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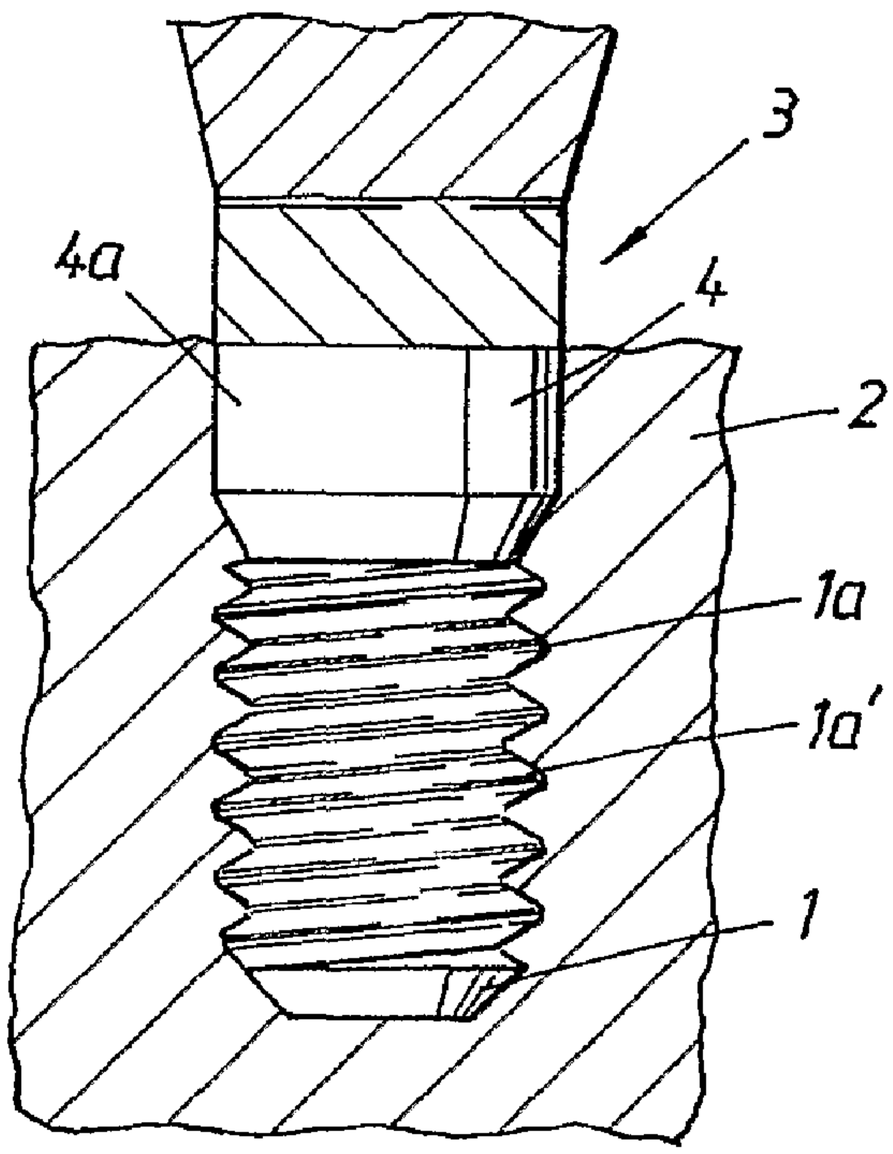
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(72) Inventeur/Inventor:
HALL, JAN, SE

(73) Propriétaire/Owner:
NOBEL BIOCARE SERVICES AG, CH

(74) Agent: FETHERSTONHAUGH & CO.

(54) Titre : IMPLANT ET PROCEDE DE FABRICATION D'UNE STRUCTURE DE SURFACE SUR L'IMPLANT
(54) Title: METHOD FOR PRODUCING A SURFACE STRUCTURE ON AN IMPLANT, AND SUCH AN IMPLANT



(57) Abrégé/Abstract:
A surface structure is produced on an outer surface of an implant or a fixture and forms a base structure in a range of implants related to different types and qualities of jaw bone. During production of the surface, parts of a turning tool are placed against the implant or against a blank which is intended to form the implant. The parts and/or the implant are assigned controls which give rise to mutual displacements between the parts and the implant so that the parts follow a substantially spiral trajectory along the outer surface. By means of said controls, a long wave pattern is formed with successive peaks and with through lying between these. In this connection, a through can be arranged adjacent to the outer parts of an existing thread. The controls are chosen so as to produce through depths in the range of 25 to 250 μm, preferably 50 to 200 μm. The invention also relates to an implant which has the same character as the implant produced by the method.

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(71) Applicant *(for all designated States except US)*: **NOBEL BIOCARE AB (publ)** [SE/SE]; Box 5190, S-402 26 Göteborg (SE).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **HALL, Jan** [SE/SE]; Stabbegatan 2A, S-416 80 Göteborg (SE).

(74) Agent: **OLSSON, Gunnar**; Nobel Biocare AB (publ), Box 5190, S-402 26 Göteborg (SE).

