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(54) **IMPLANT**

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Description

Field of the Invention

[0001] The present invention relates to an implant having a shaft which is adapted in use to be embedded in bone tissue and which has an outer surface provided with a circumferentially-oriented roughness. This will hereinafter be referred to as an "implant of the type defined".

Background of the Invention

[0002] Implants of the type defined are known for use as the anchoring members of dental and orthopaedic prostheses. To this end, the implant is inserted into a bore-hole drilled into the bone tissue of a bone tissue structure at a site where a prosthesis is required, ordinarily by screwing of the implant into the bore-hole. The convention in the art is for the circumferentially-oriented roughness to take the form of a screw thread and in this case the bore-hole will ordinarily be (i) provided with internal threads in advance, or (ii) left un-tapped with the implant being provided with a self-tapping capacity, e.g. by the provision of one or more axially-extending cutting recesses or notches in the screw thread.

[0003] A superstructure having the prosthetic part of the prosthesis is then secured to the implant. In the case of a dental prosthesis, the superstructure will typically consist of a spacer or transmucosal component which engages to the implant to bridge the gingiva overlying the maxilla or mandible at the implant site and the prosthetic part, e.g. a crown, bridge or denture, is then secured to the spacer. There are various other forms that the superstructure can take as is known in the art. For instance, the prosthetic part may be secured directly to the implant.

[0004] The long-term integrity of the prosthesis is highly dependent on the successful osseointegration of the implant with the bone tissue structure, that is to say, the remodelling of the bone tissue in the bone tissue structure into direct apposition with the implant. A study on the factors which affect the osseointegration of implants was undertaken by Professor Per-Ingvar BrAnemark and coworkers and the results were published in a book entitled "Osseointegrated Implants in the Treatment of the Edentulous Jaw: Experience from a 10-Year Period". Almqvist & Wiskell International, Stockholm, Sweden, 1977. It was found by Brånemark et al that successful osseointegration depends upon *inter alia* the use of biocompatible materials for the implant, for example titanium and alloys thereof, and the surgical procedure adopted, for example leaving the implant unloaded for several months before adding the superstructure.

[0005] Implants of the type defined are not necessarily always used as part of a prosthesis, in some instances they can be a "stand alone" structure. As an example, implants of the type defined are known for use as bone fixation screws. The success of these "stand alone" implants is also highly dependent on their successful osseointegration.

[0006] Implants of the type defined have some notable advantages in promoting successful osseointegration with the adjacent bone tissue, a major one being as a result of the fact that the main loads on the implant in the clinical situation are axial loads. These implants are very well suited to support axial loads and this may be particularly important in the initial stages of the osseointegration process in which it is important that the implant is fully stable and as immovable as possible in the bore-hole (primary fixation). One can consider this to be due to the bone tissue growing into the troughs between adjacent peaks of the circumferentially-oriented roughness on the implant.

[0007] Document US 5,588,838 discloses a dental implant with two threaded sections wherein the axial spacing between the crests of adjacent threads in the first section is less than the axial spacing between the crests of adjacent threads in the second section. The first section is located coronally to the second section.

[0008] The Applicant has also identified that it is advantageous for an implant of the type defined to transmit the axial loading thereon evenly to the adjacent bone tissue to prevent high stress concentrations occurring in the adjacent bone tissue and concomitantly marginal bone tissue resorption. If marginal bone tissue resorption occurs this will reduce the anchorage of the implant and may undermine the long-term stability of the implant resulting in due course in failure of the prosthesis. In the particular case of dental prostheses, the aesthetic appeal is also undermined by marginal bone tissue resorption, an important drawback since dental prosthetics forms part of the field of cosmetic surgery.

[0009] The present invention proposes to provide an implant of the type defined having features which promote its maintenance in a bone tissue structure whilst at the same time facilitating its insertion into the bone tissue structure in the first place.

Summary of the Invention

[0010] The dental implant of the present invention is disclosed in claim 1. According to the present invention there is provided an implant of the type defined in which the circumferentially-oriented roughness has first and second axial sections each comprising a series of circumferentially-oriented peaks which have a crest and which are axially spaced apart by troughs, the axial spacing between the crests of adjacent peaks in the first axial section is less than the axial spacing between the crests of adjacent peaks in the second axial section and the first and second axial sections of circumferentially-oriented roughness are adapted in use to provide the same or substantially the same pitch.

[0011] The larger inter-peak spacing in the second axial section of circumferentially-oriented roughness acts to promote primary fixation of the implant in the bone tissue during the early phases of osseointegration since each trough between adjacent peaks can capture a relatively large volume of bone tissue to interlock the implant with the bone tissue. The smaller inter-peak spacing in the first axial section, on the other hand, enables the stiffness of the implant to be increased thereby improving the ability of the implant to transmit loads more evenly to the bone tissue to inhibit marginal bone resorption. Adapting the first and second axial sections to have the same or substantially the same pitch means that both axial sections produce the same or substantially the same axial displacement into the bone tissue on one rotation thereof thus ensuring that the provision of the two different axial sections of circumferentially-oriented roughness does not complicate insertion of the implant into the bone tissue. If the first and second axial sections of circumferentially-oriented roughness did not have the same or substantially the same pitch then a greater force would need to be applied to insert the implant resulting in fractures being formed in the bone tissue.

[0012] In an embodiment of the invention such as the one hereinafter to be described the pitch is a predetermined distance, the ratio of the predetermined distance to the axial spacing between the crests of adjacent peaks in the first axial section is a first multiple integer and the ratio of the predetermined distance to the axial spacing between the crests of adjacent peaks in the second axial section is a second multiple integer which is less than the first multiple integer. The first multiple integer may be a multiple integer of the second multiple integer.

[0013] In an embodiment of the invention such as the one hereinafter to be described the peaks in the first and second axial sections are circumferentially-oriented at a common inclined angle to the main axis of the implant.

[0014] According to the present invention the shaft has a coronal end and an apical end and the first axial section is located coronally of the second axial section.

[0015] In an embodiment of the invention such as the one hereinafter to be described the first and second axial sections are contiguous.

