefore guided by the guide **162** in longitudinal movement along the elongate body **150** in a direction towards the soft tissue **106**. Advantageously, because the denture connector **138** can move longitudinally along the elongate body **150**, at least a greater portion of load on the overdenture **102** is transferred to the soft tissue **106** instead of to the first dental implant **122**, when compared to other dental

implants that hold a guide in a fixed longitudinal position relative to the dental implant. The overdenture **102** may therefore be referred to as a "soft-tissue-supported overdenture". By facilitating transfer of load on the overdenture **102** to the soft tissue **106** adjacent the first dental implant **122**, a reduced load (also known as "vertical load") may be transferred to the first dental implant **122**, thus advantageously reducing load transferred to the affixing portion **152** that may loosen or otherwise weaken the connection of the first dental implant **122** to the bone **108**.

As indicated above, the denture connector **138** in the embodiment shown is a rubber O-ring, having a resilient tendency to push inwards on the guide **162**. Because the first width **176** is less than the second width **177**, the denture connector **138** exerts a greater inward force on the elongate surface portion **175** as the denture connector **138** is displaced along the guide **162** away from the stop **164**. Therefore, in the assembled arrangement shown in Figure **13**, a load on the overdenture **102** from biting or chewing, for example, may displace the denture connector **138** away from the stop **164**, but the inward force of the denture connector **138** on the elongate surface portion **175** urges the denture connector **138** back along the guide **162** towards the stop **164**.

In order to reduce vertical loading, contact between the end surface **142** of the denture base **104** to the end surface **168** is preferably reduced or eliminated. Therefore, the first denture connector assembly **130** in the embodiment shown includes sufficient clearance above the end surface **168** to avoid such contact. A gently curved convex end surface **168** allows for reduced clearance within the first denture connector assembly **130** when compared to some known O-ring abutments, and reducing this clearance advantageously increases thickness and strength of the denture base **104**, enabling a stronger overdenture **102**.

Although the first dental implant **122** and the first denture connector assembly **130** are shown in Figures **2** and **8**, the dental implants **300**, **210, 230**, and **330** (shown in Figures **6**, **8**, **9**, and **10** respectively), the abutment **128** of the second dental implant **124** (shown in Figures **1** and **11**), and the abutment

352 (shown in Figure **12**) function in a similar manner with a denture connector assembly such as the first denture connector assembly **130**. Therefore, the dental implants **300**, **210**, **230**, and **330** (shown in Figures **8**, **9**, and **10** respectively) and the abutment **128** and **352** (shown in Figures **11** and **12** respectively) also function as apparatuses for holding an overdenture in the mouth of a patient.

While specific embodiments of the invention have been described and illustrated, such embodiments should be considered illustrative of the invention only and not as limiting the invention as construed in accordance with the accompanying claims.

What is claimed is:

1. An apparatus for holding a denture having a denture connector in a mouth of a patient, the apparatus comprising:

an elongate body having:

affixing means for affixing the apparatus in the mouth of the patient; and

denture engaging means for engaging the denture, said denture engaging means including:

guiding means for guiding the denture connector in longitudinal movement along said elongate body, said guiding means dimensioned to enable the denture connector to move and be guided in longitudinal movement along said elongate body in response to a load on the denture to locate the denture connector in a position to facilitate transfer of the load to soft tissue adjacent the apparatus in the mouth of the patient; and

retaining means for receiving and retaining the denture connector on said guiding means.

2. The apparatus of claim **1** wherein said guiding means comprises an elongate surface portion on said elongate body, said elongate surface portion being disposed between said retaining means and said affixing means, and operably configured to slidably contact the denture connector to enable the denture connector to move longitudinally along said elongate surface portion between said retaining means and said affixing means.

3. The apparatus of claim **1** or **2** further comprising means for urging said denture connector along said guiding means towards said retaining means.

4. The apparatus of claim **2** wherein said elongate surface portion has a first width adjacent said retaining means and a second width greater than said first width adjacent said affixing means, to urge said denture connector along said guiding means towards said retaining means.

5. The apparatus of any one of claims **1** to **4** wherein said retaining means comprises a stop having a stop surface generally facing said guiding means for retaining the denture connector on said guiding means.

6. The apparatus of claim **5** wherein said stop has a peripheral torque transfer surface for receiving torque from a tool a first to affix said affixing means in the mouth of the patient.

7. The apparatus of claim **6** wherein said peripheral torque transfer surface has a generally polygonal shape.

8. The apparatus of claim **5**, **6**, or **7** wherein said stop has a recessed torque transfer surface for receiving torque from a second tool to affix said affixing means in the mouth of the patient.

9. The apparatus of claim **8** wherein said recessed torque transfer surface has a generally polygonal shape.

10. The apparatus of any one of claims **5** to **9** wherein said stop has an end surface generally opposite said stop surface, and a peripheral region between said end surface and said stop surface.

11. The apparatus of claim **10** wherein said end surface comprises a gently curved convex surface to facilitate urging the denture connector over said peripheral region and onto said guiding means.

12. The apparatus of claim **11** wherein said end surface includes a spherical cap portion.

13. The apparatus of any one of claims **1** to **12** wherein said affixing means comprises a fixture connector for connecting the apparatus to a fixture attached to bone in the mouth of the patient.

14. The apparatus of claim **13** wherein said fixture connector includes a threaded portion of said elongate body for threadably engaging a complementary portion in said fixture.

15. The apparatus of claim **13** or **14** wherein said fixture connector includes a mating surface on said elongate body for engaging a complementary receptacle of said fixture.

16. The apparatus of claim **15**, wherein said mating surface is tapered to facilitate a Morse taper with said complementary receptacle.

17. The apparatus of any one of claims **1** to **12** wherein:

said affixing means comprises a mating surface on said elongate body for contacting a complementary surface on a fixture attached to bone in the mouth of the patient; and

said elongate body defines a through-channel for receiving a fastener for fastening the apparatus to said fixture.

18. The apparatus of any one of claims **1** to **12** wherein said affixing means includes a bone connector for connecting the apparatus directly to bone in the mouth of the patient.

19. The apparatus of claim **18** wherein said bone connector includes a threaded portion of said elongate body for threadably engaging said bone.

20. The apparatus of claim **18** wherein said bone connector includes a wedge portion of said elongate body for frictionally engaging said bone.

21. The apparatus of claim **18** wherein said bone connector includes a generally cylindrical portion.

22. The apparatus of claim **20** or **21** wherein said bone connector further includes at least one projection for engaging said bone to prevent movement of the apparatus.