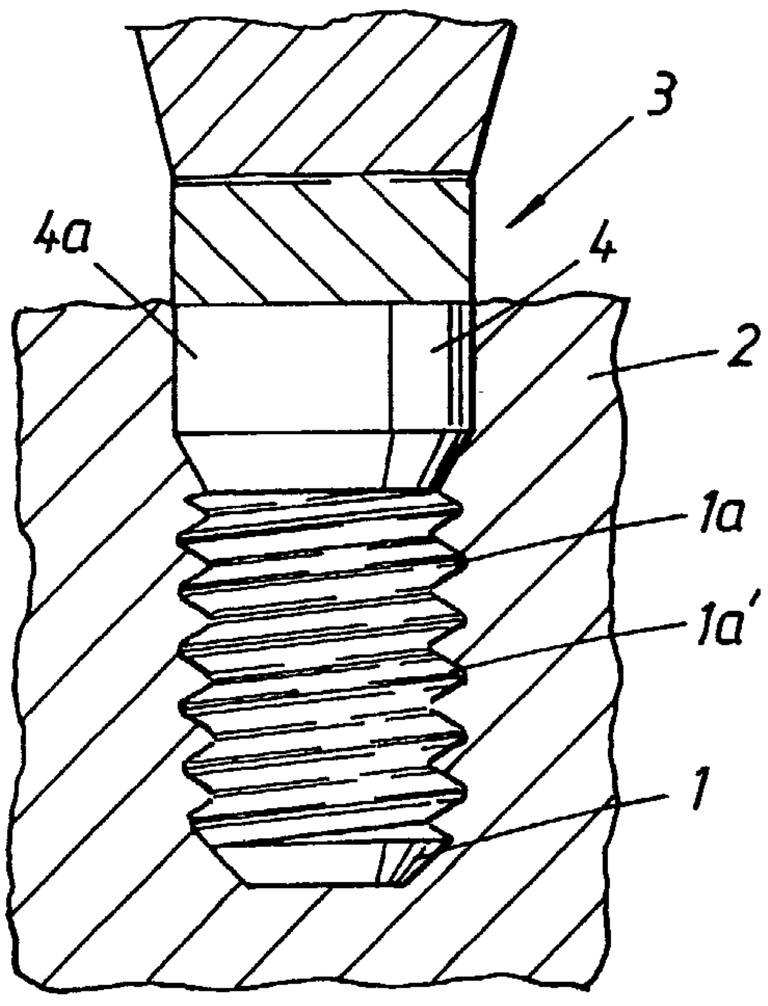
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(54) Title: METHOD FOR PRODUCING A SURFACE STRUCTURE ON AN IMPLANT, AND SUCH AN IMPLANT



(57) Abstract: A surface structure is produced on an outer surface of an implant or a fixture and forms a base structure in a range of implants related to different types and qualities of jaw bone. During production of the surface, parts of a turning tool are placed against the implant or against a blank which is intended to form the implant. The parts and/or the implant are assigned controls which give rise to mutual displacements between the parts and the implant so that the parts follow a substantially spiral trajectory along the outer surface. By means of said controls, a long wave pattern is formed with successive peaks and with through lying between these. In this connection, a through can be arranged adjacent to the outer parts of an existing thread. The controls are chosen so as to produce through depths in the range of 25 to 250 μm, preferably 50 to 200 μm. The invention also relates to an implant which has the same character as the implant produced by the method.

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Method for producing a surface structure on an implant, and such an implant

The present invention relates to a method for producing a surface structure on an outer surface of an implant or a fixture, preferably an outer surface structure which forms a base structure in a range of implants related to different types and qualities of bone, for example jaw bone. During production of the surface, parts of a tool, for example a turning tool, milling tool or shot-peening tool, are brought into cooperation with the implant or with a blank which is intended to form the implant, and at the same time the parts and/or the implant or blank are assigned controls which give rise to mutual displacements between the parts and the implant or blank so that the parts follow a substantially spiral trajectory along the surface or outer surface in question. The invention also relates to an implant which has a surface, preferably an outer surface, having a surface structure which forms a base structure in a range of implants related to different types and qualities of bone, for example jaw bone. The surface in question, preferably the outer surface in question, is arranged to cooperate with parts of a tool which can be applied to the surface, for example a turning tool, for cutting work. The outer surface is also arranged to take part in or execute a movement function together with said parts in order, depending on the controls, to allow the parts to follow a spiral trajectory along the surface in question.

In connection with the method and the implant, and with respect to the mutual movements between the parts and the implant, the parts can in principle be stationary and the implant movable, for example displaceable and/or rotatable in relation to the parts. Alternatively, the parts in question can execute the movements in relation to a stationary implant or fixture. In the third embodiment, the parts and also

the implant move in the mutual movements.

The present invention is based on one or more outer surfaces of an implant being provided with an arrangement comprising a surface pattern which has been produced by cutting work, for example turning, milling or shot-peening. Reference may be made to the prior art and quite generally to the patent literature which specifies such surface patterns on cylindrical, cone-shaped and/or threaded outer surfaces.

In connection with such an outer surface which has been produced by cutting work, it has also been proposed that porous oxide layers on, for example, titanium material can be used to stimulate bone growth when an implant is fitted in bone. In one embodiment, the present invention proposes that the outer surface with a pattern produced by cutting work be combined with oxide layers. There are a great many proposals for oxide layer structures, and reference may be made inter alia to the patents obtained by the Applicant of the present patent application and to the patent applications made: SE 97 01872-5, SE 99 01971-3, SE 99 01974-7, SE 00 01201-3 and SE 00 01202-1. Reference may also be made quite generally to US 4,330,891 (Brånemark) and EP 676179.

As far as oxide layers are concerned, a number of known oxide constructions have been proposed to function on their own in cooperation with bone or soft tissue, and a number of known oxide constructions have additionally been proposed to function as carriers of bone growth-stimulating substance. Reference may be made to the abovementioned patents and patent applications and to the patents obtained by the same Applicant and the patent applications filed: SE 99 01972-1, SE 99 01973-9, SE 01 02388-6, SE 01 02389-4, SE 01 02390-2, SE 01 02391-0 and SE 97 01647-1. Reference may also be made to the patents, patent applications and publications

cited in said patents and patent applications.

The production of microfabricated outer surfaces on implants has also been discussed in SE 98 01188-5 (from the same Applicant as the present application), US 5,588,838, EP 720454 and EP 475358. In a further embodiment according to the present invention, said layers which have been produced by cutting work are also to be combined with layers which are made in another way, for example with the aid of laser bombardment, which is also known per se.

In connection with the fitting of implants, there is a considerable requirement to be able to achieve optimum and high-quality implant results. There is a need to have access to a large number of parameters which can be exploited in different patients and different implantation situations. Given the demands of patients and treatment personnel, not all parameters can be applied in different cases. The bone quality, the patients' attitude, costs, etc., can be limiting factors, and even if development work and proposals permitting good results are moving in one direction, there may be a need for alternative solutions to be offered or used in different individual cases. Thus, for example, there may be a need to avoid bone-growth-stimulating substances but still use the associated oxide layers together with specific underlying layers. The present invention aims, inter alia, to solve this problem and proposes a unique surface layer structure produced by cutting work carried out on a cylindrical, cone-shaped and/or threaded outer surface or base surface or starting surface of an implant or fixture.