[0016] In an embodiment of the invention such as the one hereinafter to be described the first axial section extends from the coronal end of the shaft to a position coronally of the apical end and the second axial section extends from the first axial section towards the apical end of the shaft. The implant may have a coronal end which is spaced coronally from the coronal end of the shaft by a smooth coronal portion of the implant, as in the embodiment of the invention hereinafter to be described, in which case the smooth coronal portion is preferably no more than 4% of the total length of the implant, more preferably in the range 1.5-3.7% of said total length.

[0017] In an embodiment of the invention such as the one hereinafter to be described the axial extent of the first axial section is greater than the axial extent of the second axial section. Alternatively, the axial extent of the first axial section may be less than the axial extent of the second axial section or the axial extents of the first and second axial sections may be the same or substantially the same.

[0018] In an embodiment of the invention in which the first axial section is disposed coronally of the second axial section, such as the one hereinafter to be described, a blind bore extends apically into the shaft from the coronal end thereof to an end surface in-between the apical and coronal ends of the shaft for a superstructure to be secured to the implant, the blind bore comprising an internally-threaded section having a coronal edge and an apical edge for screw connection of the superstructure to the implant with the apical edge terminating at a position which is disposed apically of the first axial section. Alternately, the apical edge of the internally-threaded section of the blind bore may terminate at a position which is disposed coronally of the second axial section. The internally-threaded section may be an apical section of the blind bore, as in the embodiment of the invention hereinafter to be described.

[0019] In an embodiment of the invention such as the one hereinafter to be described all or substantially all of the crests of the peaks in the first and second axial sections lie on an axial plane parallel to the main axis of the shaft. Expressed another way, the major transverse dimension of the implant at the first and second axial sections is uniform.

[0020] In an embodiment of the invention such as the one hereinafter to be described the height of the peaks, as measured from the troughs to the crests, in the first axial section differs from that in the second axial section. To advantage, the height of the peaks in the first axial section is less than that in the second axial section. This feature further enables the stiffness of the implant to be increased.

[0021] In an alternative embodiment of the invention the height of the peaks, as measured from the troughs to the crests, in the first axial section is the same or substantially the same as in the second axial section.

[0022] In an embodiment of the invention such as the one hereinafter to be described the ratio of the height of the peaks, as measured from the troughs to the crests, to the axial spacing between the crests of adjacent peaks in the first axial section is the same or substantially the same as in the second axial section.

[0023] In an embodiment of the invention such as the one hereinafter to be described the height of the peaks, as measured from the troughs to the crests, in the first axial section is no greater than 0.2 mm, for example in the range 0.02-0.20 mm, and the height of the peaks, as measured from the troughs to the crests, in the second axial section is greater than that in the first axial section, for instance in the range 0.15mm to 1 mm. Such heights complement the primary fixation and stiffness characteristics of the implant provided by the different inter-peak spacings of the first and second axial sections.

[0024] In an embodiment of the invention such as the one hereinafter to be described the peaks in the first and second axial sections are bounded by flank surfaces and the angle between the opposed flanks of adjacent peaks in the first and second axial sections is the same.

[0025] In an embodiment of the invention such as the one hereinafter to be described the troughs in at least one of the first and second axial sections are a continuous curved surface.

[0026] In an embodiment of the invention such as the one hereinafter to be described the circumferentially-oriented roughness in the first and/or second axial section is presented by a screw thread profile with the circumferentially-oriented peaks being defined by thread elements of the screw thread profile.

[0027] Typically, the screw thread profile of the first and/or second axial section will be formed by a screw thread structure. In such case, the screw thread structure of the first axial section may be formed by a first set of independent screw threads each having turns; the turns of each independent screw thread in the first set defining thread elements in the first axial section and being sequentially arranged with the turns of the other independent screw threads in the first set with adjacent turns of one of the independent screw threads of the first set being axially-spaced apart by a predetermined spacing distance which is the same for adjacent turns of the other independent screw threads in the first set; and the screw thread structure of the second axial section may be formed by (i) an independent screw thread having turns which define the thread elements of the second axial section and are axially-spaced apart by the predetermined spacing distance or essentially the predetermined spacing distance, or (ii) a second set of independent screw threads numbering less than in the first set each having turns, the turns of each independent screw thread in the second set defining thread elements in the second axial section and being sequentially arranged with the turns of the other independent screw threads in the second set with adjacent turns of each independent screw thread of the second set being axially-spaced apart by the predetermined spacing distance or essentially the predetermined spacing distance.

[0028] In an embodiment of the invention one or more of the independent screw threads of the first and second axial sections are shared by the first and second axial sections.

[0029] In an embodiment of the invention such as the one hereinafter to be described the or each independent screw thread of at least one of the first and second axial sections is a microthread, that is to say, a thread having a height which is no greater than 0.2mm.

[0030] In an embodiment of the invention only the screw threads of the first axial section are microthreads. It could be the case, though, that the screw threads of both the first and second axial sections are microthreads.

[0031] In an embodiment of the invention the circumferentially-oriented roughness in at least one of the first and second axial sections is formed by a series of axially spaced-apart circumferential lines of beads. The beads in each line may be circumferentially spaced-apart.

[0032] In an embodiment of the invention such as the one hereinafter to be described the implant is a dental implant adapted for implantation in the maxilla or mandible of an edentulous patient for supporting a superstructure which presents one or more artificial teeth.

[0033] A method of implanting an implant into a bone tissue structure comprises the steps of providing an implant according to the invention, providing a bore-hole in the bone tissue structure and screwing the implant into the bore-hole so that the shaft is embedded in the bone tissue.

Brief Description of the Drawings

[0034] By way of example, a self-tapping endosseous screw-type dental implant in accordance with the present invention will now be described with reference to the accompanying Figures of drawings in which:

Figure 1 is a side view of the dental implant;

Figure 2 is a perspective view of the dental implant;

Figure 3 is a cross-sectional side view of the dental implant;

Figure 4 is a plan view of the dental implant;

Figure 5 is an underneath view of the dental implant;

Figure 6 is an exploded view of a first section of the external screw threading on the dental implant; and

Figure 7 is an exploded view of a second section of the external screw threading on the dental implant.