23. The apparatus of claim **20**, **21**, or **22** wherein said bone connector further includes at least one recess for engaging said bone to prevent movement of the apparatus.

24. The apparatus of any one of claims **18** to **23** wherein said bone connector includes a shoulder portion adjacent said denture engaging means to facilitate bone growth over said shoulder portion to retain said bone connector in said bone.

25. Use of the apparatus of any one of claims **1** to **24** for holding the denture in the mouth of the patient.

26. A denture system comprising:

at least one of the apparatus of any one of claims **1** to **24**, said affixing means of each said at least one apparatus affixed in bone in a mouth of a patient; and

a denture having at least one connector, each said at least one connector being held by a corresponding said denture engaging means of a respective one of said at least one apparatus.

27. The denture system of claim **26** wherein each said at least one denture connector comprises a cushion.

28. The denture system of claim **27** wherein each said cushion comprises a resilient ring.

29. An apparatus for holding a denture having a denture connector in a mouth of a patient, the apparatus comprising:

an elongate body having:

an affixing portion operably configured to affix the apparatus in the mouth of the patient; and

a denture engaging portion operably configured to engage the denture, said denture engaging portion including:

a guide operably configured to guide the denture connector in longitudinal movement along said elongate body, said guide dimensioned to enable the denture connector to move and be guided in longitudinal movement along said elongate body in response to a load on the denture to locate the denture connector in a position to facilitate transfer of the load to soft tissue adjacent the apparatus in the mouth of the patient; and

a stop operably configured to receive and retain the denture connector on said guide.

30. The apparatus of claim **29** wherein said guide comprises an elongate surface portion on said elongate body, said elongate surface portion being disposed between said stop and said affixing portion, and operably configured to slidably contact the denture connector to enable the denture connector to move longitudinally along said elongate surface portion between said stop and said affixing portion.

31. The apparatus of claim **30** wherein said elongate surface portion has a first width adjacent said stop and a second width greater than said first width adjacent said affixing portion, to urge said denture connector along said guide towards said stop.

32. The apparatus of claim **29**, **30**, or **31** wherein said stop has a stop surface generally facing said guide, said stop surface operably

configured to stop the denture connector from separating from said guide.

33. The apparatus of claim **32** wherein said stop has an end surface generally opposite said stop surface, and a peripheral region between said end surface and said stop surface.

34. The apparatus of claim **33** wherein said end surface comprises a gently curved convex surface to facilitate urging the denture connector over said peripheral region and onto the guide.

35. The apparatus of claim **34** wherein said end surface includes a spherical cap portion.

36. The apparatus of any one of claims **29** to **35** wherein said stop has a peripheral torque transfer surface for receiving torque from a first tool to affix said affixing portion in the mouth of the patient.

37. The apparatus of claim **36** wherein said peripheral torque transfer surface has a generally polygonal shape.

38. The apparatus of any one of claims **29** to **37** wherein said stop has a recessed torque transfer surface for receiving torque from a second tool to affix said affixing portion in the mouth of the patient.

39. The apparatus of claim **38** wherein said recessed torque transfer surface has a generally polygonal shape.

40. The apparatus of any one of claims **29** to **39** wherein said affixing portion comprises a fixture connector for connecting the apparatus to a fixture attached to bone in the mouth of the patient.

41. The apparatus of claim **40** wherein said fixture connector includes a threaded portion of said elongate body for threadably engaging a complementary portion in said fixture.

42. The apparatus of claim **40** or **41** wherein said fixture connector includes a mating surface on said elongate body for engaging a complementary receptacle of said fixture.

43. The apparatus of claim **42** wherein said mating surface is tapered to facilitate a Morse taper with said complementary receptacle.

44. The apparatus of any one of claims **29** to **39** wherein:

said affixing portion comprises a mating surface on said elongate body for contacting a complementary surface on a fixture attached to bone in the mouth of the patient; and

said elongate body defines a through-channel for receiving a fastener for fastening the apparatus to said fixture.

45. The apparatus of any one of claims **29** to **39** wherein said affixing portion includes a bone connector for connecting the apparatus directly to bone in the mouth of the patient.

46. The apparatus of claim **45** wherein said bone connector includes a threaded portion of said elongate body for threadably engaging said bone.

47. The apparatus of claim **45** wherein said bone connector includes a wedge portion of said elongate body for frictionally engaging said bone.

48. The apparatus of claim **45** wherein said bone connector includes a generally cylindrical portion.

49. The apparatus of claim **47** or **48** wherein said bone connector further includes at least one longitudinal projection for engaging said bone to prevent movement of the apparatus.

50. The apparatus of claim **47**, **48**, or **49** wherein said bone connector further includes at least one recess for engaging said bone to prevent movement of the apparatus.

51. The apparatus of any one of claims **45** to **50** wherein said bone connector includes a shoulder portion adjacent said denture engaging portion to facilitate bone growth over said shoulder portion to retain said bone connector in said bone.

52. Use of the apparatus of any one of claims **29** to **51** for holding the denture in the mouth of the patient.

53. A denture system comprising:

at least one of the apparatus of any one of claims **29** to **51**, said affixing portion of each said at least one apparatus affixed in bone in a mouth of a patient; and

a denture having at least one connector, each said at least one connector being held by a corresponding said denture engaging portion of a respective one of said at least one apparatus.

54. The denture system of claim **53** wherein each said at least one denture connector comprises a cushion.

55. The denture system of claim **54** wherein each said cushion comprises a resilient ring.

56. A method of holding a denture having a denture connector in a mouth of a patient, the method comprising:

retaining the denture connector on a guiding portion of an elongate body affixed in the mouth of the patient; and

guiding the denture connector in longitudinal movement along said guiding portion in response to a load on the denture to locate the denture connector in a position on the guiding portion that facilitates transfer of the load to soft tissue adjacent the apparatus in the mouth of the patient.

57. The method of claim **56** further comprising urging said denture connector along said guiding portion away from said soft tissue.