The present invention is based on the idea of achieving substantial stability of the implant incorporation in the bone in a short time, for example after just 1 to 5 days. The invention solves this problem too. In one embodiment, it is important to prevent or counteract

bacterial growth at the parts where the implant emerges from the bone, for example the jaw bone. There is also a need to be able to obtain the surface pattern in question using an economical technique. This problem too is solved by the invention.

The feature which can principally be regarded as characterizing the method is that the initially mentioned control function is used to form a long wave pattern with successive peaks and with one or more troughs lying between these, or troughs surrounded by peaks. Thus, for example, a trough is obtained which extends along the outer parts of a thread. The control function is chosen so that it produces trough depths in the range of 25 to 250 μm, preferably in the range of 50 to 200 μm.

In embodiments of the novel method, one, two or more parallel troughs are formed upon said cooperation between the parts and the implant or blank. On threaded outer surfaces, the troughs are given courses which substantially follow the spiral course of the threads. In the range of implants mentioned in the introduction, the outer surfaces of the different implants are provided with different wave patterns, that is to say with different trough depths and/or peaks.

The feature which can principally be regarded as characterizing the novel implant (or the novel fixture) is that the surface in question, preferably in the form of an outer surface, has a long wave pattern formed by said control and movement function and with successive peaks or troughs separated by intermediate troughs or peaks, respectively. In this connection, a thread can be provided at its outer parts with a trough surrounded by peaks. The trough depths are in the range of 25 to 250 µm, preferably in the range of 50 to 200 µm.

In one embodiment, two or more troughs between the

peaks can extend substantially parallel along the spiral trajectory. At the threaded outer surface, the troughs follow the spiral course of the thread, and the long wave pattern can be regular or can vary along the direction of its extend, that is to say in the direction substantially coinciding with the main direction of the implant. In one embodiment, the trough depths can be different or, in another embodiment, identical along the spiral course(s) of the trough or troughs. In the case of one or two or more troughs extending in parallel or alongside one another, it is possible, in a further embodiment, for the trough depth to be different. With different implants from the range of implants, these can be arranged with different long wave patterns, that is to say with different trough depths and/or peaks.

According to another embodiment of the invention, there is provided a method for producing a surface structure on an outer surface having a thread, of an implant or a blank which is intended to form the implant, comprising controlling a cutting machine comprising a tool with parts for cutting work to perform cutting work on the implant or blank and at the same time mutually displace the parts and the implant or blank so that the parts follow a substantially spiral trajectory along the surface, and controlling the cutting machine to provide a trough having a course which follows the spiral course of said thread on its outer parts and having a depth in the range of 25 to 250 µm.

According to a further embodiment of the invention, there is provided an implant comprising an outer surface having a thread extending along a spiral trajectory, and a trough which follows the spiral trajectory of said thread on its outer parts and having a depth in the range of 25 to 250 µm.

By means of what has been proposed above, important combination elements to the already known technique are obtained in order to obtain implant situations which are well adapted to the patients and individualized. The technique of turning as such is already known and is well proven and can be used in connection with the novel method and the novel implant. By this means, technically reliable and economically advantageous arrangements are obtained for producing combination elements and placing them on the market.

A presently proposed embodiment of a method and an implant according to the invention will be described below with reference to the attached drawings, in which

Figure 1 shows an example of an implant of the type in question which has been fitted in the jaw and has been connected to a prosthetic structure, which is indicated symbolically,

Figure 2 shows a diagrammatic view, from the side, of a base structure produced by cutting work on an implant surface of the type in question, which base structure has been provided with a wave pattern arrangement lying on top, on which wave pattern arrangement a further wave pattern and/or layer arrangement has been produced in turn,

Figure 3 shows in a side view, and in cross section, the principle for producing a wave pattern by means of cutting work (turning),

Figure 4 shows, diagrammatically and symbolically, an arrangement for applying or establishing an oxide layer on an implant which has been treated by means of cutting work,

Figure 5 shows, diagrammatically and symbolically, the application of a layer on top of the layer according to Figure 3 which has been produced by cutting work, the layer on top being produced with the aid of a laser technique by means of which a laser bombardment is effected on the implant surface or fixture surface in question,

Figure 6 shows, in a perspective view, obliquely from above, an example of parts which cooperate with an implant or a blank for producing the implant so as to form the base structure on the surface/outer surface in question,

Figure 7 shows, in a side view, parts of an outer surface or thread of an implant provided with peaks and with troughs lying between these, with a trough depth of ca. 125 µm,

Figure 8 shows, in a side view, parts of the outer surface or outer thread of an implant which has been machined according to Figure 7 and which has been acted on by laser bombardment and anodic oxidation,

Figure 9 shows, in partial longitudinal section, the inverted structure of troughs and peaks of an underlying wave pattern compared with the case according to Figure 2,

Figure 10 shows, in partial longitudinal section, the application of troughs on the outer parts of a thread, and

Figure 11 shows, in a perspective view, obliquely from above, the oxide layer structure on a base structure produced by cutting work according to Figure 3.

In Figure 1, an implant or a fixture is indicated by 1. The implant is fitted in a jaw bone in a manner known per se, and a prosthetic structure which can be of a type known per se is applied on the upper end of the implant or the end facing away from the jaw bone. The implant is of the type which comprises an outer thread 1a, the outer surface of the implant or of the thread being indicated by 1a. The part of the implant emerging from the jaw bone 2 is indicated by 4. The implant can be part of a range of implants with different types of outer surfaces, threads, and different numbers of threads, etc. The outer surface structure must be designed so that effective growth of the surrounding bone onto the outer surface can take place and can be stabilized in a relatively short time. In accordance with the above, there is a need to have different surface structures on the outer surface 1a'interalia. The outer surface structure can vary along the longitudinal direction of the implant and thus, for

example, there may be a need for the outer surface 4a of the emerging part 4 to be provided with a lower roughness value than the outer surface 1a' in order to prevent growth of bacteria on the emerging part.