Description of Exemplary Embodiment of the Invention

[0035] In the accompanying Figures of drawings there is shown various views of a self-tapping endosseous screw-type dental implant 10 of a dental prosthesis in accordance with the present invention. The implant 10 is for insertion into a bore-hole drilled into a toothless-site in a maxilla or mandible of a partially or fully edentulous patient to anchor to the maxilla or mandible a superstructure of the prosthesis which comprises a prosthetic part, namely one or more artificial teeth. The implant 10 is made from commercially pure titanium, a titanium alloy, another biocompatible metal or metal alloy or a ceramic to promote osseointegration of the implant with the bone tissue of the boundary walls of the bore-hole.

[0036] Referring to Figure 1, the implant 10 has an apical end 1 which is presented by a first conical section 3 to ease insertion of the implant 10 into the bore-hole, a coronal end 5 presented by a second conical section 6 and an intermediate section 7 of constant diameter which extends between the first and second conical sections 3,6.

[0037] The length of the implant may be in the range 8-19 mm, depending on the clinical situation, and have a maximum outer diameter of 3.5 mm or 4.0 mm. The axial extent of the second conical portion 6 is preferably small compared to the total length of the implant 10, as an example no more than 4.0% perhaps in the range 1.5%-3.7%.

[0038] Turning to Figures 2 to 4, a socket 9 having an open end 11 in the coronal end 5 extends apically into the implant 10. The socket 9 is for receiving an abutment structure (not shown) which will bridge the gingiva overlying the bore-hole and support/present the prosthetic part. The socket 9 consists of a conical coronal section 13, an internally-threaded apical section 15 and a cylindrical intermediate section 17. The abutment structure will have an apical section which is able to be screw retained in the implant socket 9 for releasably securing the abutment structure to the implant 10.

[0039] As shown in Figures 1 to 3, 6 and 7, the outer surface of the implant 10 over the major part of its length is provided with screw threading which is divided into coronal and apical sections 19, 21 having different thread heights h1, h2. As shown most clearly in Figure 1, the coronal section 19 of screw threading is positioned on the intermediate cylindrical section 7 of the implant 10 whereas the apical section 21 of the screw threading bridges the intermediate cylindrical section 7 and the first conical section 3.

[0040] Referring to Figure 6, the screw threading in the coronal section 19 is composed of a series of axially spaced-apart screw thread elements each having the same height h1. These screw thread elements are formed by the turns of three separate microthreads (triple microthread) which are sequentially arranged. This means that a screw thread element formed by a first turn of one of the microthreads is axially spaced from a screw thread element formed by the next turn of that microthread by two other screw thread elements, each being respectively formed by a turn of the other two microthreads. A screw thread element belonging to one of the microthreads is therefore axially spaced from the next adjacent screw thread element formed by the same microthread by screw thread elements from each of the other two microthreads. By "microthread" is meant a screw thread having a height which is no greater than 0.2 mm. Accordingly, the screw thread elements in the coronal section 19 have a height h1 which is no greater than 0.2 mm, preferably 0.1 mm.

[0041] Referring to Figure 7, the screw threading in the apical section 21 is composed of a series of axially spaced-apart screw thread elements which, other than those in the first conical section 3, each have the same height h2. The screw thread elements of the apical section 21 are formed by the turns of a single macrothread. By "macrothread" is meant a screw thread having a height greater than 0.2 mm. Accordingly, the screw thread elements of the apical section 21 on the intermediate section 7 have a height greater than 0.2 mm, preferably 0.3 mm.

[0042] The angle formed between the coronal and apical flanks of adjacent screw thread elements is the same in both the coronal and apical sections 19, 21. Preferably the angle formed is 80°. It will also be noted from Figures 6 and 7 that the coronal and apical flanks of adjacent screw thread elements in the coronal and apical sections 19, 21 are connected by a curved surface, that is to say, there is no axial straight part in-between adjacent screw thread elements in the coronal and apical sections 19,21.

[0043] As can be seen particularly from Figures 1 and 3, the tips of the screw thread elements of the coronal section 19 and the tips of the screw thread elements of the apical section 21 positioned in the intermediate cylindrical section 7 of the implant 10 all lie on a common plane when viewed in side section and circumscribe the circumference of the cylindrical intermediate section 7. In other words, the major diameter of the intermediate cylindrical section 7 is constant.

[0044] As shown in Figures 6 and 7, as well as the screw thread elements in the coronal and apical sections 19, 21 having different heights from one another the crest-to-crest spacing between adjacent screw thread elements in the coronal section 19 is different from the crest-to-crest spacing between adjacent screw thread elements in the apical section 21. The crest-to-crest spacing in the coronal section 19 is d whereas the crest-to-crest spacing in the apical section 21 is 3d. As an example, d may be 0.22 mm. In the case where h1 is 0.1 mm and h2 is 0.3 mm the ratio of the inter-crest spacing to the height would thus be the same for both the coronal and apical threaded sections 19,21, namely d/h1 = 2.2 = 3d/h2.

[0045] It follows from the above that the crest-to-crest spacing between adjacent screw thread elements of each microthread is the same as that between adjacent screw thread elements of the macrothread, namely 3d. The fact that the crest-to-crest spacing between adjacent screw thread elements *per se* in the coronal section 19 is less than that in the apical section 21 is, of course, due to adjacent turns of each microthread being interspersed with a turn from each of the other two microthreads. It will also be noted from Figure 1 that the turns of the microthreads and the macrothreads are aligned parallel with one another at an inclined angle to the rotational axis of the implant 10.

[0046] It will gathered from the above that the pitch of the coronal and apical threaded sections 19, 21 will be the same, again being 3d. For this reason, the pitch of the implant 10 remains uniform along its length notwithstanding the difference in crest-to-crest spacing in the apical and coronal threaded sections 19, 21, that is to say, the coronal and apical screw threaded sections 19, 21 will both produce the same axial displacement of the implant 10 in the apical direction on one rotation or revolution of the implant 10 when being screwed into the bore-hole provided therefor at the toothless site in the maxilla or mandible. If the coronal and apical sections

19, 21 did not have constant pitch then a greater force would need to be applied to insert the implant 10 into the bore-hole resulting in the bone threads formed in the boundary wall of the bore-hole being fractured.

