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(71) Applicant *(for all designated States except US)*: **TRI DENTAL IMPLANTS AG** [CH/CH]; Zugerstrasse 77, CH-6430 Baar (CH).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **SZAKÁCS, Zoltán** [HU/HU]; Ibolya út 37, H-9400 Sopron (HU). **STEIGMANN, Marius** [DE/DE]; Leiblstrasse 1, 68163 Mannheim (DE).

(74) Agent: **KACSUK, Zsófia**; Üteg utca 11/A, H-1139 Budapest (HU).

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(54) Title: EXTERNALLY THREADED SELF-TAPPING DENTAL IMPLANT WITH VARYING THREAD-PROFILE

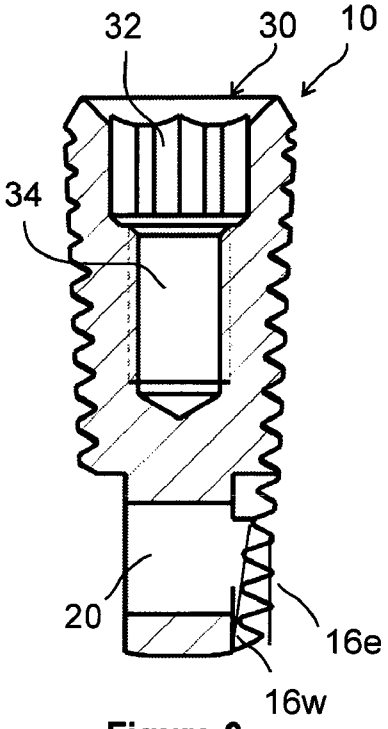

Figure 3

(57) Abstract: The invention relates to a self-tapping dental implant comprising an externally threaded body having a proximal neck portion, a middle portion, and a distal end portion, characterised in that the distal end portion is of a conical structure while the enveloping surface of the threads of the distal end portion is substantially cylindrical.

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EXTERNALLY THREADED SELF-TAPPING DENTAL IMPLANT WITH VARYING THREAD-PROFILE

The present invention relates to a self-tapping dental implant comprising an externally threaded body having a proximal neck portion a middle portion and a distal end portion.

Self-tapping implants are designed to be implanted directly into the bone during a surgical procedure. First the implantation site is exposed then a hole is drilled into the bone. The implant and a driver mount connected thereto are moved to the implantation site and the distal end of the implant is driven into the bore. As the implant is rotated, it simultaneously taps threads in the bone and is thereby screwed into these threads.

A typical self-tapping implant has a distal end which taps the threads into the bone and a proximal end for connection with an abutment designed to support a dental prosthesis. The distal end generally comprises one or more flutes or grooves provided with a cutting edge. In order to ensure perfect retention of the implant the distal end may be provided with a longitudinal apical hole and a transversal through-hole allowing the growth of the anchoring bone through the openings in the course of healing and osseointegration.

The implant body generally comprises an internal passage, which is designed to cooperate with corresponding engaging means of a healing screw and, once the healing screw is removed, with the engaging means of an abutment for a dental prosthesis.

The external surface of the prior art implants are either provided with threads of greater height and having a narrow angle of thread (i.e. the angle between two adjacent flanks measured at the cross-section of screw threads -

including the axis of the screw thread), typically an angle of thread of 45 degrees, or the external surface is provided with less high threads having a wider angle of thread, typically an angle of thread of 60 degrees.

The threads of greater height and smaller angle of thread are more optimal in respect of the self-tapping properties; however less high threads of greater angle of thread are better from the point of osseointegration and do not weaken the exterior wall of the implant whereby better resistance properties and higher implant strength is achievable.

The object of the present invention is to provide an externally threaded dental implant body with an external thread design that is superior to the prior art implants as regards tapping into the bone while at the same time facilitating osseointegration and maintaining the required wall strength and resistance.

The inventors have found that neither of the prior art solutions are optimal for performing the above functions for the following reasons.