The thread 1a with associated outer surface 1a' is shown greatly enlarged in Figure 2. According to Figure 2, the outer surface in question is to be designed as a wave pattern or with wave-shaped topography. In Figure 2, three peaks, ridges, waves, etc., succeeding one another in the wave pattern are indicated by 5, 6 and 7. The peaks are connected via troughs 8 and 9. The wave pattern is long-wave and the waves 5, 6, 7 are each chosen with a wave length A of 25 - 250 µm. The troughs in question can have a trough depth B of between 25 and 250 µm. The distances A and depths B can be the same or differ along the direction of extent of the wave pattern, which in Figure 2 is indicated by 10. In one illustrative embodiment, the outer surface 1a' can be arranged with two or more wave patterns and/or layers lying on top. Thus, for example, a wave pattern 11 with intermediate-length waves can be applied or arranged on the surface 1a'. The pattern 11 lying on top is shown greatly enlarged in relation to the underlying wave pattern which in this way forms a base structure. In the intermediate-length wave pattern 11, two peaks are indicated by 12 and 13, and a trough arranged between the peaks is indicated by 14. The wave length C is in this case chosen with a lower limit of for example 10 µm (the pit diameters can be from 75 to 150 µm). The trough depth D in this case assumes a lower value than B. Alternatively, a top layer 15 preferably consisting of an oxide layer can be arranged on the underlying wave pattern. The oxide layer 15 is shown greatly enlarged in relation to the underlying wave pattern 5, 6, 7 and the wave pattern 11 lying between. The oxide layer can be of a known type, see for example the references mentioned above. In one embodiment, all three wave patterns and layers can be

present, in which case the base structure is formed by a long wave pattern, the intermediate structure by an intermediate-length wave pattern, and the outer layer 15 is formed by an oxide layer (for example of titanium).

Figure 3 is intended to show the principles of production of the underlying base structure obtained by cutting work, said cutting work shown in the present illustrative embodiment being in the form of turning. An implant or a blank which is intended to form the implant has been shown partially by 16. The implant is arranged in a machine 17, 18 which in a manner known per se can give the implant or the blank 16 a rotational movement 19 about the longitudinal axis 16a of the implant or blank. The machining equipment in question includes a control unit 20, a turning tool is symbolized by 21, and its front or free end which can cooperate with the outer surface 16b of the implant or blank is shown by 21a. Since the equipment can be of a type known per se, it will not be described here; only the cooperation which takes place between the parts 21a and the outer surface 16b will be described in principle. The tool 21, 21a and the implant or blank can be assigned a mutual movement function. The control unit controls the movement function between the implant/blank and the turning tool 21, 21a. The control function of the control unit with respect to the equipment 17, 18 is indicated by i1, and the control function with respect to milling is indicated by i2. The implant or blank can thus be rotated about the axis 16a, and the turning tool 21, 21a can be actuated upwards and downwards in the directions of the arrows 22 as the trough formation proceeds. The control unit 20 can also assign the turning tool a displacement movement 23 along said axis of rotation 16a. In addition or as an alternative to this, the implant or blank can be displaced by controls from said control unit in its longitudinal direction, symbolized by 24.

It will be seen that a continuous turning can be carried out on the outer surface 16b as a function of the chosen movement pattern controlled by the control unit. The parts 21a of the turning tool can be provided with two front parts 21a', 21a'' which produce said trough arrangement 25 as the movement pattern is effected by the implant/blank and the turning tool 21. Said front parts 21a and 21a'' produce two parallel troughs which follow a spiral trajectory along the outer surface 16b of the implant or blank. The spiral shape is dependent on the mutual movement function, and the trough formation or wave pattern formation can be effected on the given outer surface on a cylindrical, cone-shaped and/or threaded outer surface of the implant or blank. As regards the trough pattern, reference is made to Figure 2 and the peaks 5, 6 and 7 and intermediate troughs 8 and 9 indicated there. The trough depths B are thus determined by the front parts 21a' and 21a''. The shapes and lengths of the peaks are determined by means of a part 21a''' which lies between said front parts. The turning tool can have another design, in which case, however, the described principle is preferably used. In addition, the turning tool can be given oscillating movements in the main radial direction(s) of the implant.

In accordance with what has been stated above, the long wave pattern thus established in Figure 3 can be provided with a top oxide layer in a manner known per se. Figure 4 indicates the principle of applying an oxide layer on an implant 26 which has been provided with a base structure 26a in accordance with the above. The oxide application or oxide production on the layer produced by cutting work takes place in a manner known per se in an oxidation unit 27 known per se, in which connection reference may be made to the abovementioned prior art.

Figure 5 is intended in principle to show how an

intermediate layer 11 according to Figure 2 can be applied on an implant which has been provided with an underlying wave pattern or with an underlying base structure according to Figure 3. In this case, the implant has been indicated by 28, and the layer 11 lying on top has been indicated by 28a. Laser bombardment equipment is known per se in connection with implants of this type, and such equipment has been indicated diagrammatically by 29. In an alternative embodiment, the implant 26 in Figure 4 can represent an implant provided with two layers according to Figures 3 and 5, in which case the outer layer which has been produced in accordance with Figure 5 is provided with the oxide layer 26a in question in the oxidation unit 27.

Figure 6 shows the turning tool 21 in a perspective view, obliquely from above, in relation to the surface of the implant or blank 16a. Two successive peaks are indicated by 25a and 25b, and a trough located between the peaks is indicated by 25c.

Figure 7 shows an illustrative embodiment of the application of a long wave pattern on a thread arrangement of an implant. Successive waves or peaks have been indicated by 30 and 31, and a trough lying between these, of the order of size of 125 µm, is indicated by 32.

Figure 8 shows a wave pattern according to 11 in Figure 2 which is applied on an underlying wave pattern or an underlying base structure where successive waves have been indicated by 33 and 34 and an intermediate trough arrangement has been indicated by 35. The top wave pattern according to 11 in Figure 2 consists of a pattern produced by laser equipment, and the underlying base structure has troughs with depths of ca. 75 µm. An oxide layer is additionally arranged on said top wave pattern.

Figure 9 is intended to show, at 35, the inverted structure of the wave pattern compared with Figure 7, where 35a shows the troughs and 35b the peaks. In Figure 10, reference number 36 indicates a trough arranged at or on a thread 37 whose outer parts (or edge) have been shown by 37a.

Figure 11 shows, obliquely from outside, an oxide layer 38 which is arranged on the base structure according to Figure 7, but where the trough depth is ca. 75 µm instead of ca. 125 µm. The oxide layer topography in question can be designed in a manner known per se in accordance with the above and the prior art. In Figure 11, a peak on the base structure is shown by 39, and the parts of the oxide layer cooperating with the base structure are shown by 40. The layer 38 has a known pore structure and has a depth of 0.01 to 10 µm, preferably 1 to 4 µm.

