

(19) **DANMARK**

(10) **DK/EP 3043741 T3**



(12) Oversættelse af
europæisk patentskrift

Patent- og
Varemærkestyrelsen

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- (51) Int.Cl.: **A 61 B 1/00 (2006.01)** **A 61 B 1/04 (2006.01)** **A 61 B 1/24 (2006.01)**
A 61 C 13/00 (2006.01) **A 61 C 13/08 (2006.01)**
- (45) Oversættelsen bekendtgjort den: **2017-07-17**
- (80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2017-03-29**
- (86) Europæisk ansøgning nr.: **13771079.4**
- (86) Europæisk indleveringsdag: **2013-09-13**
- (87) Den europæiske ansøgnings publiceringsdag: **2016-07-20**
- (86) International ansøgning nr.: **EP2013069017**
- (87) Internationalt publikationsnr.: **WO2015036035**
- (84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**
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- (54) Benævnelse: **FREM GANGSMÅDE TIL FREMSTILLING AF EN TANDPROTESE**
- (56) Fremdragne publikationer:
WO-A1-2009/105618
WO-A1-2012/006717
DE-A1- 10 203 664

Method for producing a dental prosthesis

Prior art

- 5 The invention relates to a method for producing a dental prosthesis. Methods of this type are known in principle.

For example, DE 102 03 664 A1 discloses a method for producing a dental prosthesis using a CAD/CAM system. In this method, a photograph is taken when the teeth are in a healthy condition, the dental prosthesis being formed later on such that it resembles the shape at
10 the time of the healthy condition.

The shaping data which are obtained of the dental prosthesis are transmitted to a milling processing device as processing commands. A block of material undergoes a milling process
15 to produce the dental prosthesis. In this method, it is necessary to have available a photograph of the teeth in a healthy condition. It is a disadvantage that it is impossible to produce the dental prosthesis without a photograph of the teeth in a healthy condition.

Furthermore, WO 2009/105618 A1 discloses a method for producing a dental prosthesis, in which a digital photograph of the patient's teeth is initially taken. Thereafter, the patient
20 chooses a dental prosthesis. In software, the patient's existing teeth in the photograph are replaced by the teeth chosen by the patient.

The patient can then consider the look of his new teeth. If the patient is not satisfied, he
25 chooses a different dental prosthesis which, in turn, replaces the old teeth in the software. These selection and comparison steps are continued until the patient has found a satisfactory shape of the dental prosthesis.

After a satisfactory shape of the dental prosthesis has been found, the acquired data are
30 transmitted to the manufacturer of the dental prosthesis. It is a disadvantage that the manufacturer only has available the data from the photographs, so that a conversion into a three-dimensional model for a CAD/CAM system is relatively inaccurate.

It is therefore the object of the present invention to provide a method for producing a dental prosthesis which does not suffer from the disadvantages of the prior art and which in particular makes it possible to optimally adapt the dental prosthesis to the patient's wishes.

5 Disclosure of the invention

The present object is achieved by a method for producing a dental prosthesis and by a dental prosthesis according to the coordinated claims.

10 The method according to the invention has the following steps:

- producing an image of the front view of the patient's face in which the patient's mouth is open and the set of the patient's teeth being replaced is visible,
- 15 - superimposing the patient's teeth in the image of the patient's face by the digital photograph of a selected set of teeth by means of image processing software,
- adapting the size and/or shape of the selected set of teeth in the photograph to the patient's mouth and/or face by means of the image processing software,
- 20 - transmitting the size and/or shape, obtained from the adaptation, of the selected set of teeth to a CAD/CAM system,
- selecting in the CAD/CAM system a three-dimensional set of teeth that corresponds to the selected set of teeth,
- 25 - adapting the three-dimensional set of teeth in the CAD/CAM system based on the size and/or shape of the selected set of teeth determined in the photograph,
- 30 - milling the dental prosthesis out of a block of material, based on the size and/or shape of the adapted three-dimensional set of teeth determined in the CAD/CAM system.

Within the meaning of the invention, the “set of teeth” can be just a single tooth; however two, three or more teeth can also be included. The set of teeth can also include entire rows of teeth of the upper jaw and/or of the lower jaw.

5 “Dental prosthesis” can mean the final dental prosthesis which is ultimately introduced into the patient’s mouth. However, within the meaning of this application, a dental prosthesis can also be merely a model or a temporary prosthesis (so-called wax-up or mock-up models) which can be introduced into and removed again from the patient’s mouth, for example for trial purposes.

10

The method according to the invention has the advantage, inter alia, that temporary prostheses can also be made so that, for example, the fit of the dental prosthesis can be tried out immediately without the final dental prosthesis having to be produced straightaway. The data which are finally acquired, such as the size and/or shape of the adapted three-dimensional set of teeth can be used for different models and temporary
15 prostheses, without having to carry out a new adaptation. This means that time and costs are significantly reduced.

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The image of the patient’s face can be produced in principle using any imaging method. The image can be, for example, a digital two-dimensional photograph, a film, a drawing and/or a three-dimensional photograph which can be produced, for example, using a face scanner.