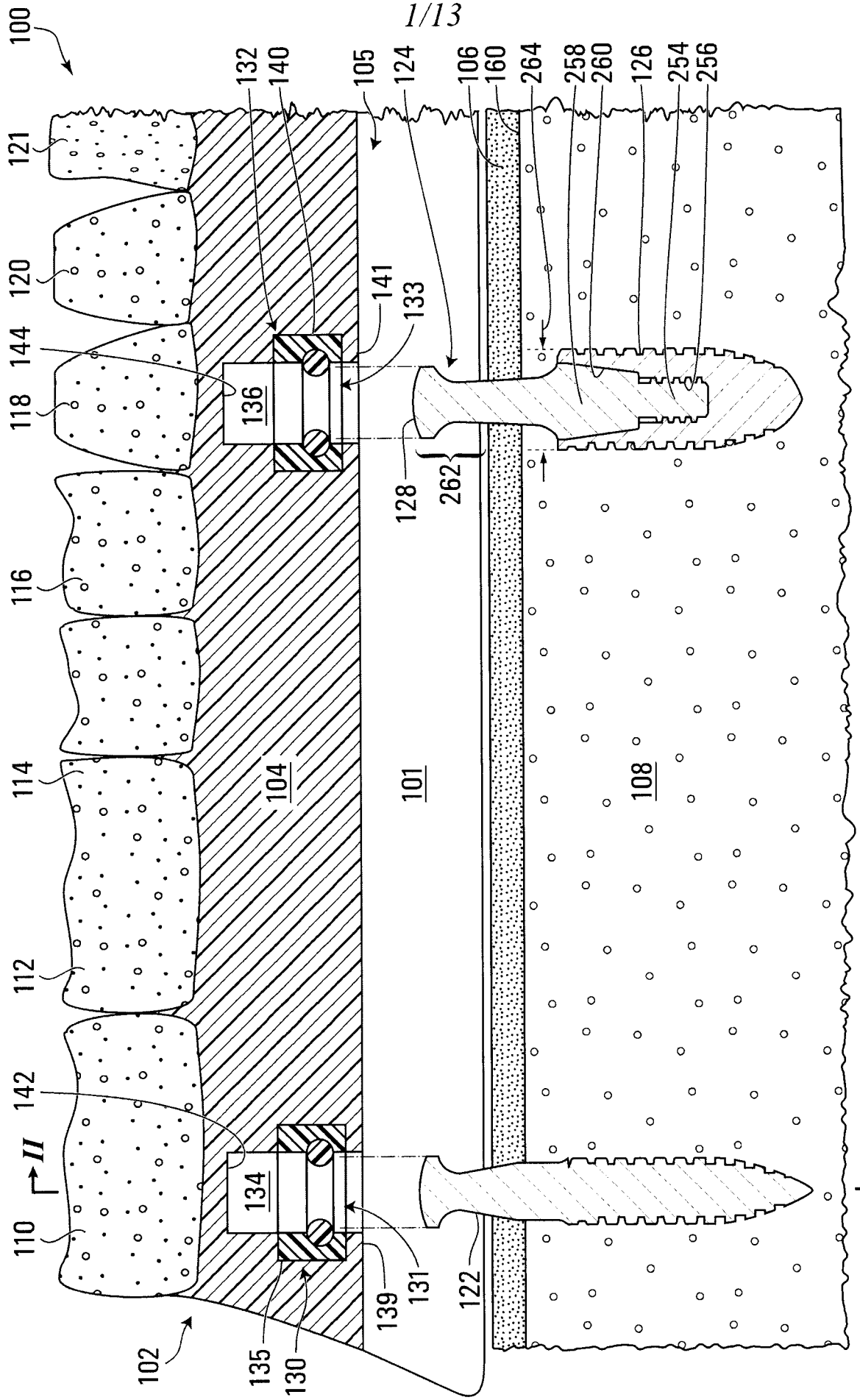
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FIG. 1