The invention is not limited to the illustrative embodiment given above by way of example, and instead it can be modified within the scope of the attached patent claims and the inventive concept. Reference is also made to the Swedish patent application filed on the same day and by the same Applicant and bearing the title "Implant, and method and system for producing such an implant".

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CLAIMS:

1. A method for producing a surface structure on an outer surface having a thread, of an implant or a blank which is intended to form the implant, comprising controlling a cutting machine comprising a tool with parts for cutting work to perform cutting work on the implant or blank and at the same time mutually displace the parts and the implant or blank so that the parts follow a substantially spiral trajectory along the surface, and controlling the cutting machine to provide a trough having a course which follows the spiral course of said thread on its outer parts and having a depth in the range of 25 to 250 µm.

2. The method of claim 1 wherein the depth is in the range of 50 to 200 µm.

3. The method as claimed in claim 1, wherein said trough is surrounded by peaks.

4. The method as claimed in any one of claims 1 to 3, wherein said surface is provided with successive peaks or troughs separated by intermediate troughs or peaks.

5. An implant comprising an outer surface having a thread extending along a spiral trajectory, and a trough which follows the spiral trajectory of said thread on its outer parts and having a depth in the range of 25 to 250 µm.

6. The implant of claim 5 wherein the depth is in the range of 50 to 200 µm.

7. The implant as claimed in claim 5, wherein said trough is surrounded by peaks.

8. The implant as claimed in any one of claims 5 to 7, wherein said surface is provided with successive peaks or troughs separated by intermediate troughs or peaks.