[0047] As a rule, a constant pitch for two threaded sections having different crest-to-crest spacings between the adjacent screw thread elements thereof will result where the first threaded section is formed by the sequential arrangement of the turns of a first set of screw threads each having the same pitch and the second threaded section is formed by (i) a single screw thread having the same pitch as the screw threads in the first threaded section, or (ii) the sequential arrangement of the turns of a second set of screw threads numbering less than in the first set each having the same pitch as the screw threads in the first threaded section. The number of screw threads in the first threaded section does not need to be a multiple integer of the number of screw threads in the second threaded section, as in the illustrated embodiment of the invention. For example, there could be five microthreads in the coronal section 19 and two macrothreads in the apical section 21.

[0048] As shown in Figures 1 to 3 and 5, the implant 10 has three cutting recesses or grooves 23a, 23b, 23c positioned symmetrically about the circumference of the apical end 1 of the implant 10 for self-tapping of the implant 10 when being screwed into the bore-hole provided therefor in the maxilla or mandible.

[0049] In use, the implant 10 is screwed into the bore-hole provided at the toothless-site in the maxilla or mandible such that the coronal and apical sections 19, 21 are embedded in bone tissue with the second conical section 6 protruding from the maxilla or mandible. The screw thread elements of the macrothreads in the apical section 21 of the implant 10 act to provide primary fixation of the implant in the bore-hole. The screw thread elements of the microthreads in the coronal section 19 also act to provide fixation for the implant 10 in the bore-hole. As a result of the screw threads in the coronal section 19 being microthreads, though, the implant 10 is stiffer than it would be if the screw threads were macrothreads as in the apical section 21. This enables the implant 10 to transfer loads more evenly to the bone tissue adjacent the implant 10 and consequently promote better remodelling of the bone tissue into apposition with the implant 10. Moreover, as the microthreads are positioned at the coronal end 5 of the implant 10 the loads transferred thereby helps alleviate the problem of bone tissue resorption at the coronal surface of the maxilla or mandible (marginal bone tissue resorption).

[0050] The provision of microthreads in the coronal section 19 also enables a reasonable wall thickness to be retained around the tapered coronal section 13 of the socket 9 in the implant 10, when compared to the wall thickness that would result from use of macrothreads in the coronal section 19 in any event. This helps preserve the mechanical strength of the implant 10.

[0051] To conclude, the dental implant 10 has a screw threaded outer surface 19,21 which (i) makes it straightforward for the implant 10 to be screwed into a bone tissue structure, and (ii) promotes the short- and long-term stability of the implant 10 in the bone tissue structure.

[0052] It will be appreciated that the invention has been illustrated with reference to an exemplary embodiment and that the invention can be varied in many different ways within the scope of the appended claims. As an example, although the illustrated example is a dental implant the invention has equal application in other areas, for example, the orthopaedic area.

[0053] Finally, it is to be noted that the inclusion in the appended claims of reference numerals used in the Figures of drawings is purely for illustrative purposes and not to be construed as having a limiting effect on the scope of the claims.

Claims

1. A dental implant (10) having a shaft which is adapted in use to be embedded in bone tissue and which has an outer surface provided with a circumferentially-oriented roughness designed to enable said dental implant to be screwed into the bone tissue, said dental implant having a coronal end which is adapted to support a superstructure, wherein the circumferentially-oriented roughness consists of first and second axial sections (19, 21), each section comprising a series of circumferentially-oriented peaks which have a crest and are axially spaced apart by troughs, the axial spacing (d) between the crests of adjacent peaks in the first axial section (19) is less than the axial spacing (3d) between the crests of adjacent peaks in the second axial section (21), and which shaft has a coronal end and an apical end (1), wherein the first axial section is located coronally of the second axial section,
   characterised in
   that the first and second axial sections of the circumferentially-oriented roughness are adapted in use to provide the same or substantially the same pitch.

2. An implant as claimed in ***[deletion(s)]*** claim 1, **characterised in that** the first and second axial sections are contiguous.

3. An implant as claimed in any one of claims 1-2, ***[deletion(s)]*** **characterised in that** the first axial section extends from the coronal end of the shaft to a position coronally of the apical end and the second axial section extends from the first axial section towards the apical end.

4. An implant as claimed in any one of claims 1-3, wherein a blind bore (9) extends apically into the shaft from the coronal end to an end surface in-be-

tween the apical and coronal ends of the shaft for a superstructure to be secured to the implant, the blind bore comprising an internally-threaded section (15) having a coronal edge and an apical edge for screw connection of the superstructure to the implant, **characterised in that** the apical edge of the internally-threaded section of the blind bore terminates at a position which is disposed apically of the first axial section.

5. An implant as claimed in claim 4, **characterised in that** the internally-threaded section is an apical section of the blind-bore.

6. An implant as claimed in any one of the preceding claims, **characterised in that** the pitch is a predetermined distance, that the ratio of the predetermined distance to the axial spacing between the crests of adjacent peaks in the first axial section is a first multiple integer, that the ratio of the predetermined distance to the axial spacing between the crests of adjacent peaks in the second axial section is a second multiple integer and that the first multiple integer is greater than the second multiple integer.

7. An implant as claimed in any one of the preceding claims, **characterised in that** the crests of all of the peaks, or substantially all of the peaks, in the first and second axial sections lie on an axial plane parallel to the main axis of the shaft.

8. An implant as claimed in any one of the preceding claims, **characterised in that** the height (h1, h2) of the peaks, as measured from the troughs to the crests, in the first axial section differs from that in the second axial section.

9. An implant as claimed in claim 8, **characterised in that** the height (h1) of the peaks in the first axial section is less than the height (h2) of the peaks in the second axial section.

10. An implant as claimed in any one of claims 1 to 7, **characterised in that** the height (h1, h2) of the peaks, as measured from the troughs to the crests, in the first axial section is the same or substantially the same as in the second axial section.

11. An implant as claimed in any one of claims 1 to 9, **characterised in that** the ratio of the height of the peaks, as measured from the troughs to the crests, to the axial spacing between the crests of adjacent peaks in the first axial section is the same or substantially the same as in the second axial section.

