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(54) **IMPLANT, AND METHOD AND SYSTEM FOR PRODUCING SUCH AN IMPLANT**

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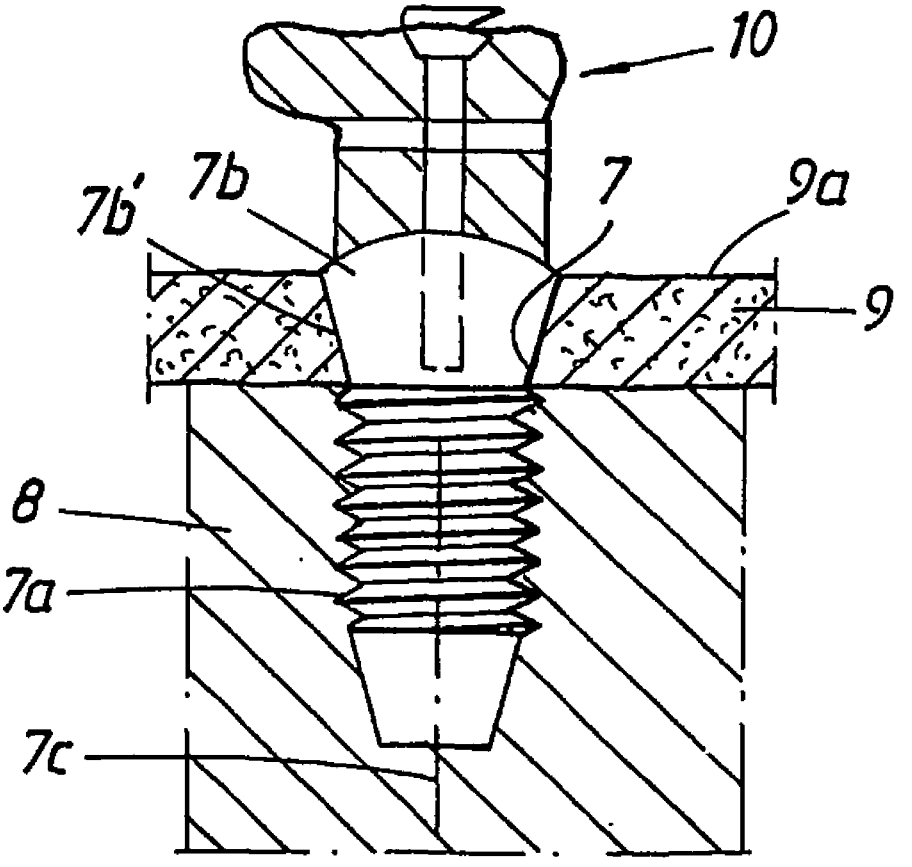
(57) **ABSTRACT**

In a method and system for producing an implant, the latter is designed with one or more surfaces extending in the longitudinal direction of the implant. Two or three production stages can be used. In one stage, either a topography with a long wave pattern is produced by means of culling work, or laser bombardment or further cutting work is used to produce a topography with an intermediate-length wave pattern. In addition, an oxidation process or shot-peening or etching is used to produce an outer layer. When using two of said production stages, said cutting work or said laser bombardment or further cutting work is followed by the oxidation process or the shot-peening or etching method. When using all three production stages, cutting work is followed by laser bombardment, or further cutting work, which in turn is followed for example by the oxidation process. The invention also relates to an implant which is produced using the method and is identified, ordered and produced using the system. The invention permits effective treatment of different implant situations.