Fig. 1

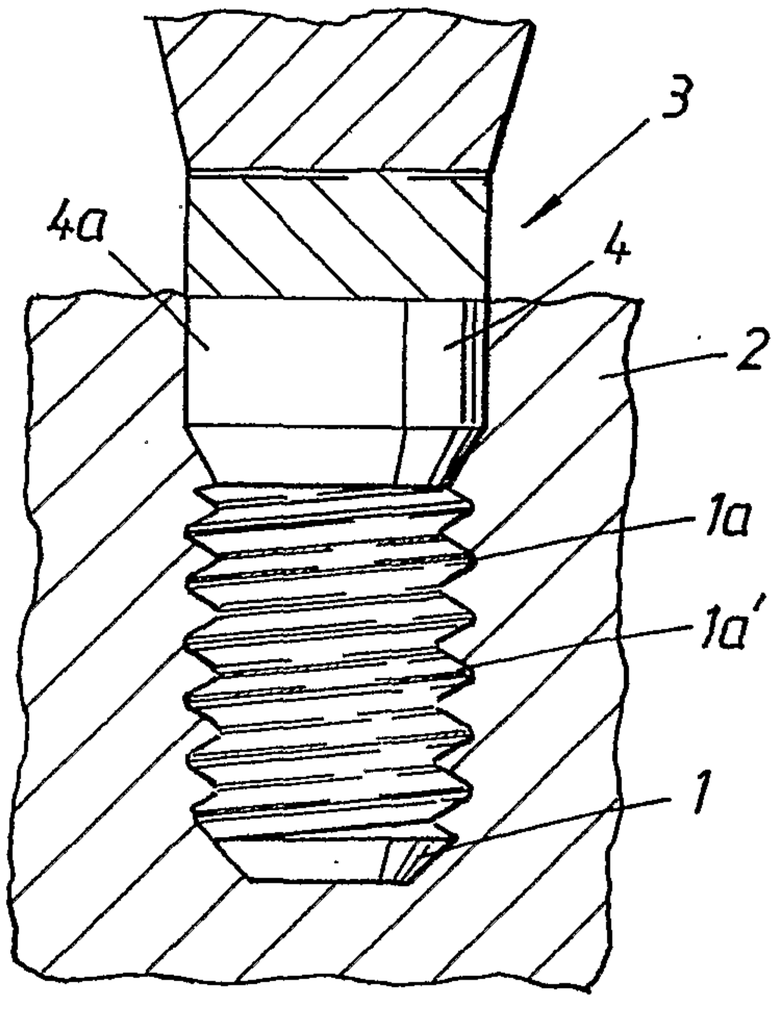


Fig. 2

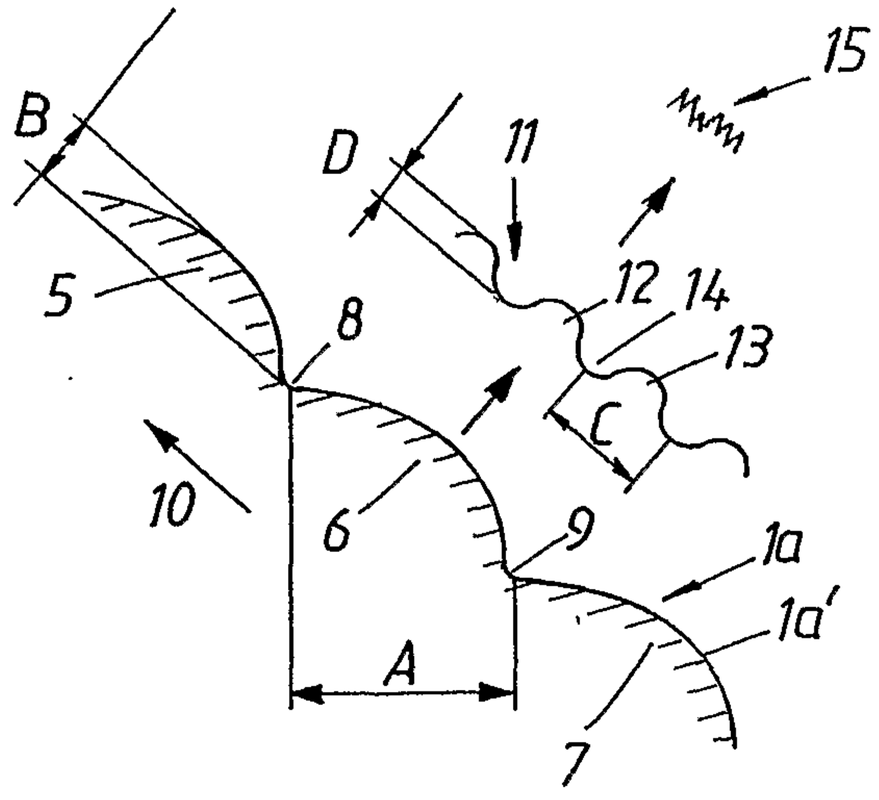


Fig. 3

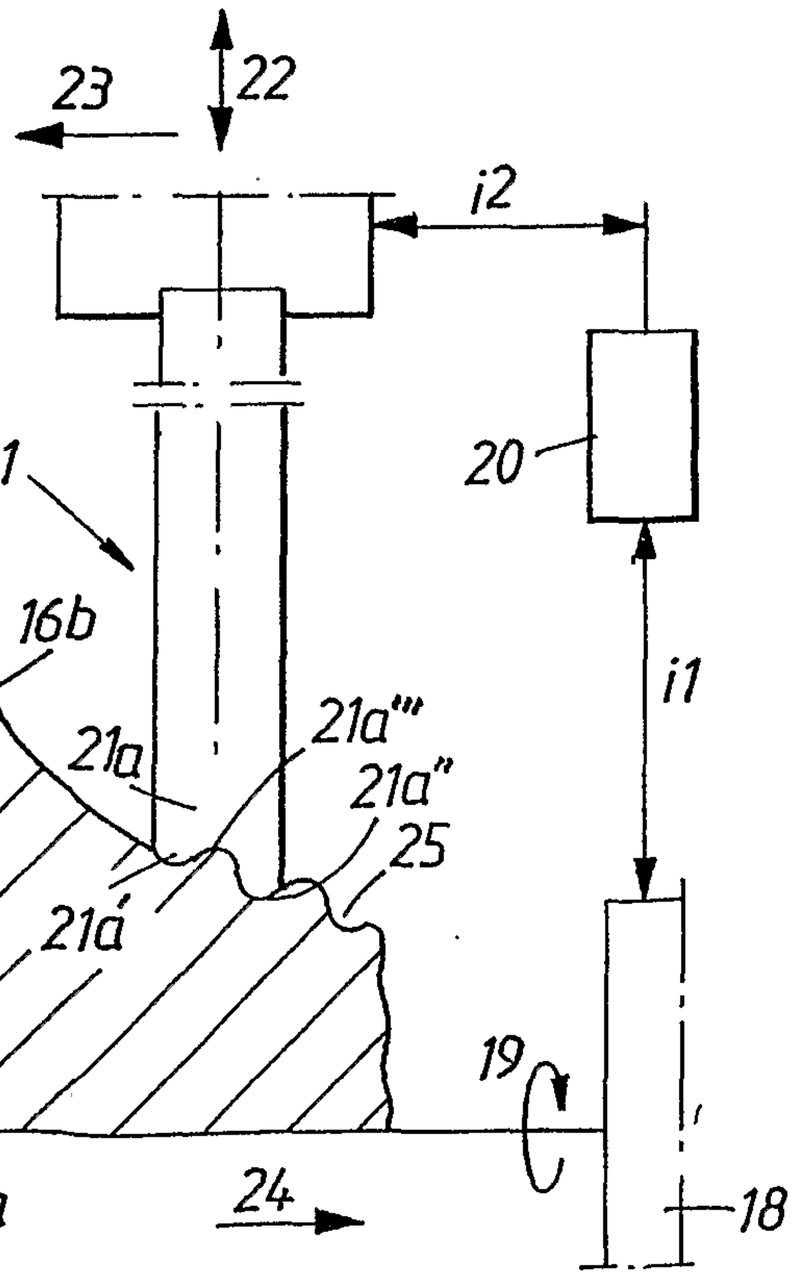


Fig. 4

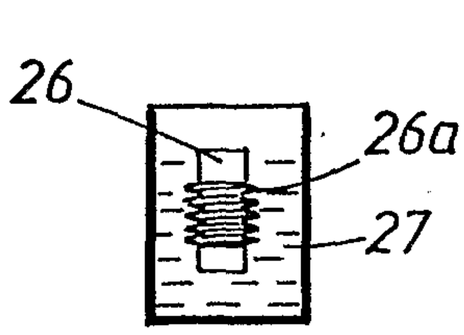


Fig. 5

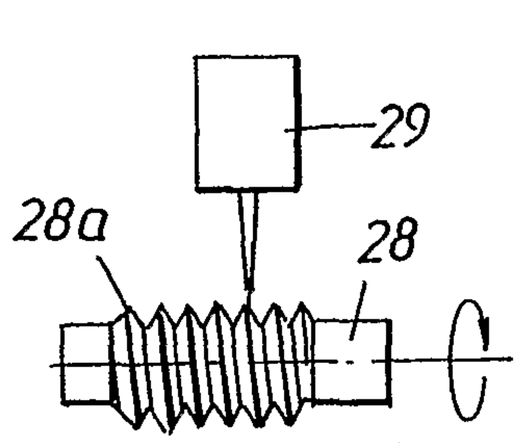


Fig. 6

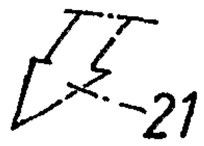
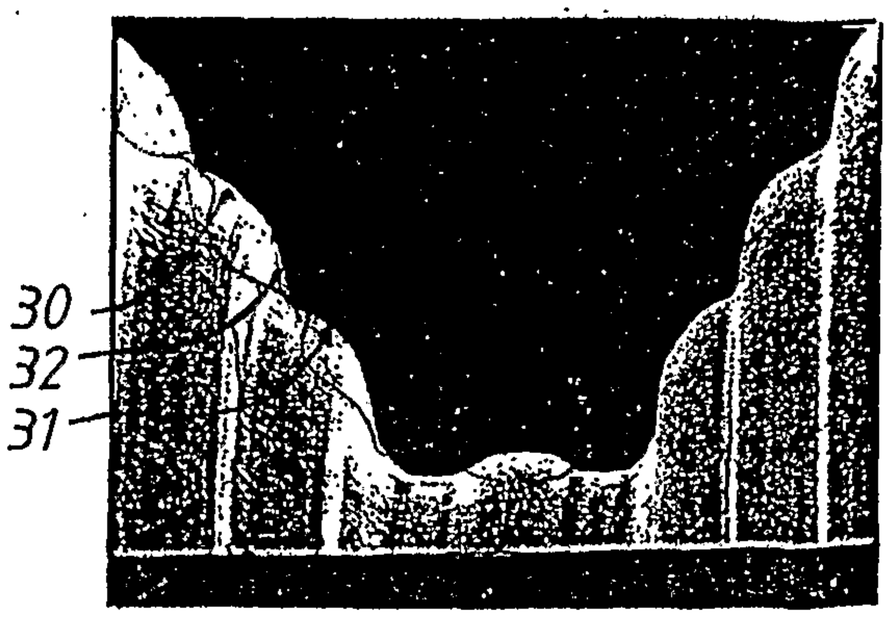