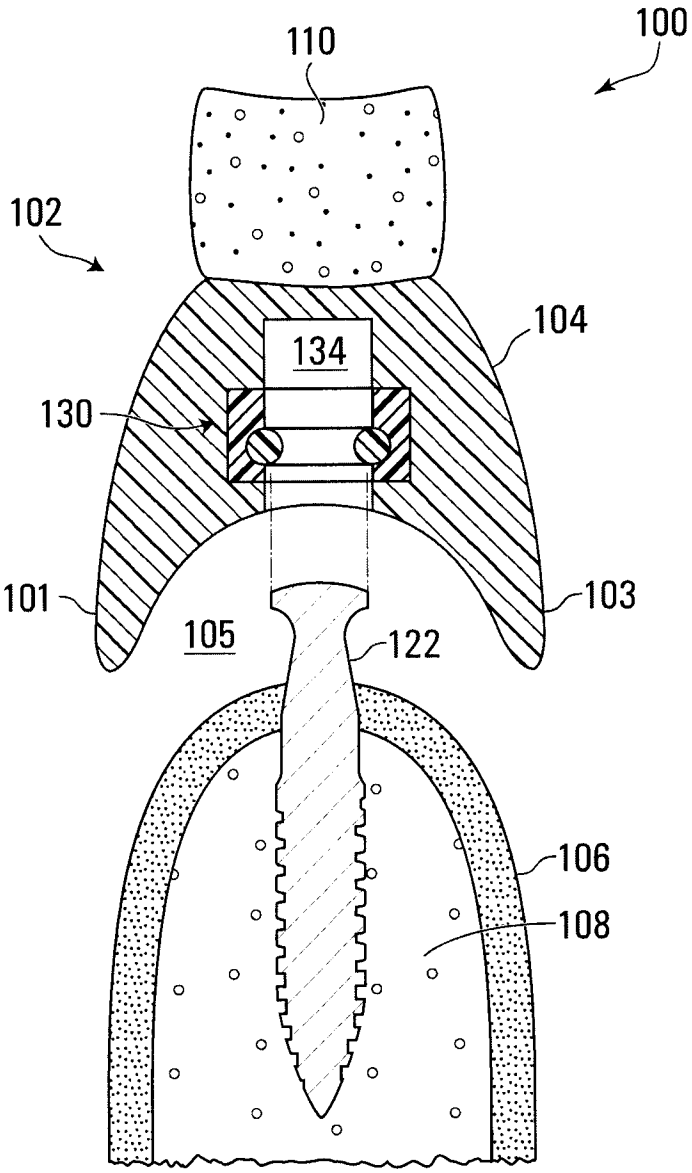

FIG. 2

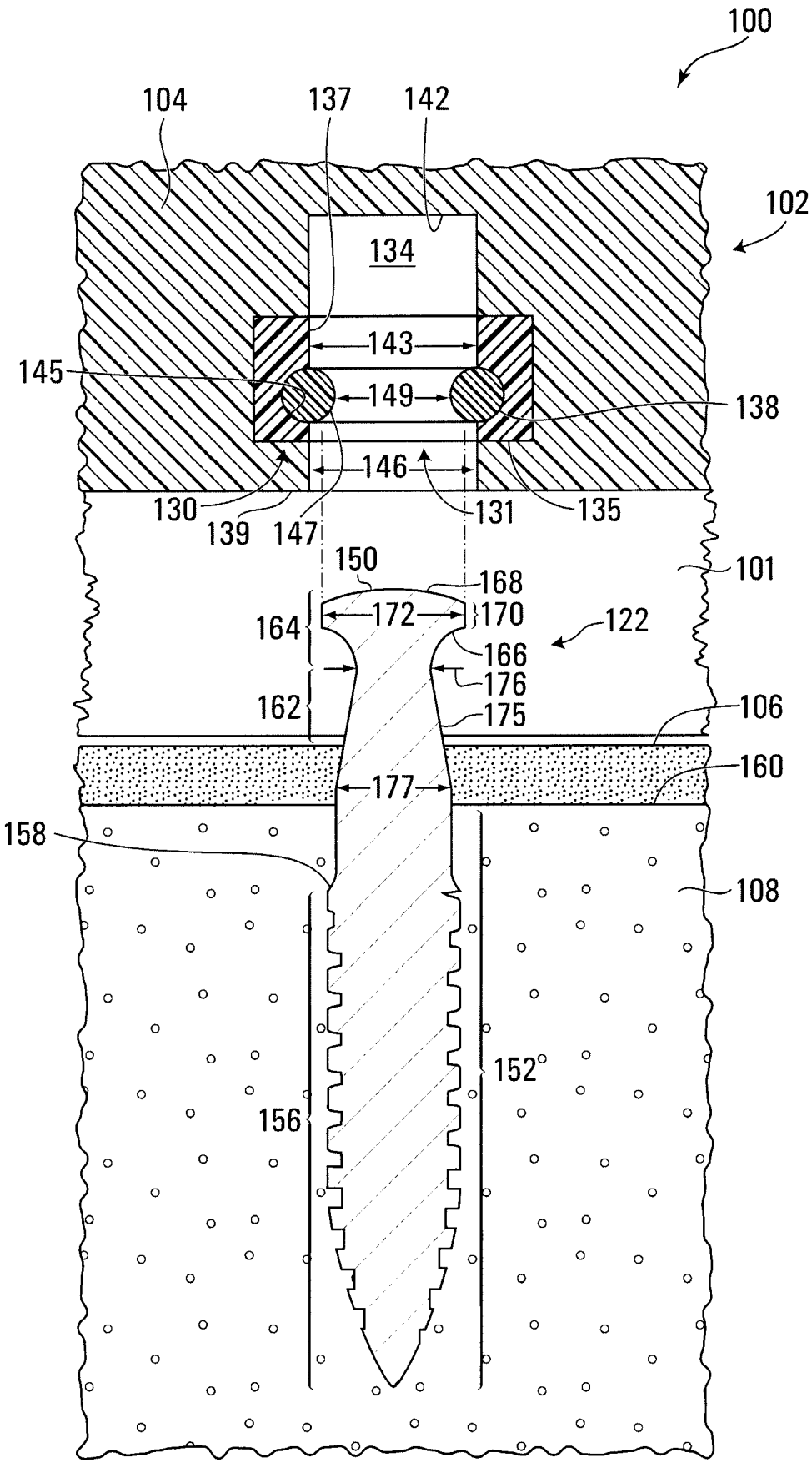
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FIG. 3

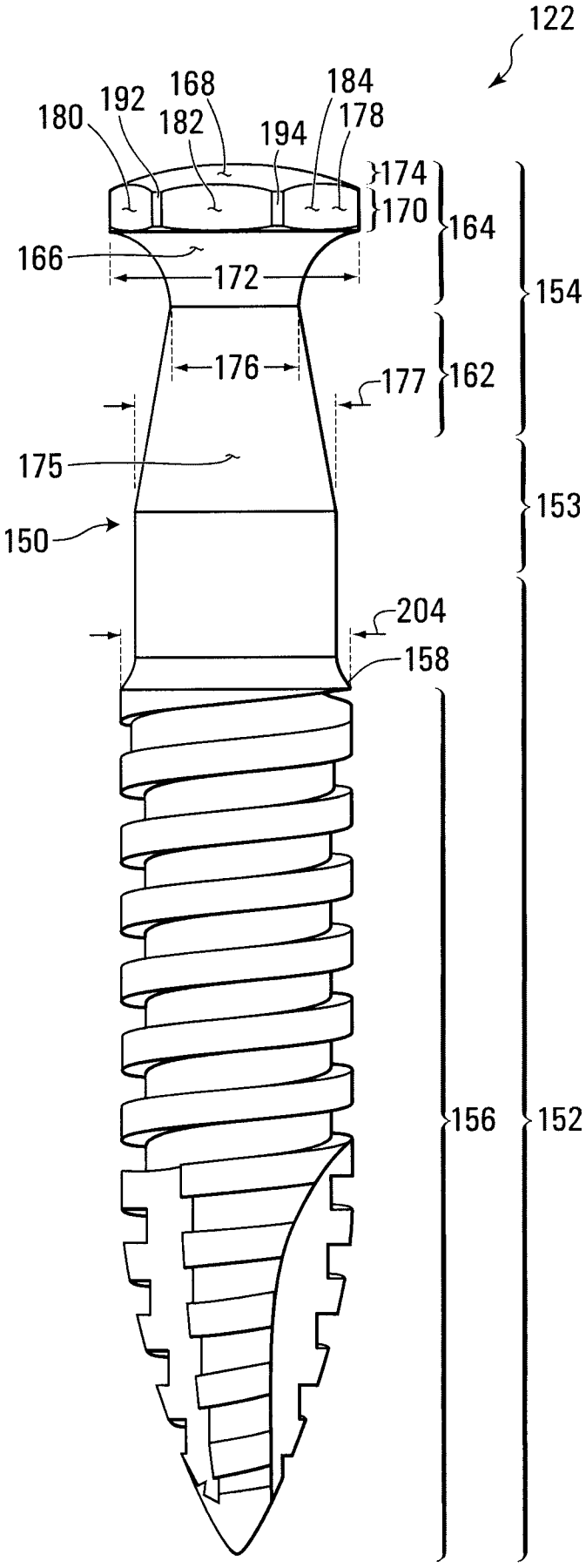
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FIG. 4