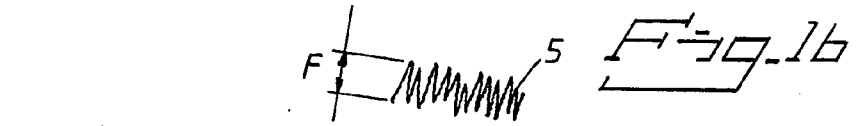


Fig. 1b

Fig. 1a

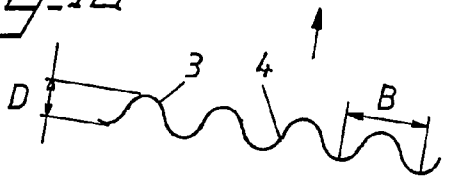


Fig. 1

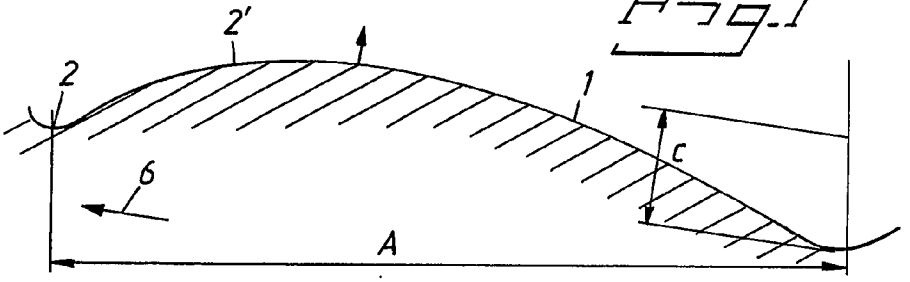
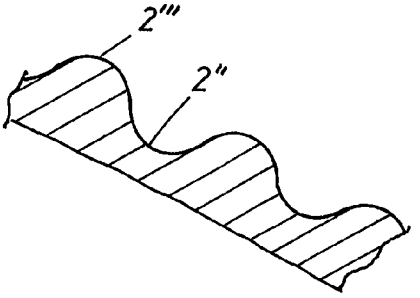