The inventors have realised that while the smaller angle of thread is more optimal for tapping into the bone, the height of the thread is limited by the necessary wall thickness required around the inner passage of the implant body. In order to overcome this problem and ensure stable wall thickness the small angle of thread (typically 45 degrees) can be combined with less high threads leaving a relatively larger external thread crest surface. However, the relatively large crest surface impairs the good self-tapping properties. Furthermore, it is disadvantageous from the point of view of osseointegration which takes place mainly on the surface of the flanks of the external threads. Thus in order to maintain the good self-tapping properties and to enhance osseointegration the external surface area of the threads should preferably be maximised, meaning that threads should preferably comprise as little crest surfaces and external root surfaces as possible - instead larger flank area should be provided.

The inventors have further realised that the self-tapping properties of the threads can be ameliorated by providing threads of increasing height in the direction of the distal end of the implant.

The inventors have also realised that where the wall thickness of the implant does not allow for threads of greater height the larger angle of thread (typically 60 degrees) is optimal for minimising the crests and thereby maximising the external surface area of the flanks for the purpose of ameliorated osseointegration. Furthermore the less sharp threads are better from the point of view of force distribution once a prosthesis is supported by the implant and the prosthesis experiences external load in the course of chewing.

The inventors have thus realised that the object of the invention can be achieved by combining the benefits of the threads of greater height (and smaller angle of thread) at the distal end of the implant and the benefits of the larger angle of thread at the middle portion of the implant when designing the external threads of a dental implant body.

The above object is achieved by a self-tapping dental implant comprising an externally threaded body having a proximal neck portion, a middle portion, and a distal end portion, wherein the distal end portion is of a conical structure while the enveloping surface of the threads of the distal end portion is substantially cylindrical.

This structure provides for threads of increasing height in the direction of the distal end of the implant, whereby self-tapping properties of the thread is ameliorated where it is most needed.

Preferably the threads of the middle portion of the externally threaded body are substantially of a first height and have a first angle of thread, and the threads of the distal end portion are substantially of a second height being greater than the first height, and have a second angle of thread being smaller than the first angle of thread.

Further advantageous embodiments of the invention are defined in the attached dependent claims.

Further details of the invention will be apparent from the accompanying figures and exemplary embodiments.

Fig. 1 is a perspective side view of a first embodiment of a dental implant according to the invention.

Fig. 2 is a perspective side view of the first embodiment of the implant taken from a different angle.

Fig. 3 is a sectional view of the first embodiment of the implant taken along line A-A of Fig. 1.

Fig. 4 is a top plan view of the first embodiment of the implant.

Fig. 5 is a cross sectional profile of the first embodiment of the implant.

Fig. 6 is the enlarged view of section A of Fig. 5.

Fig. 7 is the enlarged view of section B of Fig. 5.

Fig. 8 is the enlarged view of section C of Fig. 5.

Fig. 9 is a perspective side view of a second embodiment of a dental implant according to the invention.

Fig. 10 is a perspective side view of the second embodiment of the implant taken from a different angle.

Fig. 11 is a sectional view of the second embodiment of the implant taken along line A-A of Fig. 9.

Fig. 12 is a top plan view of the second embodiment of the implant.

Fig. 13 is a cross sectional profile of the second embodiment of the implant.

Fig. 14 is the enlarged view of section A of Fig. 13.

Fig. 15 is the enlarged view of section B of Fig. 13.

Fig. 16 is the enlarged view of section C of Fig. 13.

Fig. 1 and 2 illustrate a first preferred embodiment of a self-tapping dental implant 10 in accordance with the present invention. The implant 10 has an externally threaded body 12 comprising a middle portion 14 of height H1 adjoining a distal end portion 16 of height H2 and a proximal neck portion 18 of height H3. In the present embodiment the body 12 has a transverse through-hole 20 at least partially within its distal end portion 16 allowing growth of the bone therethrough in the course of osseointegration. Optionally an apical hole (not shown) may be provided at the distal end of the distal end portion to further enhance anchoring of the implant 10. The through-hole 20 terminates in a flute 22 with a cutting edge 24 facilitating tapping into the bone at the implantation site when the implant 10 is screwed therein.