Fig. 8

Fig. 7



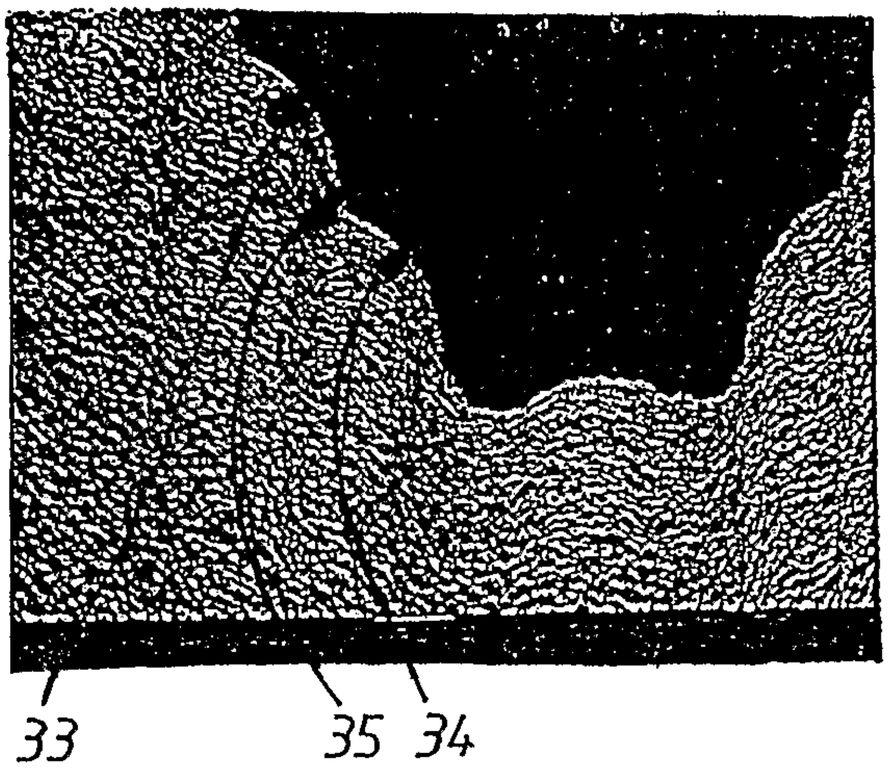


Fig. 9

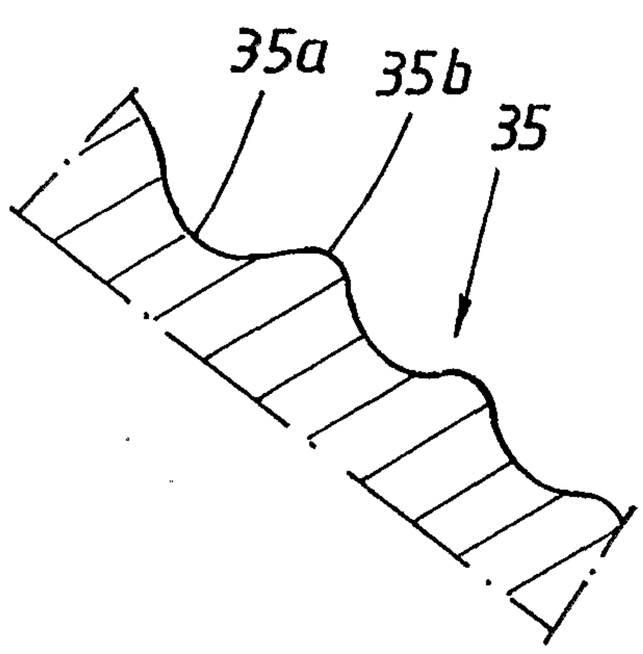


Fig. 10