25

The patient’s teeth are superimposed by the photograph of the selected set of teeth using a suitable, conventional image processing software which is known from the prior art. According to the invention, the selected set of teeth is adapted to the patient’s mouth or face such that the selected set of teeth is optimally suitable for the patient’s mouth and face.

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In this respect, medical aspects can be considered. Furthermore, aesthetic considerations can be made, regarding which the shape and/or size can be optimised. The patient can immediately see what the selected set of teeth would look like in his mouth, and he is able to express his wishes.

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Thus, for example, each individual tooth can be positioned and changed with respect to shape and/or size in the photograph until it fits optimally in the patient’s mouth or in the

image of the patient's mouth. This can be carried out tooth by tooth until the entire set of teeth has been adapted.

5 If the patient is not satisfied, he can select a different set of teeth. Consequently, it is advantageously possible to optimally consider the patient's wishes. Optimum adaptations of the size and/or shape of the set of teeth are advantageously possible in respect of medical and/or aesthetic aspects as well.

10 The size and/or shape, obtained thus, of the set of teeth or the associated data are detected by the image processing software and stored, if appropriate. According to the invention, these data are transmitted to the CAD/CAM system. The CAD/CAM system is software, known from the prior art, for the computer-aided construction and manufacture of a dental prosthesis. The dental technician can change the size and/or shape of the teeth or of the set of teeth using a CAD/CAM system of this type.

15 Thus, for example, the width of each individual tooth can be established and measured in the image processing software. The measured width can be input into the CAD/CAM system so that the optimally adapted width can also be used in the CAD/CAM system. This procedure can be carried out for each tooth until the entire set of teeth has been completely adapted.

20

The three-dimensional image of the selected set of teeth is stored or contained in an electronic form in the CAD/CAM system. As a result, it is advantageously possible to transfer the data, established with the image processing software, to the three-dimensional electronic model in the CAD/CAM system. Consequently, an optimum implementation of the size and/or shape, established in the image processing software, is achieved in the CAD/CAM system.

25

The three-dimensional set of teeth which corresponds to the photographed set of teeth is saved in the CAD/CAM system. The set of teeth can be adapted automatically in the CAD/CAM system, but this can also be carried out manually by the dental technician. After finally establishing or finally determining the size and/or shape of the three-dimensional set of teeth in the CAD/CAM system, these data can then be transmitted to a milling device which is known from the prior art and which processes the data and mills out the dental prosthesis.

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The dental prosthesis produced in this way now advantageously meets the patient's requirements and satisfies all medical and/or aesthetic aspects or requirements imposed on the dental prosthesis.

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According to an exemplary embodiment of the present invention, it is provided that the photograph of the set of teeth is selected from a tooth library in which a large number of photographs of different sets of teeth are stored, the sets of teeth differing with regard to their surface textures (for example grooves on the teeth), tooth shapes and/or sizes.

10

The tooth library can be, for example, a printed catalogue, from which the patient can choose the optimum set of teeth according to his wishes. The tooth library can also be in electronic form, so that the different sets of teeth and the different photographs of the sets of teeth are present as files or image files.

15

Consequently, it is advantageously possible to offer the patient a wide choice of sets of teeth, which means that advantageously patient satisfaction can be ultimately further improved. Medical aspects can naturally also be considered in the selection of the set of teeth from the tooth library.

20

According to a further exemplary embodiment of the present invention, it is provided that the photographs of the sets of teeth in the tooth library are photographs of real teeth. "Real teeth" means that the photographs have been taken of teeth of real people or patients. As a result, the appearance of the set of teeth is advantageously improved because the teeth of the set of teeth suit each other in an optimum manner.

25

According to a further exemplary embodiment of the present invention, it is provided that the photograph of the set of teeth is selected from the tooth library based on plaster or plastics moulds of the photographed sets of teeth. These plaster or plastics moulds exist in addition to the photographs of the sets of teeth.

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Thus, the patient can not only look at the photograph, but he can also closely inspect the entire three-dimensional appearance of the set of teeth. Consequently, it is advantageously possible to adapt the dental prosthesis optimally to the patient's wishes.

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According to a further exemplary embodiment of the present invention, it is provided that the plaster or plastics moulds are moulds of real teeth which are identical to the corresponding photographed sets of teeth in the tooth library and to the three-dimensional sets of teeth in the CAD/CAM system. This means that the plaster or plastics moulds are
5 moulds of the same real teeth which are presented in the photographs of the sets of teeth. Consequently, it is possible to further improve the production of the dental prosthesis.

According to a further exemplary embodiment of the present invention, it is provided that the plaster or plastics moulds are divided into moulds of male and female individuals. This
10 means that it is advantageously possible for the different appearance of male and female teeth to be considered in the selection of the set of teeth and thus in the production of the dental prosthesis.