12. An implant as claimed in any one of the preceding claims, **characterised in that** the height of the peaks, as measured from the troughs to the crests, in the first axial section is no greater than 0.20 mm.

13. An implant as claimed in any one of the preceding claims, **characterised in that** the height of the peaks, as measured from the troughs to the crests, in the second axial section is in the range 0.15-1 mm.

14. An implant as claimed in any one of the preceding claims, **characterised in that** the circumferentially-oriented roughness in at least one of the first and second axial sections is presented by a screw thread profile with the circumferentially-oriented peaks being defined by thread elements of the screw thread profile.

15. An implant as claimed in any one of claims 1 to 13, **characterised in that** both the first and second axial sections are presented by a screw thread profile with the circumferentially-oriented peaks being defined by thread elements of the screw thread profiles.

16. An implant as claimed in claim 14 or 15, **characterised in that** the or each screw thread profile is formed by a screw thread structure.

17. An implant as claimed in claim 16 when appendant on claim 15, **characterised in that** the screw thread structure of the first axial section is formed by a first set of independent screw threads each having turns; the turns of each independent screw thread in the first set defining thread elements in the first axial section and being sequentially arranged with the turns of the other independent screw threads in the first set with adjacent turns of one of the independent screw threads of the first set being axially-spaced apart by a predetermined spacing distance which is the same for adjacent turns of the other independent screw threads in the first set; and the screw thread structure of the second axial section is formed by (i) an independent screw thread having turns which define the thread elements of the second axial section and are axially-spaced apart by the predetermined spacing distance or essentially the predetermined spacing distance, or (ii) a second set of independent screw threads numbering less than in the first set each having turns, the turns of each independent screw thread in the second set defining thread elements in the second axial section and being sequentially arranged with the turns of the other independent screw threads in the second set with adjacent turns of each independent screw thread of the second set being axially-spaced apart by the predetermined spacing distance or essentially the predetermined spacing distance.

18. An implant as claimed in claim 17, **characterised in that** one or more of the independent screw threads of the first and second axial sections are shared by the first and second axial sections.

19. An implant as claimed in claim 17 or 18, **characterised in that** the or each independent screw thread of at least one of the first and second axial sections is a microthread.

20. An implant as claimed in claim 19, **characterised in that** only the independent screw threads of the first axial section are microthreads.

21. An implant as claimed in claim 19, **characterised in that** the independent screw threads of the first and second axial sections are microthreads.

22. An implant as claimed in any one of claims 1 to 13, **characterised in that** the circumferentially-oriented roughness in at least one of the first and second axial sections is formed by a series of axially spaced-apart circumferential lines of beads.

23. An implant as claimed in claim 22, **characterised in that** the beads in each line are circumferentially spaced-apart.

24. An implant as claimed in any one of the preceding claims, **characterised in that** the implant is a dental implant adapted for implantation in the maxilla or mandible of an edentulous patient for supporting a superstructure which presents one or more artificial teeth.

Patentansprüche

1. Dentalimplantat (10) mit einem Schaft, der bei Verwendung geeignet ist, in Knochengewebe eingebettet zu werden, und der eine äußere Fläche aufweist, die mit einer in Umfangsrichtung orientierten Rauigkeit versehen ist, die dafür ausgelegt ist, ein Einschrauben des Dentalimplantats in das Knochengewebe zu ermöglichen, wobei das Dentalimplantat ein koronales Ende aufweist, das für das Tragen eines Überbaus geeignet ist, wobei die in Umfangsrichtung orientierte Rauigkeit aus ersten und zweiten axialen Abschnitten (19, 21) besteht, wobei jeder Abschnitt eine Reihe von in Umfangsrichtung orientierten Spitzen umfasst, die einen Scheitel aufweisen und axial voneinander durch Mulden getrennt sind, wobei der axiale Abstand (d) zwischen den Scheiteln benachbarter Spitzen im ersten axialen Abschnitt (19) geringer ist als der axiale Abstand (3d) zwischen den Scheiteln benachbarter Spitzen in dem zweiten axialen Abschnitt (21) und der Schaft ein koronales Ende sowie ein apikales Ende (1) aufweist, wobei der erste axiale Abschnitt koronal vom zweiten axialen Abschnitt aus angeordnet ist,
dadurch gekennzeichnet,
dass der erste und zweite axiale Abschnitt der in Umfangsrichtung orientierten Rauigkeit bei Verwendung geeignet ist, die gleiche oder weitgehend die gleiche teilung bereitzustellen.

2. Implantat nach Anspruch 1, **dadurch gekennzeichnet, dass** der erste und der zweite axiale Abschnitt angrenzen.

3. Implantat nach einem der Ansprüche 1 - 2, **dadurch gekennzeichnet, dass** sich der erste axiale Abschnitt vom koronalen Ende des Schaftes aus bis zu einer Stelle erstreckt, die koronal vom apikalen Ende aus liegt, und sich der zweite axiale Abschnitt vom ersten axialen Abschnitt aus entgegen apikalen Ende hin erstreckt.

4. Implantat nach einem der Ansprüche 1 - 3, wobei sich eine Blindbohrung (9) apikal in den Schaft von dem koronalen Ende aus bis zu einer Endfläche zwischen dem apikalen und dem koronalen Ende des Schaftes erstreckt, um einen Überbau an dem Implantat zu befestigen, wobei die Blindbohrung einen mit Innengewinde versehenen Abschnitt (15) umfasst, der ein koronales Ende und ein apikales Ende für eine Schraubverbindung des Überbaus mit dem Implantat aufweist, **dadurch gekennzeichnet, dass** das apikale Ende des mit einem Innengewinde versehenen Abschnitts der Blindbohrung an einer Stelle endet, die apikal vom ersten axialen Abschnitt aus liegt.

5. Implantat nach Anspruch 4, **dadurch gekennzeichnet, dass** der mit Innengewinde versehene Abschnitt ein apikaler Abschnitt der Blindbohrung ist.