An internal passage 30 is provided within the body 12 as can be seen in the sectional view of Fig. 3. The internal passage 30 is designed to receive and cooperate with corresponding engaging means of various objects such as a driver mount a healing screw and an abutment for a dental prosthesis.

The internal passage 30 preferably comprises a proximal anti-rotational engagement portion 32 adapted for cooperation with a driver mount for driving the implant into the implantation site. In the present embodiment the anti-rotational engagement portion 32 is formed by a hex-shaped internal wall surface 32a as can be best seen in the top plan view of Fig. 4.

Preferably the anti-rotational engagement portion 32 is followed by an internally threaded bore 34 allowing a healing screw to be screwed therein.

In accordance with the invention threads 50 of different profiles are formed on the external surface of the implant body 12. The first threads 50a of the middle portion 14 of the externally threaded body 12 are substantially of a first height h1 (indicated in the enlarged view of Fig. 6) and have a first angle of thread α1. The second threads 50b of the distal end portion 16 are of a varying second height h2 greater than the first height h1 and increasing in the direction of the distal end 16a. The second threads 50b have a second angle of thread α2 being preferably smaller than the first angle of thread α1. The distal end portion 16 is of a conical design having a tapered wall 16w as illustrated in Figure 3, while the increasing height of the second threads 50b results in a substantially cylindrical enveloping surface, as illustrated by reference number 16e. The enveloping surface 16e is defined by the crests of the threads 50b. The tapered wall 16w of the conical distal end portion 16 defined by the bottom of the thread grooves is preferably tapered at an angle of at least 1 degree, more preferably at an angle of at least 2 degrees and preferably not more than by about 10 degrees.

The increased height h2 of the second threads 50b, as well as the decreased angle of thread α2, result in a narrower crest as can be seen in Fig. 7. The sharper and deeper external threads 50b of the distal end portion 16, especially in the vicinity of the distal end 16a, provide for better tapping and bite when screwing the implant 10 into the bone at the implantation site, while the

first threads 50a of the middle portion 14 ensure optimal osseointegration without compromising the required wall thickness of the implant 10. If the external threads 50b of the distal end portion 16 were not self-tapping, inserting the implant 10 into the bone would require considerably more time and effort. Furthermore, if the first external threads 50a were used at the distal end portion 16 too the primer stability of the implant 10 would be impaired, since less high threads do not reach into the bone deep enough. The implant 10 according to the invention has for benefit that sharper and deeper second external threads 50b are applied at the distal end portion 16 where bite and self-tapping properties are of utmost importance, while the middle portion 14 is provided with the less deep external threads 50a in order to maintain the required wall thickness. Moreover, since the greater second external threads 50b terminate in the smaller first external threads 50a the bone chips cut by the self-tapping first external threads 50b are compacted between the crests 50 of the first external threads 50a.

Advantageously, the proximal neck portion 18 of the implant body 12 is also provided with threads 50c substantially along its full length. The threads 50c are of a third height h3 being smaller than the first height h1. Preferably, the threads 50c of the neck portion 18 have a third angle of thread α3 being substantially the same as the first angle of thread α1 in order to simplify the production of the implant 10. The threaded neck portion 18 provides for better osseointegration as compared to the unthreaded neck portions of the prior art. According to medical studies it has been shown that where no osseointegration occurs bone resorption will take place over a number of years, sometimes over as little as one or two years. In order to hinder bone resorption and enhance osseointegration the neck portion 18 of the implant 10 according to the invention is provided with threads 50c. A further advantage of the threads 50c is that it helps distribute the load in the harder corticalis which also contributes to prohibiting bone resorption.

The first and the third angle of thread α1 and α3 are preferably between 50 to 70 degrees, preferably between 55 to 65 degrees, more preferably about

60 degrees, and the second angle of thread α2 is between 35 to 55 degrees, preferably between 40 to 50 degrees, more preferably about 45 degrees.