Fig. 1c



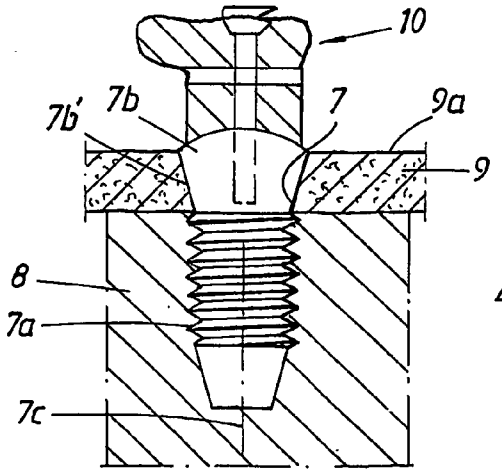


Fig. 2

Fig. 5

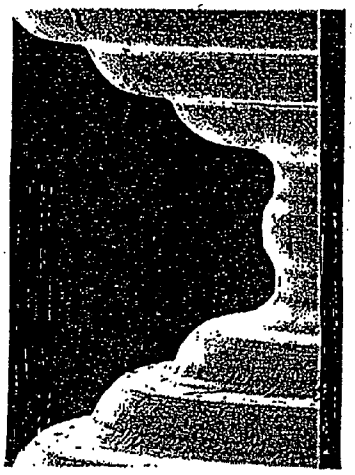


Fig. 6

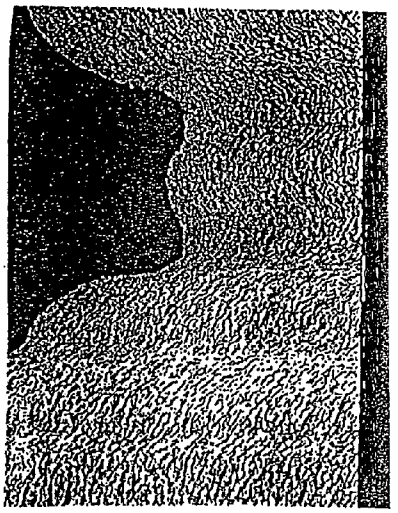


Fig. 3

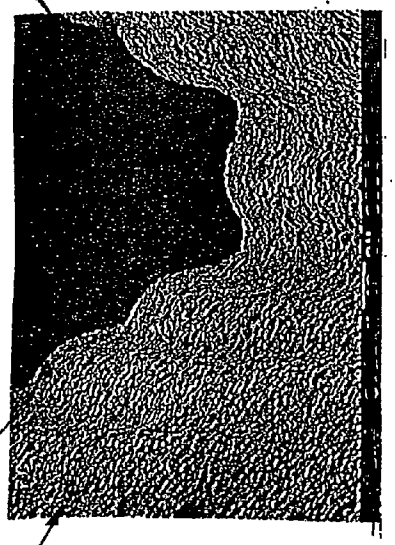


Fig. 4

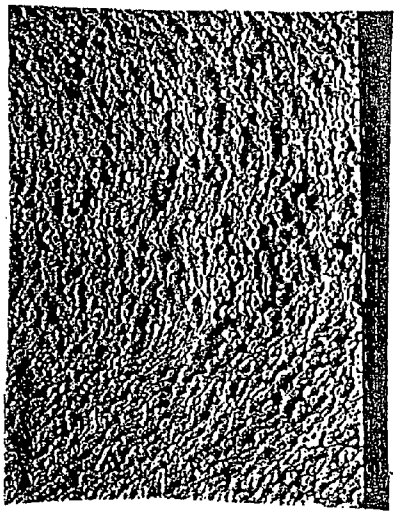


Fig. 7

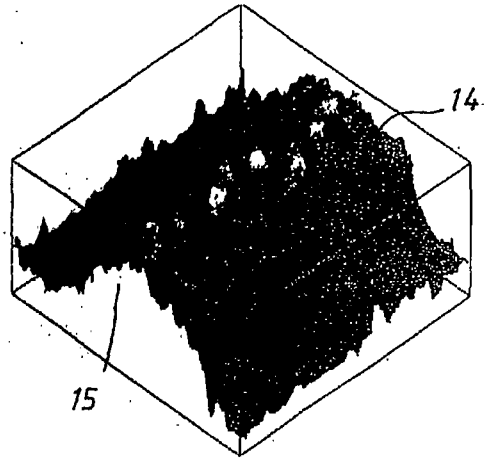

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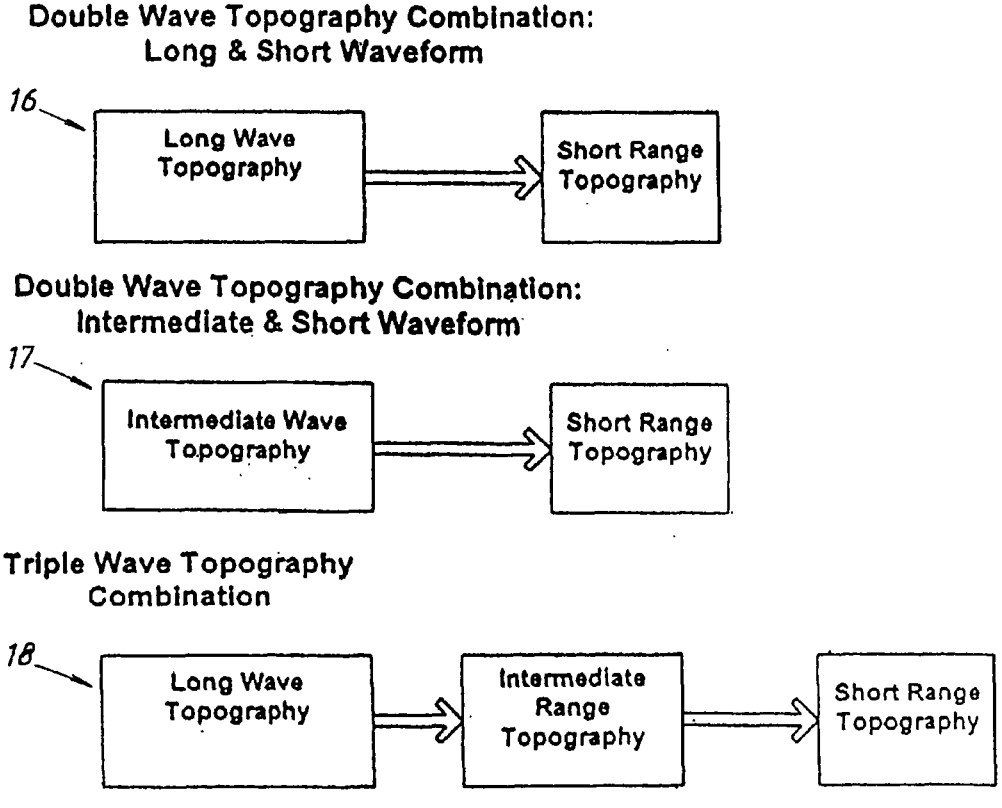
Fig. 8