6. Implantat nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die teilung ein vorgegebener Abstand ist, dass das Verhältnis aus dem vorgegebenen Abstand zum axialen Abstand zwischen den Scheiteln benachbarter Spitzen im ersten axialen Abschnitt ein erstes ganzzahliges Vielfaches ist, dass das Verhältnis aus dem vorgegebenen Abstand zum axialen Abstand zwischen den Scheiteln benachbarter Spitzen im zweiten axialen Abschnitt eine zweites ganzzahliges Vielfaches ist und dass das erste ganzzahlige Vielfache größer als das zweite ganzzahlige Vielfache ist.

7. Implantat nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Scheitel aller Spitzen oder nahezu aller Spitzen in dem ersten und dem zweiten axialen Abschnitt in einer axialen Ebene liegen, die parallel zur Hauptachse des Schaftes ist.

8. Implantat nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die von den

Mulden bis zu den Scheiteln gemessene Höhe (h1, h2) der Spitzen sich in dem ersten axialen Abschnitt von der im zweiten axialen Abschnitt unterscheidet.

9. Implantat nach Anspruch 8, **dadurch gekennzeichnet, dass** die Höhe (h1) der Spitzen in dem ersten axialen Abschnitt kleiner als die Höhe (h2) der Spitzen in dem zweiten axialen Abschnitt ist.

10. Implantat nach einem der vorhergehenden Ansprüche 1 bis 7, **dadurch gekennzeichnet, dass** die von den Mulden bis zu den Scheiteln gemessene Höhe (h1, h2) der Spitzen im ersten axialen Abschnitt die gleiche oder nahezu die gleiche ist wie im zweiten axialen Abschnitt.

11. Implantat nach einem der vorhergehenden Ansprüche 1 bis 9, **dadurch gekennzeichnet, dass** das Verhältnis der von den Mulden bis zu den Scheiteln gemessenen Höhe der Spitzen zum axialen Abstand zwischen den Scheiteln benachbarter Spitzen im ersten axialen Abschnitt das gleiche oder nahezu das gleiche ist wie im zweiten axialen Abschnitt.

12. Implantat nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die von den Mulden bis zu den Scheiteln gemessene Höhe der Spitzen im ersten axialen Abschnitt nicht größer als 0,20 mm ist.

13. Implantat nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die von den Mulden bis zu den Scheiteln gemessene Höhe der Spitzen im zweiten axialen Abschnitt im Bereich von 0,15 - 1 mm liegt.

14. Implantat nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die in Umfangsrichtung orientierte Rauigkeit in mindestens einem Abschnitt aus dem ersten und zweiten axialen Abschnitt durch ein Schraubgewindeprofil mit den in Umfangsrichtung orientierten Spitzen gebildet wird, die durch Gewindeelemente des Schraubgewindeprofils festgelegt sind.

15. Implantat nach einem der Ansprüche 1 bis 13, **dadurch gekennzeichnet, dass** sowohl der erste als auch der zweite Abschnitt durch ein Schraubgewindeprofil mit den in Umfangsrichtung orientierten Spitzen gebildet wird, die durch Gewindeelemente des Schraubgewindeprofils festgelegt sind.

16. Implantat nach Anspruch 14 oder 15, **dadurch gekennzeichnet, dass** das oder jedes Schraubgewindeprofil durch eine Schraubgewindestruktur ausgebildet wird.

17. Implantat nach Anspruch 16, wenn er dem Anspruch 15 nachgeordnet ist, **dadurch gekennzeichnet, dass** die Schraubgewindestruktur des ersten axialen Abschnitts durch einen ersten Satz von unabhängigen Schraubgewinden gebildet wird, von denen jedes Gewindegänge aufweist, wobei die Gewindegänge eines jeden unabhängigen Schraubgewindes im ersten Satz Gewindeelemente in dem ersten axialen Abschnitt festlegen und sie aufeinanderfolgend mit den Gewindegängen der anderen unabhängigen Schraubgewinde im ersten Satz angeordnet sind, wobei die benachbarten Gewindegänge eines der unabhängigen Schraubgewinde des ersten Satzes durch eine vorgegebene Abstandsstrekke axial voneinander getrennt sind, welche die gleiche für benachbarte Gewindegänge der anderen unabhängigen Schraubengewinde im ersten Satz ist, und die Schraubgewindestruktur des zweiten axialen Abschnitts gebildet wird durch (i) ein unabhängiges Schraubgewinde, das Gewindegänge aufweist, welche die Gewindeelemente des zweiten axialen Abschnitts festlegen und welche durch die vorgegebene Abstandsstrecke oder im Wesentlichen durch die vorgegebene Abstandsstrecke axial voneinander getrennt sind, oder durch (ii) einen zweiten Satz unabhängiger Schraubgewinde mit einer geringeren Anzahl als im ersten Satz, von denen jedes Gewindegänge aufweist, wobei die Gewindegänge eines jeden unabhängigen Schraubgewindes im zweiten Satz Gewindeelemente in dem zweiten axialen Abschnitt festlegen und sie aufeinanderfolgend mit den Gewindegängen der anderen unabhängigen Schraubgewinde im zweiten Satz angeordnet sind, wobei die benachbarten Gewindegänge eines jeden unabhängigen Schraubgewindes des zweiten Satzes durch die vorgegebene Abstandsstrecke oder im Wesentlichen durch die vorgegebene Abstandsstrecke axial voneinander getrennt sind.

18. Implantat nach Anspruch 17, **dadurch gekennzeichnet, dass** eines oder mehrere der unabhängigen Schraubgewinde des ersten und zweiten axialen Abschnitts durch den ersten und zweiten axialen Abschnitt gemeinsam genutzt werden.

19. Implantat nach Anspruch 17 oder 18, **dadurch gekennzeichnet, dass** das oder jedes unabhängige Schraubgewinde von mindestens einem Abschnitt aus dem ersten und zweiten axialen Abschnitt ein Mikrogewinde ist.

20. Implantat nach Anspruch 19, **dadurch gekennzeichnet, dass** nur die unabhängigen Schraubgewinde des ersten axialen Abschnitts Mikrogewinde sind.

21. Implantat nach Anspruch 19, **dadurch gekennzeichnet, dass** die unabhängigen Schraubgewinde des ersten und zweiten axialen Abschnitts Mikrogewinde sind.