The height h1, h2, h3 of the threads 50 is preferably as follows. The first height h1 of the first type of thread 50a provided on the middle portion 14 is preferably between 0.3 to 0.4 mm, most preferably about 0.35 mm. It is also conceivable that the first height h1 of the first threads 50a varies within the preferred interval such that the first height h1 of the first threads 50a increases from the proximal end of the middle portion 14 towards the distal end of the middle portion 14, i.e. from the direction of the proximal neck portion 18 in the direction of the distal end portion 16 of the implant body 12.

The second type of thread 50b provided on the distal end portion 16 of the implant body 12 are of an increasing height, which is preferably between 0.4 to 0.55 mm, most preferably about 0.45 to 0.5 mm. The second height h2 of the second threads 50b varies within the preferred interval such that the second height h2 of the second threads 50a increases from the middle portion 14 of the implant 10 towards the distal end 16a of the implant 10 whereby the enveloping surface 16c of the crests of the second threads 52b is a cylindrical surface.

The third height h3 of the third type of thread 50c provided on the proximal neck portion 18 of the implant body 12 is preferably between 0.15 to 0.25 mm, most preferably about 0.2 mm. It is also conceivable that the third height h3 of the third threads 50c varies within the preferred interval such that the third height h3 of the third threads 50c decreases from the middle portion 14 of the implant 10 towards the proximal end 18a of the implant 10.

In a preferred embodiment external threading of the implant body 12 comprises at least two threads 50 with separate leads. More preferably triple threads 50 are provided, which run substantially along the entire body 12 of the implant 10. The multiple threads further enhance the tapping capacity and bite of the self-tapping implant 10.

The height H1 of the middle portion 14 is determined by the required full height H of the dental implant 10.

When a tooth is extracted the opening left behind the root is of a diameter of about 5 mm, while the common implant-diameter is about 3.5 to 4.7

mm. In the case of immediate implantation in order to firmly attach an implant 10 to the implantation site prior art research has found that it is sufficient to screw a relatively short portion of the implant into the bone at the distal end of the opening left by the extracted tooth root. The state of the art recommends driving the implant 10 into the bone at a depth of about 2 to 3 mm. The height H2 of the distal end portion 16 having the deeper and sharper second threads 50b designed for tapping the bone and having an ameliorated bite preferably corresponds to the required insertion length into the bone, thus the height H2 of the distal end portion 16 is preferably about 2 to 3 mm, more preferably about 2.5 mm.

The height H3 of the proximal neck portion 18 of the implant body 12 is determined by the length of the anti-rotational engagement portion 32 within the internal passage 30 of the implant 10. Higher threads are more advantageous from the point of view of fastening the implant, however the height of the threads 50c provided on the external wall portion of the implant 10 surrounding the anti-rotational engagement portion 32 is limited by the required minimum wall thickness. The anti-rotational engagement portion 32 preferably has a greater diameter than the rest of the internal passage 30 in order to allow for exercising sufficient torque via the driver mount when it is coupled with the anti-rotational engagement portion 32, while at the same time the wall surrounding the engagement portion 32 must be of sufficient thickness to resist any deformation of the implant body 12 when said torque is exercised. Thus the proximal neck portion 18 comprising smaller threads 50c preferably corresponds to the portion of the implant body 12 surrounding the anti-rotational engagement portion 32, its height H3 is therefore preferably only slightly more than the typical length of an anti-rotation engagement portion 32, i.e. about 2 to 3 mm, preferably about 2.5 mm. Furthermore the external threads 50c are preferably provided along at least half of the height of the neck portion 18, more preferably the threads 50c are provided along at least two thirds of the height H3 of the neck portion 18.

The implant 10 is preferably made of TAV, i.e. Ti-6Al-4V type titanium, which is at least 10% stronger than the Grade 4 type titanium commonly used in

the state of the art implant products. The increased strength of the applied material makes it possible to form the sharp exterior threads 50b of ameliorated self-tapping properties.