Double Wave Topography Combination:
Long & Short Waveform
16
Long Wave Topography
Short Range Topography
Double Wave Topography Combination:
Intermediate & Short Waveform
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Intermediate Wave Topography
Short Range Topography
Triple Wave Topography Combination
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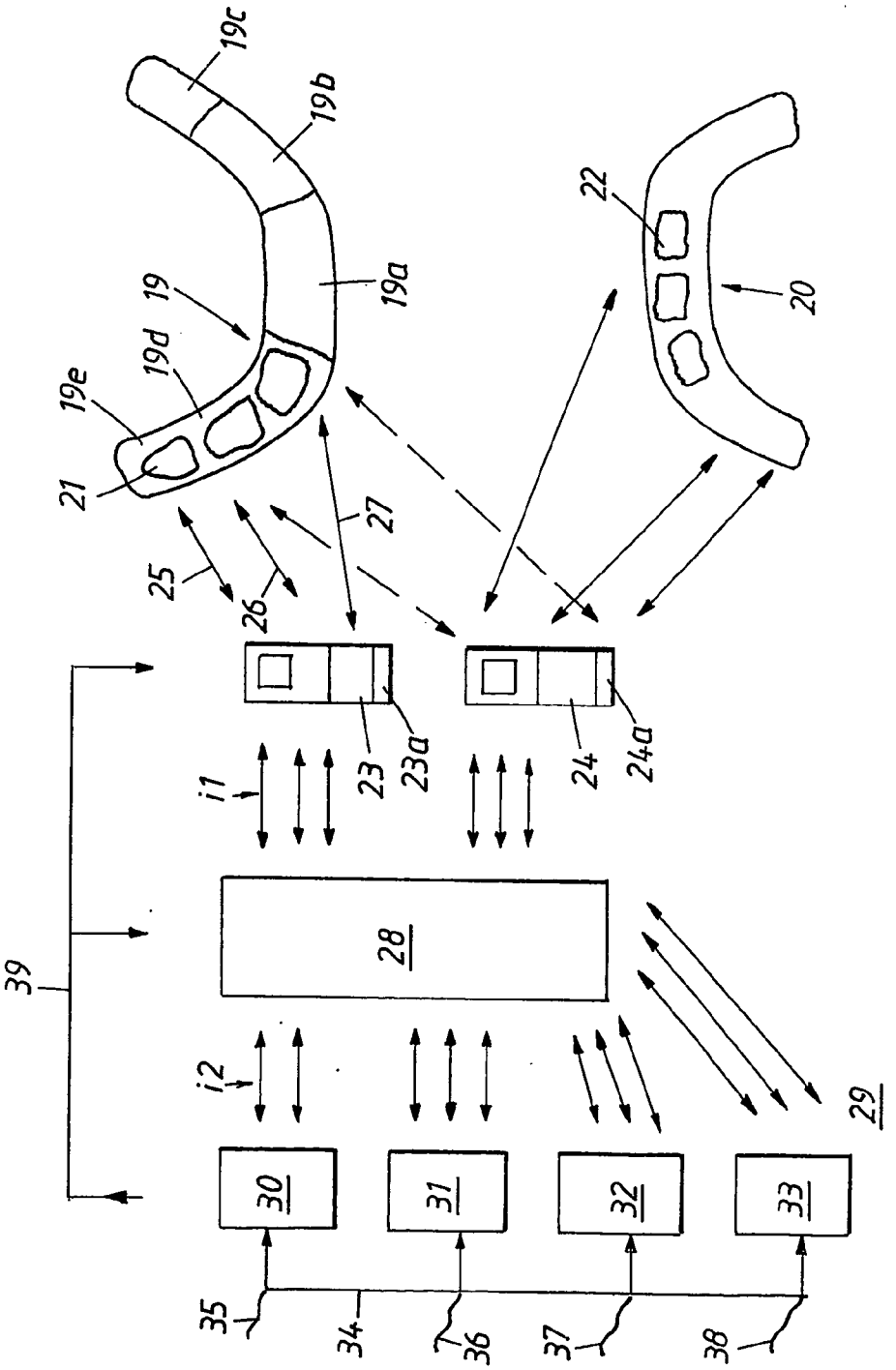
Long Wave Topography
Intermediate Range Topography
Short Range Topography

Fig. 4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IMPLANT, AND METHOD AND SYSTEM FOR PRODUCING SUCH AN IMPLANT

[0001] The present invention relates to a method for producing an implant or fixture which is designed with one or more outer surfaces extending about the longitudinal direction of the implant or fixture. The invention further relates to an implant with such outer surfaces, and to a system for providing the implant. Said system comprises first members for identification and possible analysis and/or modification of the respective implant, second members for transmitting data information related to the identification and possibly to the analysis and/or modification, and third members which, as a function of said data information, are arranged to produce the respective implant.