22. Implantat nach einem der Ansprüche 1 bis 13, **dadurch gekennzeichnet, dass** die in Umfangsrichtung orientierte Rauigkeit in mindestens einem Abschnitt aus dem ersten und zweiten axialen Abschnitt durch eine Reihe von axial voneinander getrennten Umfangswulstlinien gebildet wird.

23. Implantat nach Anspruch 22, **dadurch gekennzeichnet, dass** die Wülste in jeder Linie in Umfangsrichtung voneinander getrennt sind.

24. Implantat nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** das Implantat ein Dentalimplantat ist, das zum Implantieren in den Oberkiefer oder den Unterkiefer eines zahnlosen Patienten geeignet ist, um einen Überbau zu tragen, der einen oder mehrere künstliche Zähne aufweist.

Revendications

1. Implant dentaire (10) ayant une tige qui est adaptée à l'utilisation pour être incluse dans un tissu osseux et qui a une surface externe fournie avec une rugosité orientée à la circonférence conçue pour permettre audit implant dentaire d'être vissé dans le tissu osseux, ledit implant dentaire ayant une extrémité coronale qui est adaptée pour supporter une superstructure, dans lequel la rugosité orientée à la circonférence consiste en des première et seconde sections axiales (19, 21), chaque section comprenant une série de pics orientés à la circonférence qui ont une crête et qui sont espacés de façon axiale par des creux, l'espacement axial (d) entre les crêtes des pics adjacents dans la première section axiale (19) est inférieur à l'espacement axial (3d) entre les crêtes des pics adjacents dans la seconde section axiale (21), et laquelle tige a une extrémité coronale et une extrémité apicale (1), dans laquelle la première section axiale est localisée de façon coronale par rapport à la seconde section axiale, **caractérisé en ce que** les première et seconde sections axiales de la rugosité orientée à la circonférence sont adaptées à l'utilisation pour fournir le même ou substantiellement le même pas.

2. Implant selon la revendication 1, **caractérisé en ce que** les première et seconde sections axiales sont contiguës.

3. Implant selon l'une quelconque des revendications 1 à 2, **caractérisé en ce que** la première section axiale s'étend depuis l'extrémité coronale de la tige jusqu'à une position coronale par rapport à l'extrémité apicale et la seconde section axiale s'étend depuis la première section axiale vers l'extrémité apicale.

4. Implant selon l'une quelconque des revendications 1 à 3, dans lequel un trou aveugle (9) s'étend en direction apicale dans la tige depuis l'extrémité coronale jusqu'à une surface terminale se trouvant entre les extrémités apicale et coronale de la tige pour pouvoir fixer une superstructure à l'implant, le trou aveugle comprenant une section à filetage interne (15) ayant un bord coronal et un bord apical pour un assemblage par vissage de la superstructure à l'implant, **caractérisé en ce que** le bord apical de la section à filetage interne du trou aveugle se termine à une position qui est en position apicale par rapport à la première section axiale.

5. Implant selon la revendication 4, **caractérisé en ce que** la section à filetage interne est une section apicale du trou aveugle.

6. Implant selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le pas est une distance prédéterminée, que le rapport de la distance prédéterminée sur l'espacement axial entre les crêtes des pics adjacents dans la première section axiale est un premier multiple d'entier, que le rapport de la distance prédéterminée sur l'espacement axial entre les crêtes des pics adjacents dans la seconde section axiale est un second multiple d'entier et que le premier multiple d'entier est supérieur au second multiple d'entier.

7. Implant selon l'une quelconque des revendications précédentes, **caractérisé en ce que** les crêtes de tous les pics, ou substantiellement tous les pics, dans les première et seconde sections axiales s'étendent sur un plan axial parallèle à l'axe principal de la tige.

8. Implant selon l'une quelconque des revendications précédentes, **caractérisé en ce que** la hauteur (h1, h2) des pics, comme mesurée à partir des creux jusqu'aux crêtes, dans la première section axiale diffère de celle dans la seconde section axiale.

9. Implant selon la revendication 8, **caractérisé en ce que** la hauteur (h1) des pics dans la première section axiale est inférieure à la hauteur (h2) des pics dans la seconde section axiale.

10. Implant selon l'une quelconque des revendications 1 à 7, **caractérisé en ce que** la hauteur (h1, h2) des pics, comme mesurée à partir des creux jusqu'aux crêtes, dans la première section axiale est la même ou substantiellement la même que dans la seconde section axiale.

11. Implant selon l'une quelconque des revendications

1 à 9, **caractérisé en ce que** le rapport de la hauteur des pics, comme mesurée à partir des creux jusqu'aux crêtes, sur l'espacement axial entre les crêtes des pics adjacents dans la première section axiale est la même ou substantiellement la même que dans la seconde section axiale.

12. Implant selon l'une quelconque des revendications précédentes, **caractérisé en ce que** la hauteur des pics, comme mesurée à partir des creux jusqu'aux crêtes, dans la première section axiale n'est pas supérieure à 0,20 mm.

13. Implant selon l'une quelconque des revendications précédentes, **caractérisé en ce que** la hauteur des pics, comme mesurée à partir des creux jusqu'aux crêtes, dans la seconde section axiale est dans la fourchette de 0,15 à 1 mm.

14. Implant selon l'une quelconque des revendications précédentes, **caractérisé en ce que** la rugosité orientée à la circonférence dans au moins l'une des première et seconde sections axiales est présentée par un profil de filetage de vis avec des pics orientés à la circonférence étant définis par les éléments filetés du profil de filetage de vis.

15. Implant selon l'une quelconque des revendications 1 à 13, **caractérisé en ce qu'**à la fois les première et seconde sections axiales sont présentées par un profil de filetage de vis avec des pics orientés à la circonférence étant définis par les éléments filetés des profils de filetage de vis.

16. Implant selon la revendication 14 ou 15, **caractérisé en ce que** le ou chaque profil de filetage de vis est formé par une structure de filetage de vis.