Fig. 9 to 16 show by way of illustration another preferred embodiment of the present invention - the same components are indicated with the same reference numbers. The internal passage of the implant 10' of the second embodiment comprises three neighbouring portions: an anti-rotational engagement portion 32 with a first diameter, a centring portion 90 having a cylindrical wall of a second diameter being smaller than the first diameter, and a internally threaded portion 34 of a third diameter being smaller than the second diameter.

The anti-rotational engagement portion 32 comprises at least one longitudinal groove 92 formed in the internal wall 94 of the passage 30 and designed to cooperate with corresponding longitudinal projections of e.g. a dental abutment for a prosthesis.

In the illustrated embodiment the implant 10' is provided with a through-hole 20 at its distal end portion 16, however depending on the length of the implant 10' the through hole may have to be dispensed with due to the substantially longer inner passage 30 formed of three portions. A through-hole 20 or an apical hole (not shown) may be provided if the full height H of the implant 10 is sufficiently greater than the full length of the inner passage 30 as in the case of the illustrated embodiment.

Preferably, one or more flutes 22 with cutting edges 24 are provided at the distal end portion 16 of the implant body 12 in order to facilitate tapping into the bone at the implantation site.

The self-tapping dental implant 10, 10' according to the invention is applied as follows. First the implantation site is prepared, which may comprise extracting a tooth and drilling an artificial bore into the opening left by the extracted tooth root. The self-tapping implant 10, 10' is then positioned at the implantation site and is drilled into the bone at the distal end of the opening or optionally of the artificial bore at a depth of about 2 to 2.5 mm via a driver mount attached to the anti-rotational engagement portion 32 of the implant body 12.

The driver mount is then removed and a healing screw is screwed into the internal passage 30 of the implant body 12 such as to engage the internal threaded bore therein. The implant 10, 10' remains within the bone allowing for healing and osseointegration to take place. The healing screw is removed during a second surgical procedure when the implant 10, 10' is re-exposed and an abutment for a dental prosthesis is adjoined to the internal passage 30 of the implant body 12.

The above-described embodiments are intended only as illustrating examples and are not to be considered as limiting the invention. Various modifications will be apparent to a person skilled in the art without departing from the scope of protection determined by the attached claims.

CLAIMS

1. Self-tapping dental implant comprising an externally threaded body having a proximal neck portion, a middle portion, and a distal end portion, **characterised** in that the distal end portion is of a conical structure while the enveloping surface of the threads of the distal end portion is substantially cylindrical.

2. The implant according to claim 1, wherein the threads of the middle portion of the externally threaded body have a first angle of thread, and the threads of the distal end portion have a second angle of thread being smaller than the first angle of thread.

3. The implant according to claim 2, wherein the threads of the middle portion of the externally threaded body are substantially of a first height and the proximal neck portion is provided with threads of a third height being smaller than the first height.

4. The implant according to claim 3, wherein the threads of the neck portion have a third angle of thread being substantially the same as the first angle of thread.

5. The implant according to any of claims 2 to 4, wherein the first angle of thread is 50 to 70 degrees, preferably 55 to 65 degrees, more preferably about 60 degrees, and the second angle of thread is 35 to 55 degrees, preferably 40 to 50 degrees, more preferably about 45 degrees.

6. The implant according to any of claims 1 to 5, wherein the external threading comprises at least double, preferably triple threads running substantially along the entire body of the implant.

7. The implant according to any of claims 1 to 6, wherein the length of the distal end portion is about 2 to 3 mm, preferably about 2.5 mm.

8. The implant according to any of claims 1 to 7, wherein the length of the proximal neck portion is about 2 to 3 mm, preferably about 2.5 mm, and external threads are provided along at least half of the length, preferably along at least two thirds of the length of the neck portion.

9. The implant according to any of claims 1 to 8, wherein an internal passage is provided within the body that has a proximal anti-rotational engagement portion therein.

10. The implant according to claim 9, wherein the anti-rotational engagement portion comprises a hex-shaped internal wall surface.