[0002] The present invention is based, inter alia, on the awareness that porous oxide layers on, for example, titanium material can be used to stimulate bone growth when an implant is fitted in bone. A very great many proposals have been made 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 by it: SE 97 01872-5, SE 99 01971-3, SE 99 01974-7, SE 00 01201-3 and SE 00 012002-1. Reference is also made quite generally to U.S. Pat. No. 4,330,891 and EP 676179.

[0003] A number of known oxide layer structures have been proposed to function only in cooperation with bone or soft tissue and a number of known oxide layer constructions have been proposed to function as carriers of substances which stimulate bone growth. 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 mentioned in said patents and patent applications.

[0004] Production of microfabricated outer surfaces on implants has also been discussed in SE 98 01188-5 (from the same Applicant as the present application), U.S. Pat. No. 5,588,838, EP 720454 and EP 475358.

[0005] 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 attitude of the patients, 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 novel solution for optimum and effective implant fitments representing specific choices and unique combinations taken from a very wide-ranging assortment of components and designs available on the general market.

[0006] The present invention is based on the idea of achieving effective incorporation of an implant in the particular bone, for example the jaw bone, and of thereby achieving substantial stability of the implant 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. This problem too is solved by the invention.

[0007] There is also a need to find a technically economical way of obtaining an economical and efficient production chain in which computerized equipment and mechanical production equipment can be used to identify the individual requirement, execute order functions, and produce the identified and ordered implants with a very high degree of precision. The invention solves this problem too.

[0008] The feature which can principally be regarded as characterizing a method or an implant according to the invention is that a number of production stages are used for each outer surface concerned. It is thus proposed, inter alia, to produce, by cutting work, a topography with a long wave pattern in which the waves extend substantially in the longitudinal direction of the implant. Alternatively, or in addition, a topography with an intermediate-length wave pattern, in which the waves extend substantially in said longitudinal direction, is to be produced by laser bombardment or cutting work, which can include or use oscillation movements. An oxidation process is also to be used to produce an oxide layer. Alternatively, a shot-peening or etching method can be used to produce a shot-peened or etched layer. According to the invention, at least two of said production stages are used, either said cutting work or said laser bombardment or cutting work to be followed by the oxidation process or shot-peening or etching method. In the case where all three production stages are used, the cutting work is first done, followed by the laser bombardment or the further cutting work, which in turn is followed by the oxidation process, or shot-peening or etching method.

[0009] An implant or a fixture according to the present invention can be regarded as being chaacterized by either of two construction possibilities. In the first case, an underlying wave pattern with long waves or intermediate-length waves is arranged on the surface or its material, and an oxide layer or shot-peened layer or etched layer is arranged on top of the underlying wave pattern. The long waves and intermediate-length waves extend substantially in said longitudinal direction. In the second case, an underlying wave pattern with long waves is used, which in turn is arranged with a wave pattern with intermediate-length waves. An oxide layer or shot-peened or etched layer is arranged on top of the last-mentioned wave pattern. Said long waves and intermediate-length waves extend substantially in said longitudinal direction.

[0010] Each wave pattern and layer combination is preferably arranged to obtain values or data for one or more parameters, for example surface area, surface volume and Ra and PV values, which pertain to the actual implant situation. With an optimum increase in surface area and/or an optimum increase in surface volume, each surface is designed with an underlying wave pattern established by cutting work, an intermediate pattern established by laser bombardment or further cutting work, and a top layer established by an oxidation process or by shot-peening or etching. In the case of an underlying wave pattern obtained

by cutting work, this pattern comprises substantially parallel troughs or depressions chosen with a depth in the range of 25 to 200 μm, preferably 50 to 150 μm. In the case of a threaded surface or threaded surfaces, for example, the troughs follow each thread spiral in the main direction of the implant. Underlying and intermediate wave patterns which are established by laser bombardment or further cutting work correspondingly comprise substantially parallel troughs or depressions, which can assume depths in the range of 10 to 75 μm and diameters of 75 to 150 μm. The top pattern can be arranged in a manner known per se. Each outer surface can be designed with different wave pattern and layer combinations along its longitudinal extent. At the part of the implant emerging from the bone in question, for example the jaw bone, there is a wave pattern and layer combination which gives a relatively small increase in surface area or surface volume compared to surfaces with said wave pattern and layer combination or wave pattern and layer combinations.