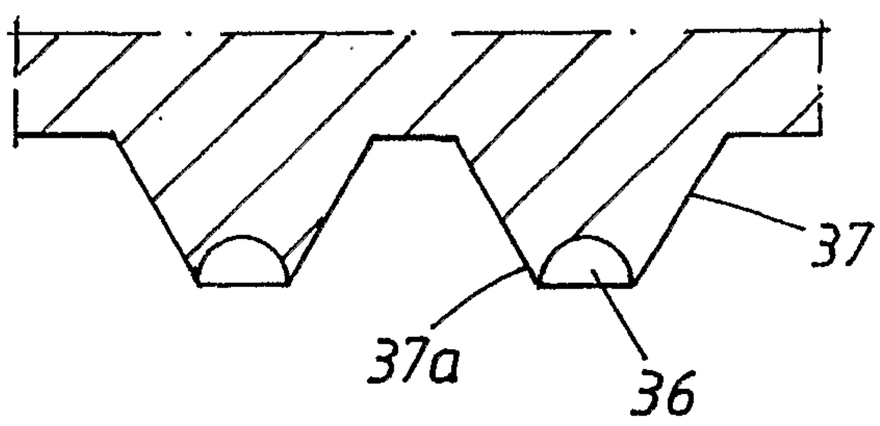
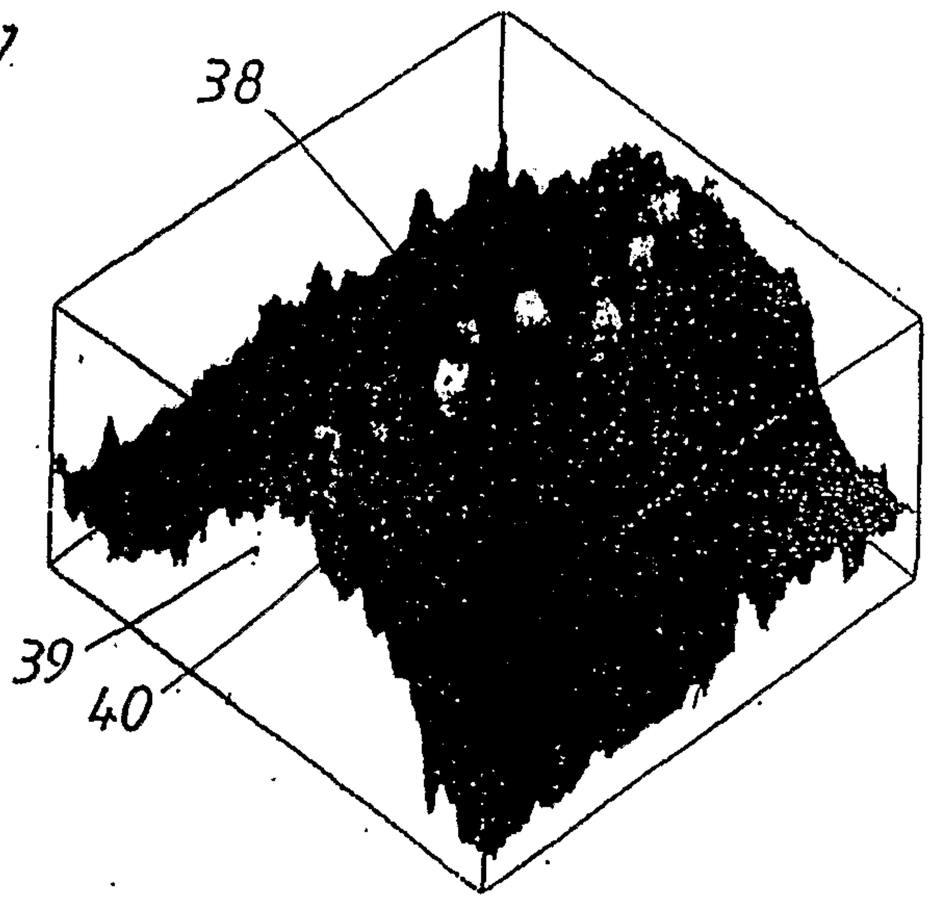
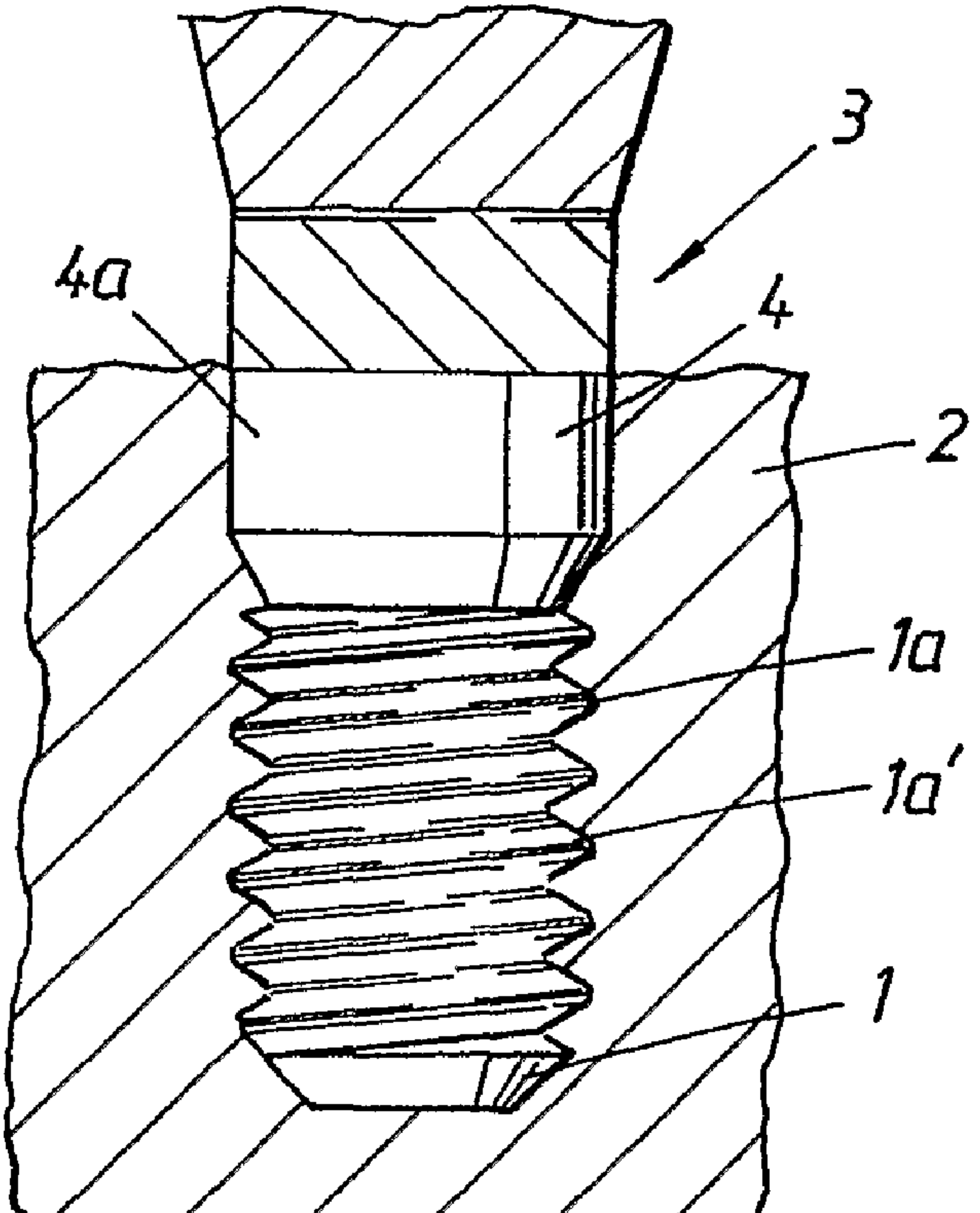


Fig. 11




3
4a
4
2
1a
1a'
1