11. The implant according to claim 10, wherein the passage further comprises an internally threaded portion extending into the body of the implant.

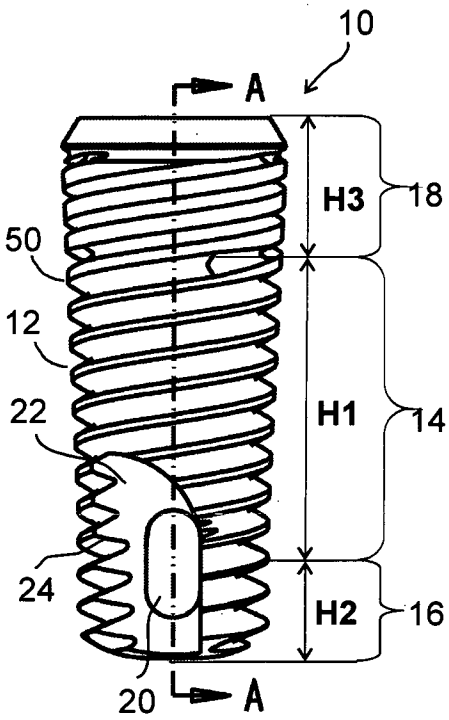
12. The implant according to claims 9 or 11, wherein the body has an apical hole and a transverse through-hole at least partially within its distal end portion.

13. The implant according to claim 9, wherein the anti-rotational engagement portion comprises at least one longitudinal groove extending substantially along the engagement portion and a centring portion is provided between the engagement portion and the internally threaded portion of the internal passage.

14. The implant according to claim 13, wherein the engagement portion is of a first diameter and the centring portion has a cylindrical wall of a second

diameter being smaller than the first diameter and the internally threaded portion is of a third diameter being smaller than the second diameter.

15. The implant according to any of claims 1 to 14, wherein the distal end portion is formed as a tapping end wherein a flute is provided with a cutting edge.



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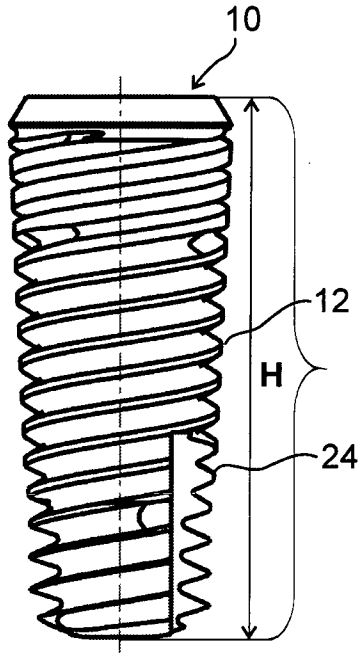

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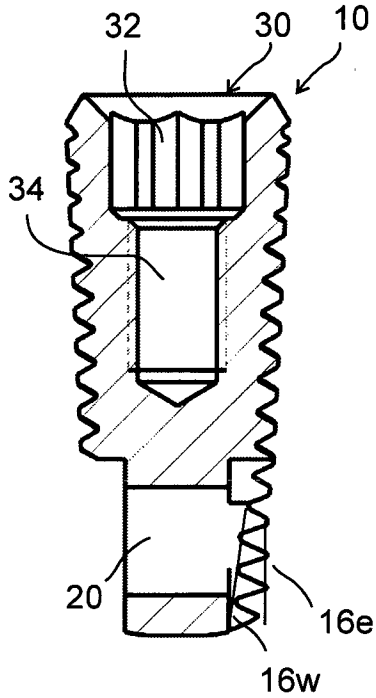

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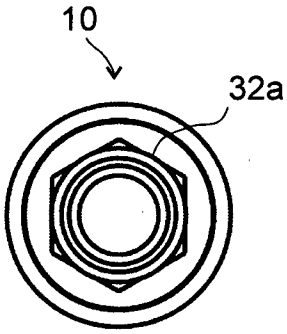