[0011] The feature which can principally be regarded as characterizing a system according to the invention is that the data information mentioned in the introduction is designed to initiate or activate wave pattern and layer combinations arranged on top of one another on one or more implant outer surfaces extending in the longitudinal direction of the implant. The computer information can be designed to initiate a first wave pattern and layer combination which comprises, on the one hand, an underlying wave pattern with long waves by means of cutting work or an underlying wave pattern with intermediate-length waves by means of laser bombardment or further cutting work, and, on the other hand, an oxide layer lying on top. In an alternative possibility, the data information can initiate a second wave pattern and layer combination with an underlying wave pattern with long waves by means of cutting work, with a wave pattern lying in between with intermediate-length waves obtained by laser bombardment or cutting work, and a layer lying on top and obtained by an oxidation process, etching or shot-peening.

[0012] In one embodiment, the first members mentioned in the introduction are designed to assign different bone parts, for example jaw-bone parts, to different wave pattern and layer combinations. The first members can be arranged to assign hard bone or a hard bone part to wave pattern and layer combinations with only two wave patterns which are arranged one on top of the other and which have a relatively small increase in area and/or volume compared to implants with said wave pattern and layer combinations. The first members can also be arranged to assign medium-hard bone or bone parts to wave pattern or layer combinations with one or two wave patterns arranged on top of one another and layers which give a relatively large increase in area and/or volume compared to the case with implants having wave pattern and layer combinations. The first members can also be arranged to assign soft bone only to wave and layer patterns which have three wave patterns and layers arranged on top of one another, and so on. Further embodiments of the system according to the invention are set out in the dependent claims concerning the system.

[0013] By means of what has been proposed above, sophisticated and high-precision treatment methods and implant constructions can be used effectively in the wide variety of existing bone types. Bone formation and healing functions can be effectively stimulated regardless of the bone structure. An advantageous arrangement can be provided for the whole treatment chain involving dentist, dental surgeon, dental technician and the mechanical production.

[0014] A presently proposed method, implant and system according to the invention will be described below with reference to the attached drawings, in which

[0015] **FIG. 1** shows a diagrammatic representation, on an enlarged scale, of parts of a first underlying wave pattern which has been obtained by means of cutting work,

[0016] **FIG. 1***a* shows a diagrammatic representation of a second wave pattern, enlarged in relation to **FIG. 1** and obtained by laser bombardment,

[0017] **FIG. 1***b* shows a diagrammatic representation, enlarged in relation to **FIGS. 1 and 1***a*, of a layer which is obtained by means of oxidation,

[0018] **FIG. 1***c* shows, in longitudinal section, parts of a threaded implant with troughs and peaks,

[0019] **FIG. 2** shows, in vertical cross section, an implant in a partially indicated jaw bone,

[0020] **FIG. 3** shows, in a vertical view, parts of an outer thread of an implant, the outer surface of the thread being designed with underlying troughs covered with an intermediate wave pattern obtained by laser bombardment, and an oxide layer applied on top of the last-mentioned wave pattern,

[0021] **FIG. 4** shows, in a vertical view, and enlarged in relation to **FIG. 1**, parts of an outer thread of an implant arranged under an intermediate wave pattern established by laser bombardment, and an oxide layer applied on top of said pattern,

[0022] **FIG. 5** shows, in a vertical view, at another scale, a wave pattern with a wave height or wave depth of ca. 75 μm,

[0023] **FIG. 6** shows, in a vertical view, a wave pattern obtained by cutting work and trough depths of 125 μm and outer covering in the form of an oxide layer,

[0024] **FIG. 7** shows, in a perspective view obliquely from outside, a first embodiment of an oxide layer lying on top,

[0025] **FIG. 8** shows, in block diagram form, different wave pattern combinations,

[0026] **FIG. 9** shows a system for assigning wave patterns to different bone parts in the jaw bone and members for identification, transfer and production of implants.

[0027] In **FIG. 1**, an outer part of a thread of an implant is shown by **1**. The surface comprises a base structure which is produced in a known manner by cutting work, for example by turning, milling or shot-peening. The base structure is designed with an underlying wave pattern with long waves. The wave length A is chosen in the range of 75 to 250 μm. The outer surface **1** is rippled or undulated with a second wave pattern **3** which has been shown separately and enlarged in **FIG. 1***a* in relation to **FIG. 1**. The wave length B for the waves or peaks in the second pattern is chosen in the range of 50 to 100 μm, and the waves are joined via troughs or depressions **4**. This intermediate layer is obtained by laser application. In the illustrative embodiment accord-