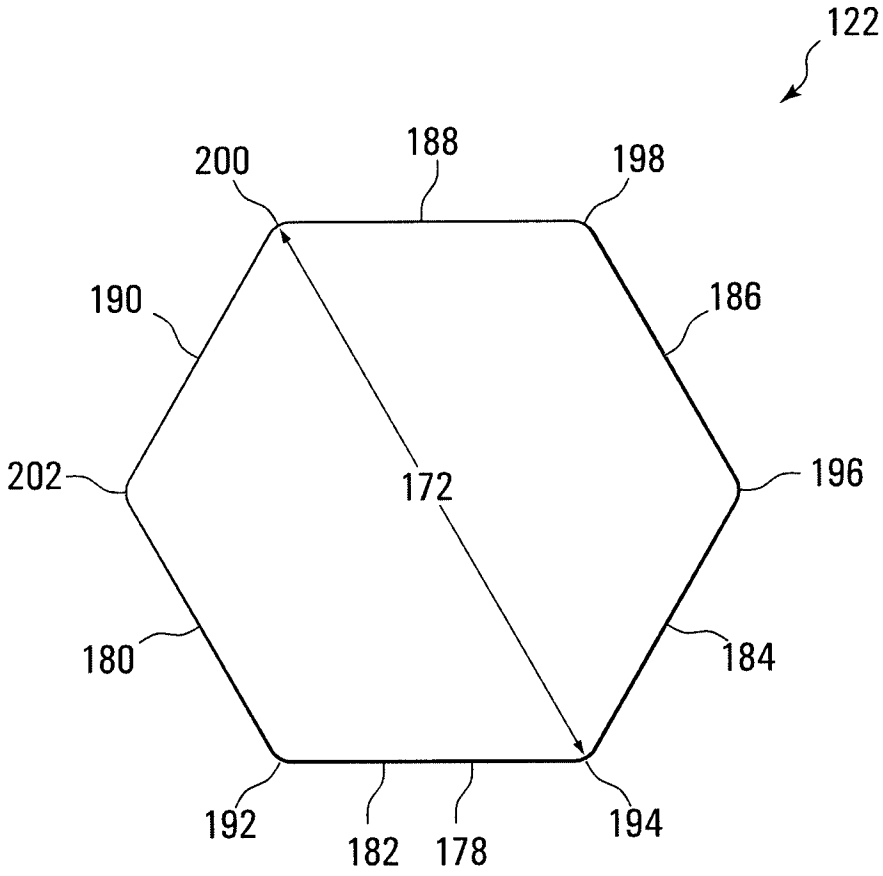

FIG. 5

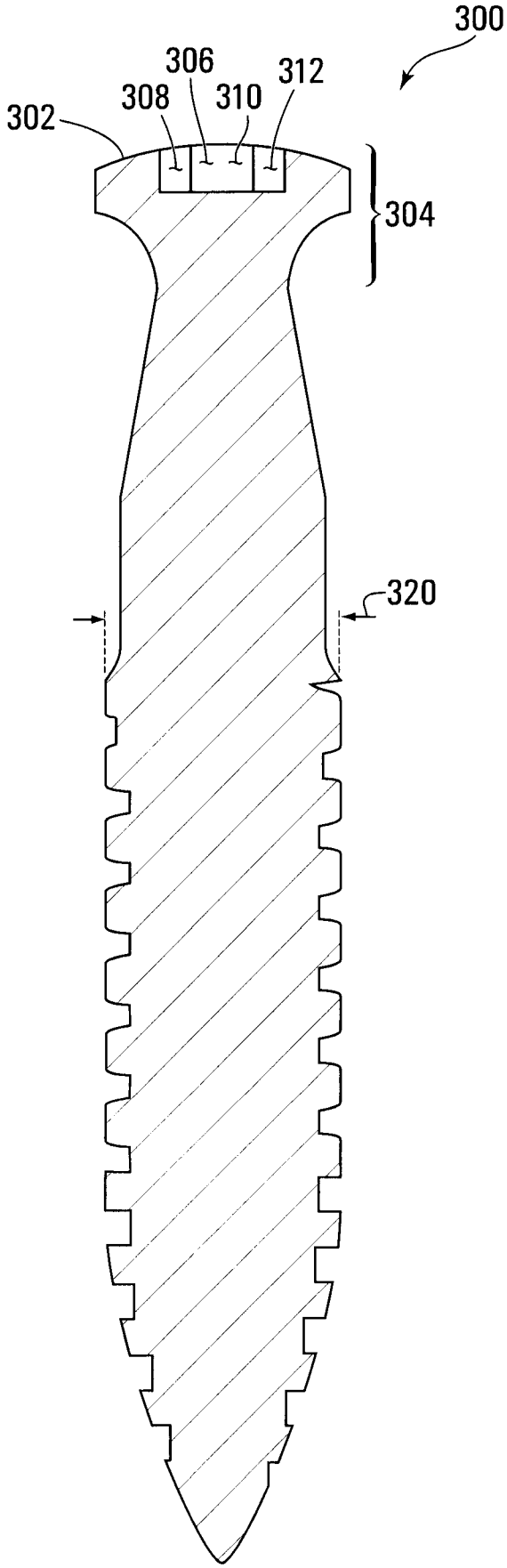

FIG. 6

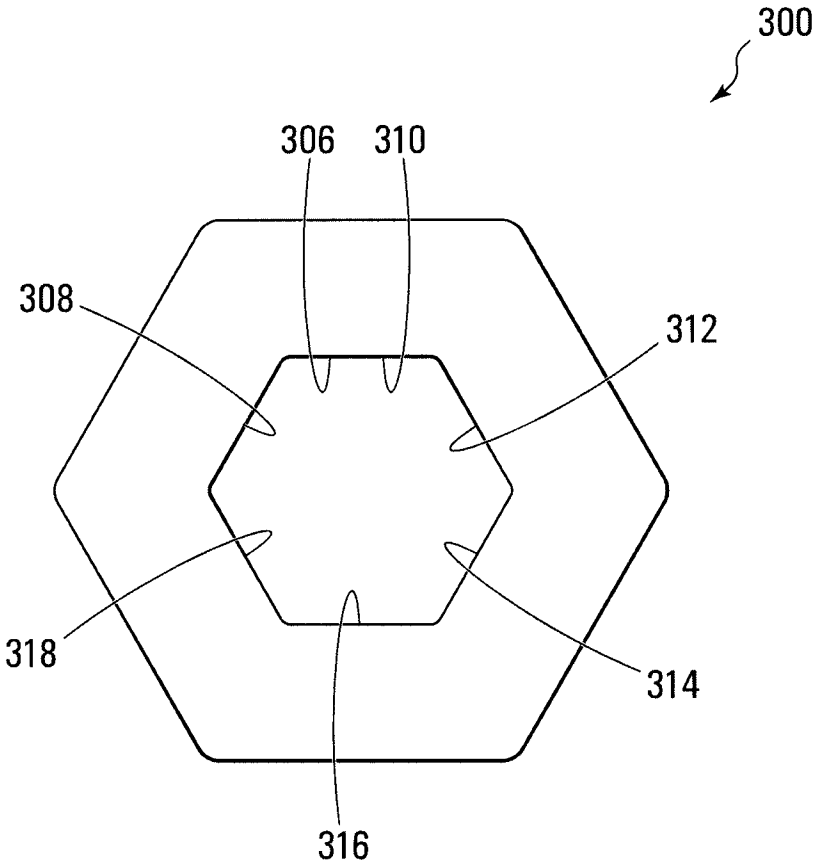

FIG. 7

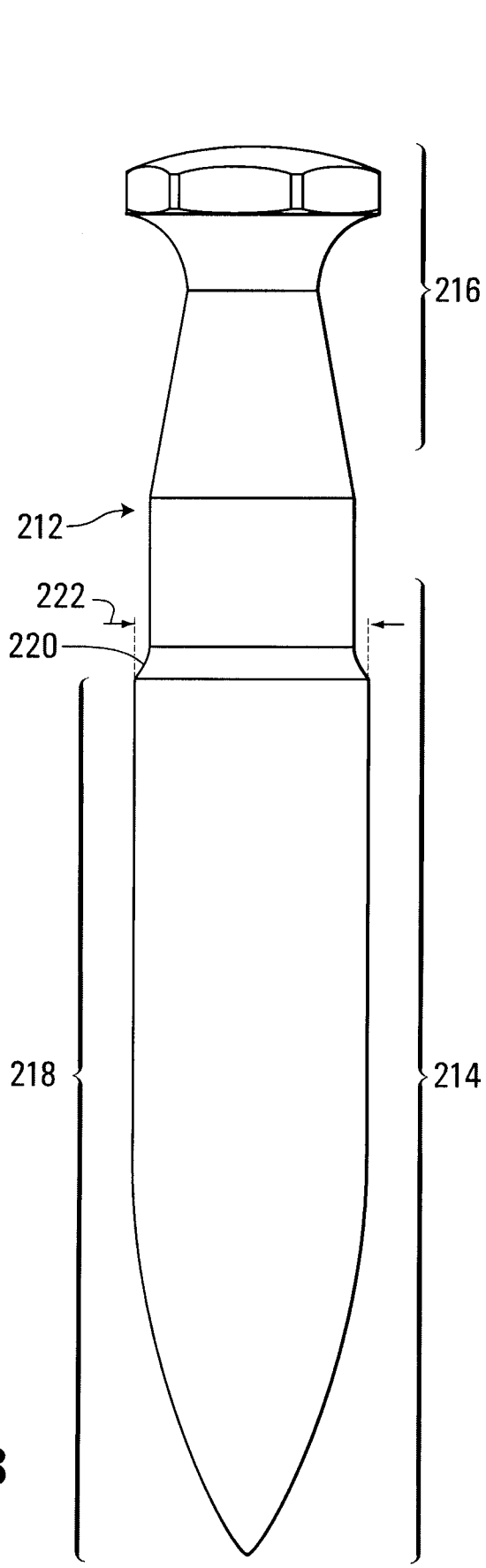

FIG. 8

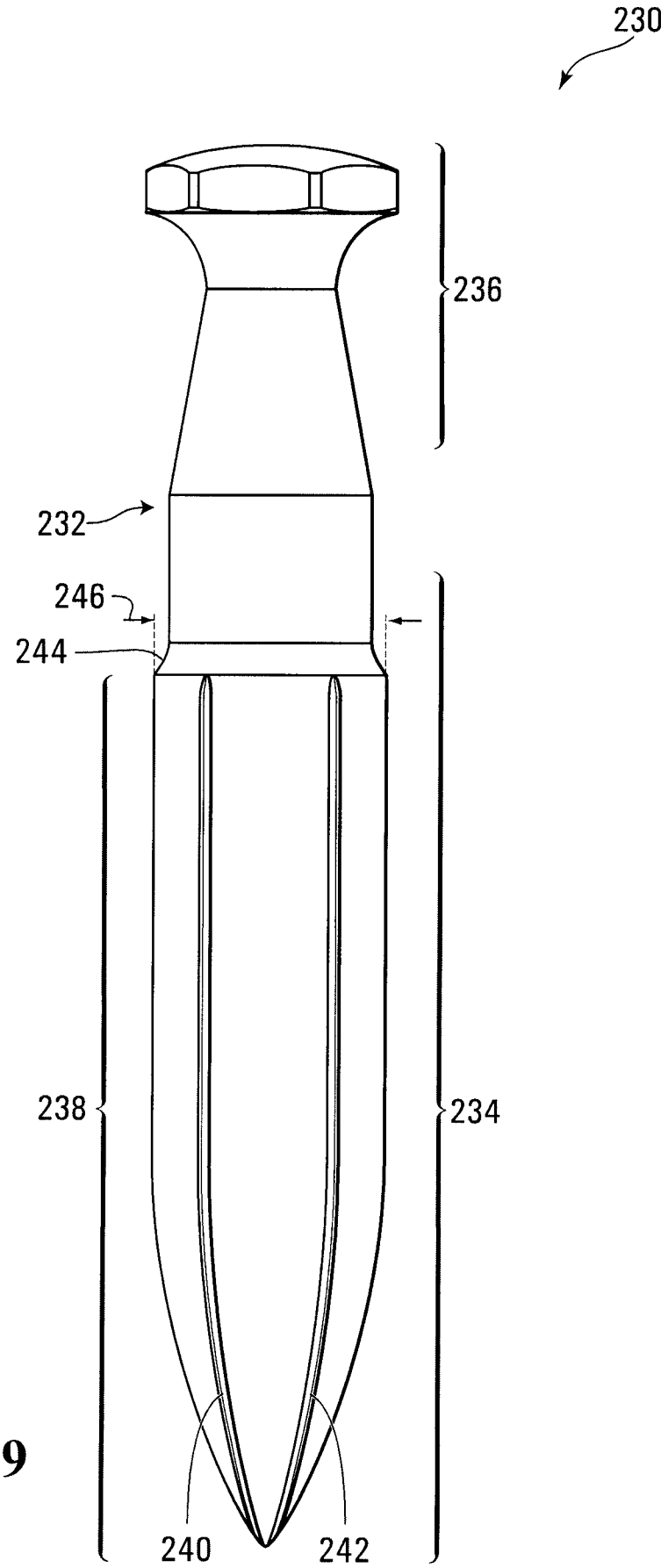

FIG. 9

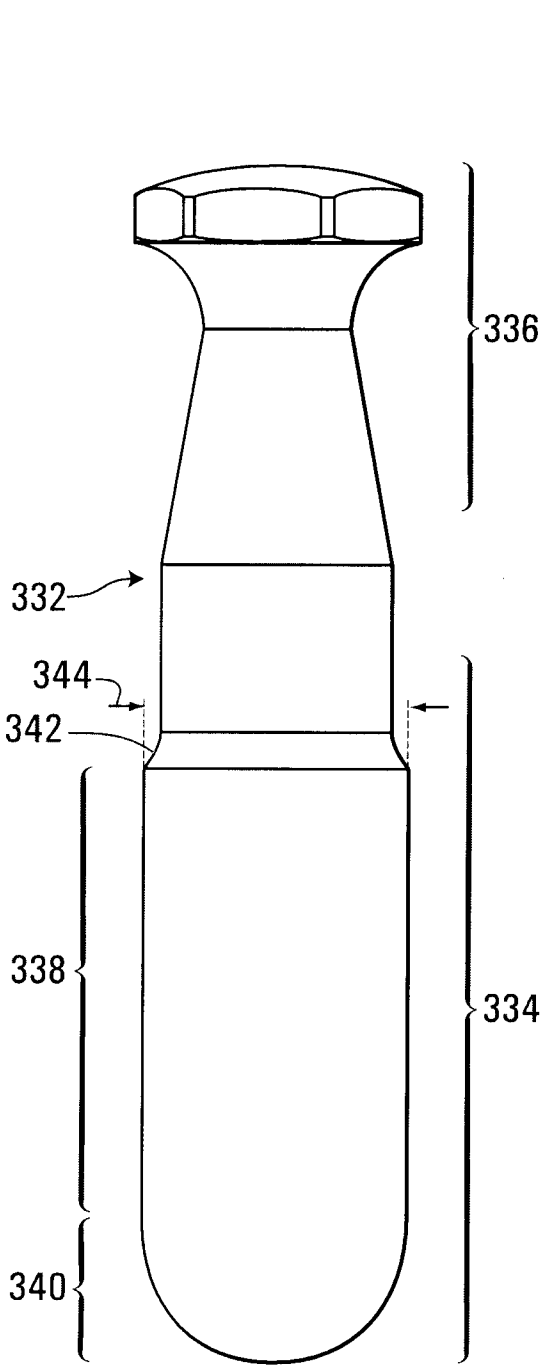

FIG. 10

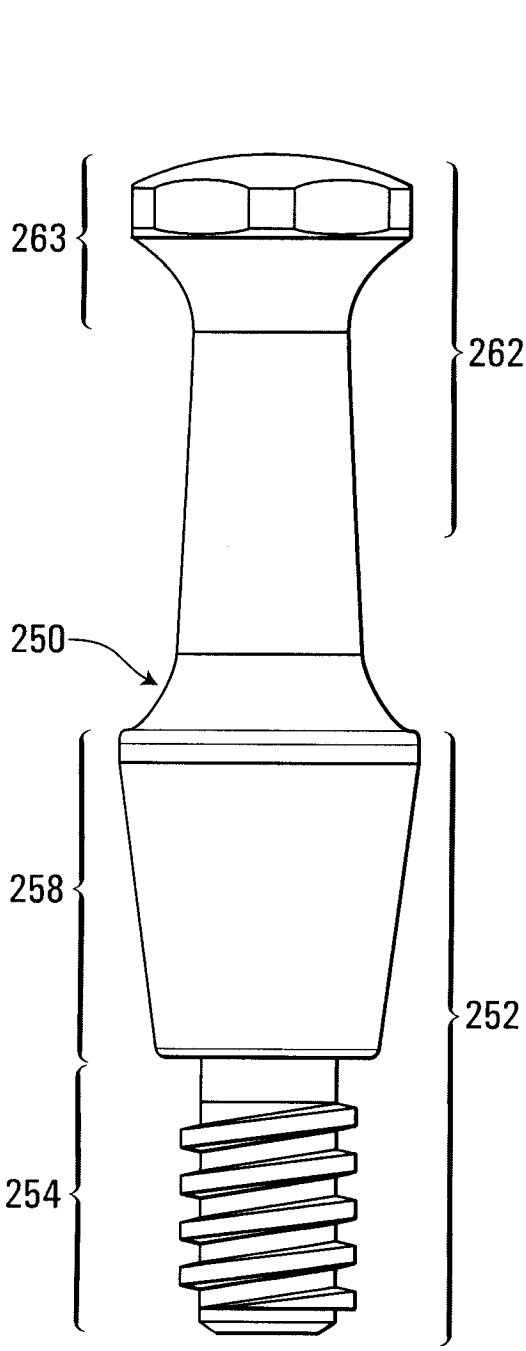

FIG. 11

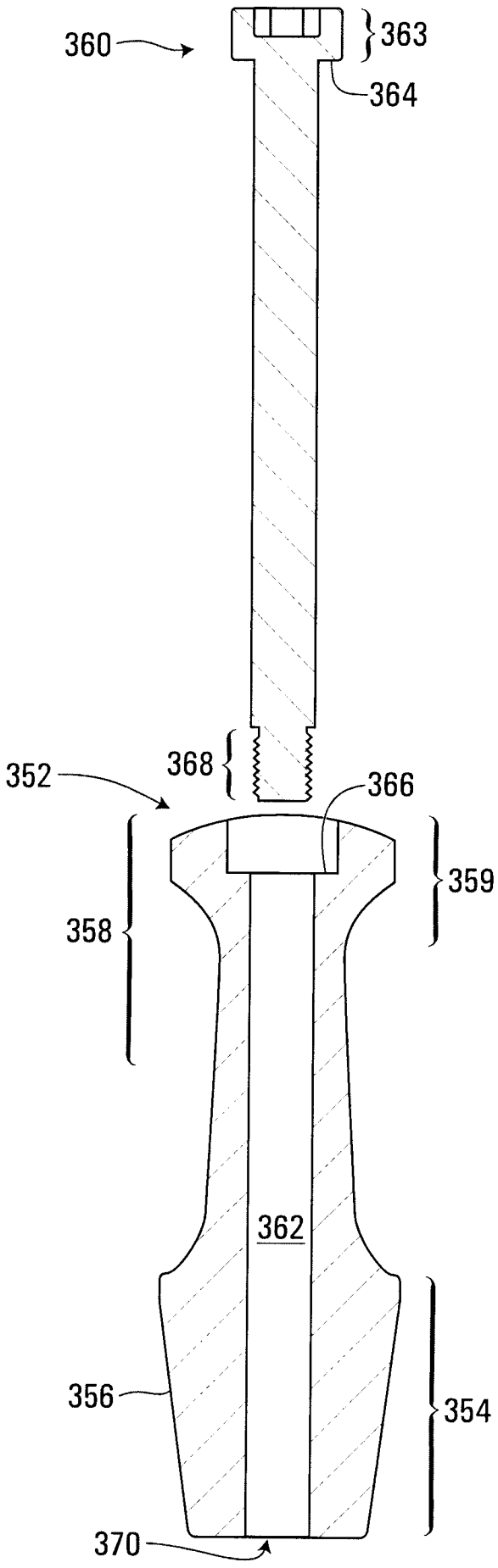

FIG. 12

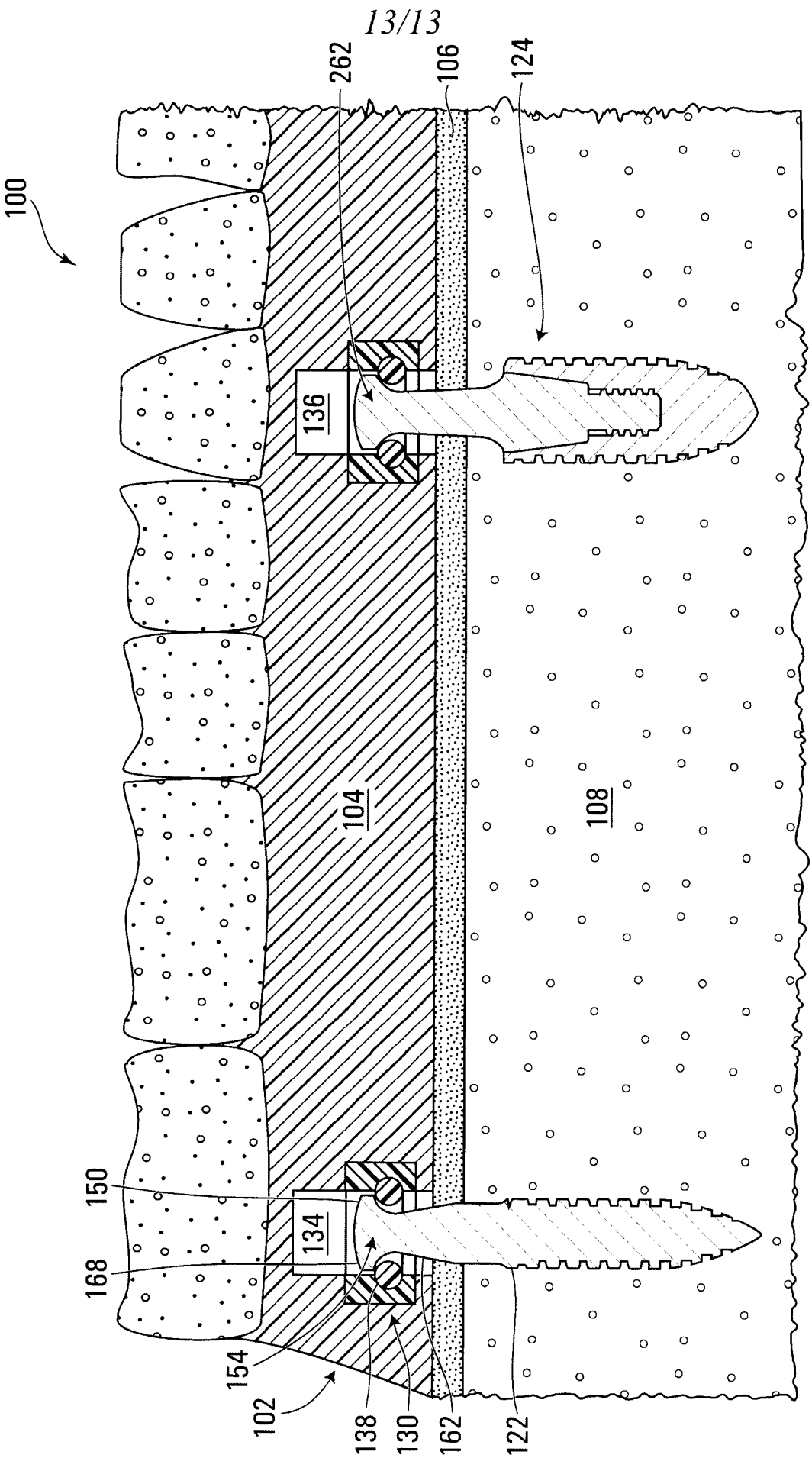

FIG. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2009/001798