17. Implant selon la revendication 16, annexée à la revendication 15, **caractérisé en ce que** la structure de filetage de vis de la première section axiale est formée par un premier jeu de filets indépendants ayant chacun des tours ; les tours de chaque filet indépendant dans le premier jeu définissant des éléments filetés dans la première section axiale et étant séquentiellement agencés avec les tours des autres filets indépendants dans le premier jeu avec les tours adjacents de l'un des filets indépendants du premier jeu étant espacés de façon axiale par une distance d'espacement prédéterminée qui est la même pour les tours adjacents des autres filets indépendants dans le premier jeu ; et la structure de filetage de vis de la seconde section axiale est formée par (i) un filet indépendant ayant des tours définissant les éléments filetés de la seconde section axiale et qui sont espacés de façon axiale par la distance d'espacement prédéterminée ou essentiellement la distance d'espacement prédéterminée, ou (ii) un second jeu de filets indépendants inférieurs en nombre au premier jeu, ayant chacun des tours, les tours de chaque filet indépendant dans le second jeu définissant des éléments filetés dans la seconde section axiale et étant séquentiellement agencés avec les tours des autres filets indépendants dans le second jeu avec les tours adjacents de chaque filet indépendant du second jeu étant espacés de façon axiale par la distance d'espacement prédéterminée ou essentiellement la distance d'espacement prédéterminée.

18. Implant selon la revendication 17, **caractérisé en ce que** un ou plusieurs filets indépendants des première et seconde sections axiales sont partagés par les première et seconde sections axiales.

19. Implant selon la revendication 17 ou 18, **caractérisé en ce que** le ou chaque filet indépendant d'au moins l'une des première ou seconde sections axiales est un micro filet.

20. Implant selon la revendication 19, **caractérisé en ce que** seuls les filets indépendants de la première section axiale sont des micro filets.

21. Implant selon la revendication 19, **caractérisé en ce que** les filets indépendants des première et seconde sections axiales sont des micro filets.

22. Implant selon l'une quelconque des revendications 1 à 13, **caractérisé en ce que** la rugosité orientée à la circonférence dans au moins l'une des première et seconde sections axiales est formée par une série de lignes axiales de billes séparées à la circonférence.

23. Implant selon la revendications 22, **caractérisé en ce que** les billes de chaque ligne sont séparées à la circonférence.

24. Implant selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'implant est un implant dentaire adapté pour l'implantation dans le maxillaire ou la mandibule d'un patient édenté pour supporter une superstructure qui présente une ou plusieurs dents artificielles.

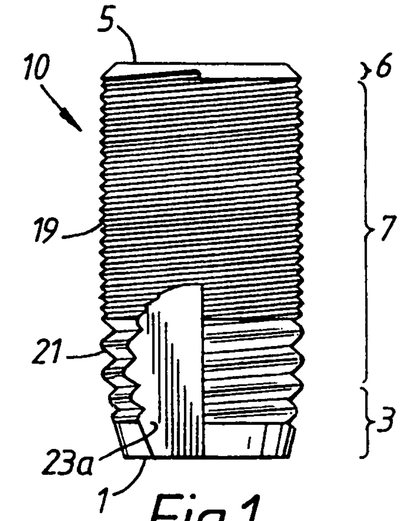

Fig.1

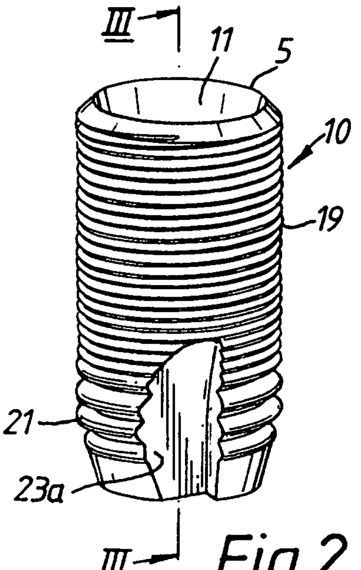

Fig.2

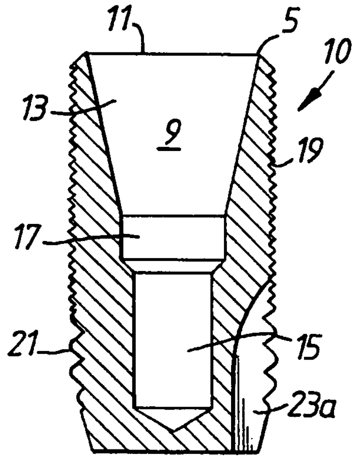

Fig. 3

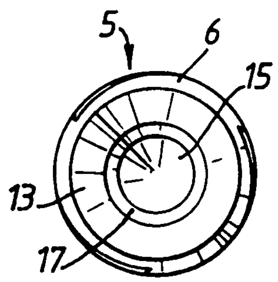

Fig.4

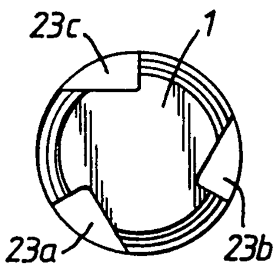

Fig.5

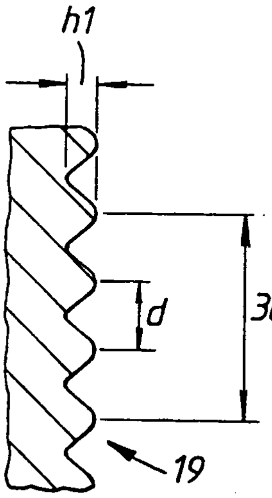

Fig.6

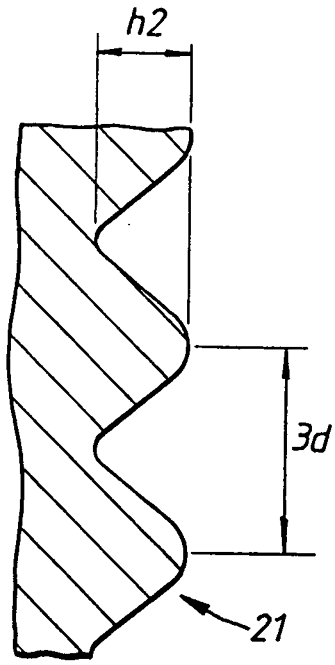

Fig.7