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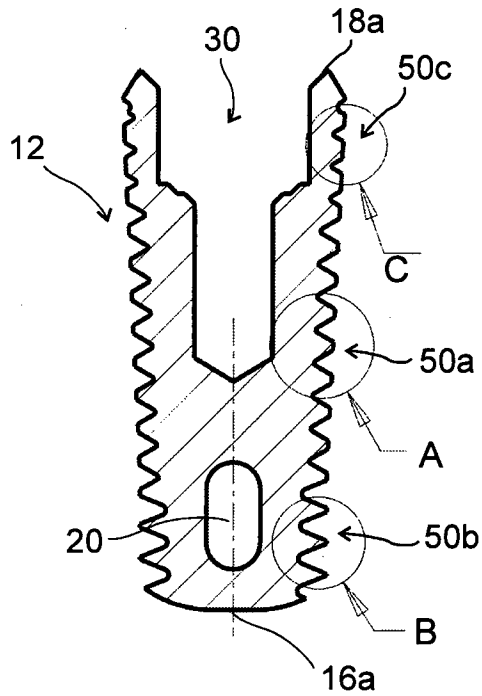

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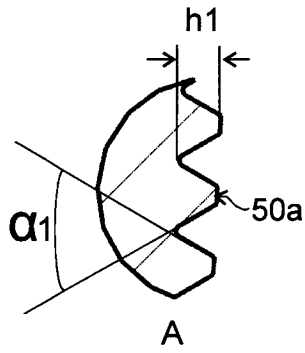

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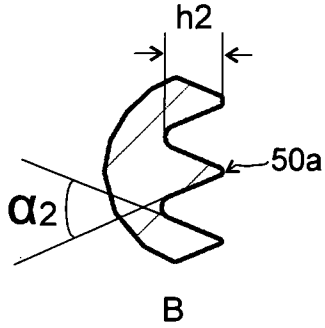

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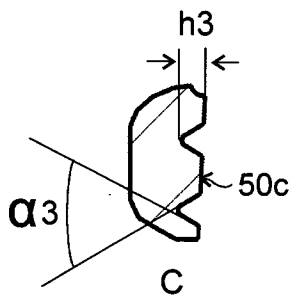

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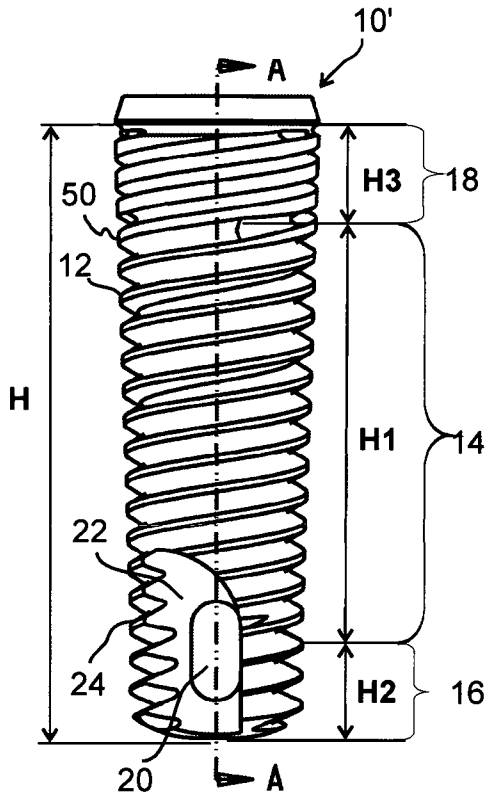

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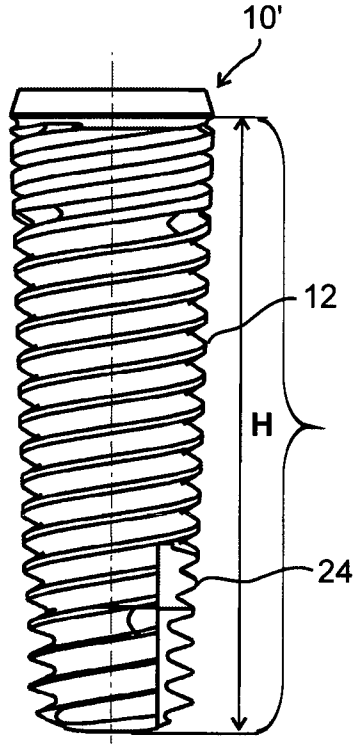