A. CLASSIFICATION OF SUBJECT MATTER
IPC: ***A61C 13/225*** (2006.01) , ***A61C 13/265*** (2006.01) , ***A61C 13/30*** (2006.01)
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 [2006.01] : A61C

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

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
Epodoc : A61C 13/xx - A61C 8/xx ; denture ; implant/bone connector .

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,488,875 A (NIZNICK, G.A.) 18 December 1984 (18-12-1984) * Whole document *	1-5,10-13,15,18,19-26,29-35,40,42,45-53, 56
Y		6-9,14,16,17,27,28,36-39, 41, 43,44,54,55,57
Y	US 5,049,072 A (LUESCHEN, J.D.) 17 September 1991 (17-09-1991) * Abstract * * Figures 1, 2 *	6-9, 14, 17, 36-39, 41, 44
Y	US 6,302,693 B1 ((MENA, R.R.) 16 October 2001 (16-10-2001) *Figures 1-4 * *Col. 2, lines 8-39 *	16, 27, 28, 43, 54, 55
Y	US 2005/0250072 A1 (LAUX, T.) 10 November 2005 (10-11-2005) * Abstract * * Figure 3 *	57

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

[X] See patent family annex.

* Special categories of cited documents :

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

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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Date of the actual completion of the international search	Date of mailing of the international search report
28 July 2010 (28-07-2010)	20 August 2010 (20-08-2010)

Name and mailing address of the ISA/CA	Authorized officer
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CA2009/001798

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