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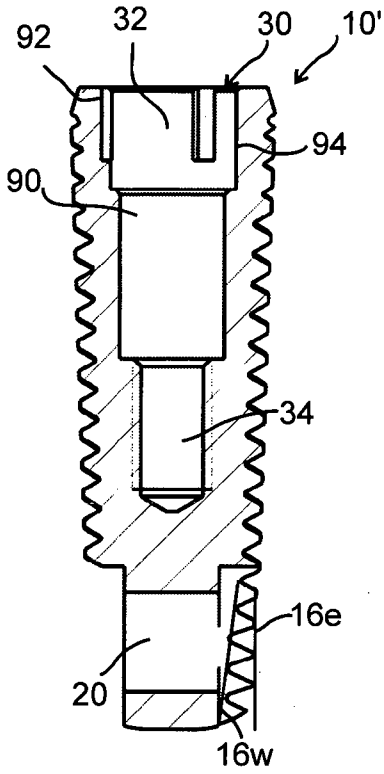

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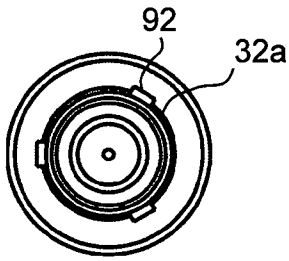
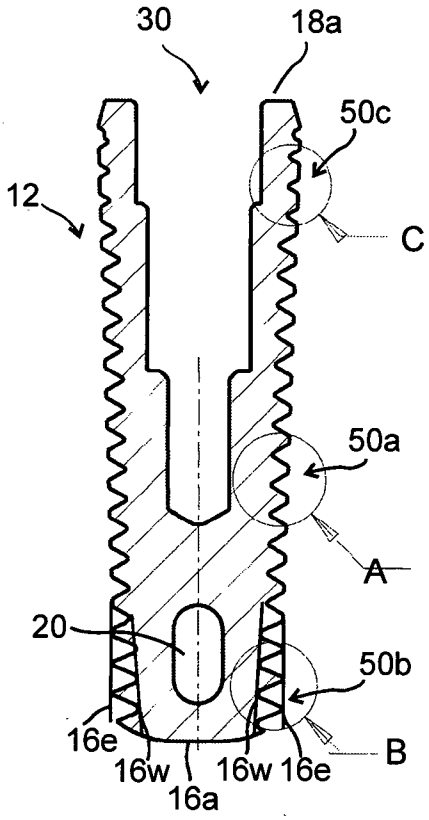


Figure 12



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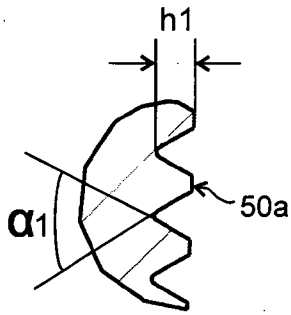

Figure 14

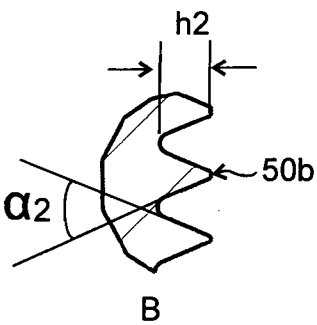

Figure 15

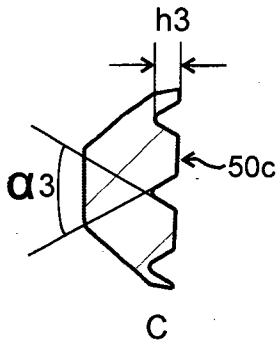

Figure 16