According to a further exemplary embodiment of the present invention, it is provided that
15 the patient's face is measured and the size and/or shape of the selected set of teeth in the photograph is determined based on this facial measurement and furthermore the teeth can be positioned in an optimum manner. Facial measurement means that different points or lines are determined which can be considered during the production of the dental prosthesis. Consequently, the set of teeth can be adapted more effectively to the conditions
20 of the patient's mouth or face, as well as in an aesthetic and functional respect.

According to a further exemplary embodiment of the present invention, it is provided that the centre of the patient's face is determined and the size and/or shape of the selected set of teeth in the photograph is determined based on the determined centre of the face.
25 Within the meaning of this invention, the centre of the face can include a point or also a line.

The centre of the face is thus a reference line or a reference point which can be used to improve the dental prosthesis or the production method. The centre of the face does not necessarily have to comprise the geometric centre or the geometric line of symmetry of the
30 face; in fact it can also be a subjective reference line or a subjective reference point determined by the dental technician.

According to a further exemplary embodiment of the present invention, it is provided that the patient's pupils are used as reference points for determining the centre of the face. Since

the patient's pupils are significant for the symmetry of the face, the appearance of the set of teeth can thus be advantageously greatly improved.

5 According to a further exemplary embodiment of the present invention, it is provided that an optical device is used to determine the centre of the face. A device of this type is known, for example, from DE 20 2004 016 058 U1, the disclosure of which is hereby explicitly included in the disclosure of the application. For example, the vertical centre of the patient's face can be marked with greater accuracy using a device of this type. It is thus advantageously possible to further improve the production method.

10

According to a further exemplary embodiment of the present invention, it is provided that a photograph of the face which is provided with a grid is used to determine the centre of the face. This means that when the photograph of the face is being taken, a grid consisting, for example of vertical and horizontal lines is held in front of the face so that on the photograph, grid lines can be used as reference lines or grid points can be used as reference points. It is thereby possible to improve the production method.

15

The centre of the face which is determined (for example using the device known from DE 20 2004 016 058 U1) can also be input or transferred into the CAD/CAM system, so that it is possible to achieve a better adaptation of the set of teeth due to the possibility of using the centre of the face as a reference line in the CAD/CAM system as well.

20

The present invention also relates to a dental prosthesis which is produced by a method according to any of the preceding embodiments. A dental prosthesis of this type is produced from the conventional materials which are known from the prior art. Regarding the advantages of this dental prosthesis, reference is made to the above information regarding the method.

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An embodiment of the present invention is shown in the drawings and is described in detail in the following description.

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Brief description of the drawings

Fig. 1 schematically shows a block diagram which represents the sequence of the method according to the invention, according to an exemplary embodiment,

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Fig. 2, 3 and 4 each show an image of a patient's face.

Embodiments of the invention

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Fig. 1 schematically shows a block diagram which represents the sequence of the method according to the invention, according to an exemplary embodiment.

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Block 100 symbolises the production of a digital photograph of the patient's face in a front view, the patient's mouth being open and the patient's set of teeth which is to be replaced being visible. This photograph shows, so to speak, the current condition of the patient with his teeth as they currently are. In this respect, the current teeth can be seen, although it is also possible to see only the treated tooth stumps.

15

It is important for the patient's mouth to be open and for the current set of teeth to be visible so that in the further method, the replacement set of teeth can be introduced into the open mouth. The photograph of the face can also already be provided with a grid which can be used as reference points or reference lines. The centre of the face is advantageously also determined in this step of the method. For this purpose, the position of the pupils can be used, for example. However, a conventional device for determining the centre of the face can also be used, as is known from DE 20 2004 016 058 U1.

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Block 101 symbolises the selection of a set of teeth which is to be used as a replacement for the patient's teeth. The patient can select the desired set of teeth, for example from a tooth library which is in the form of a catalogue. Alternatively or additionally, the patient can also select the desired set of teeth from plaster or plastics moulds.

30

Block 102 symbolises the superpositioning of the patient's teeth in the photograph of the patient's face by the digital photograph of the selected set of teeth by means of an image processing software. For this purpose, for example the photograph of the face and the photograph of the selected set of teeth are inserted into the image processing software. The photograph of the selected set of teeth can then be placed over the patient's current teeth in the image processing software.

The patient can now see what the selected set of teeth would look like in his mouth and he can decide whether or not he likes the appearance of the set of teeth. If he is not satisfied, the method returns to block 101 so that a different set of teeth is selected from the tooth library, for example. This back reference is symbolised by block 103.

5

When the patient is happy with the appearance of the set of teeth, in block 104 the size and/or shape of the selected set of teeth is adapted to the patient's mouth and/or face in the image processing software. It is helpful during this adaptation, for example, if the centre of the patient's face has been determined or if the patient's face has been provided with a grid.

10

Thus, for example, individual teeth can be adapted in terms of size or shape. The positions of the teeth can also be changed. Of course, the patient's wishes can also be considered during this adaptation of the set of teeth. If at this stage, it turns out that the patient does not like the set of teeth after all, it is possible to return to block 101 from this method step as well and to select a new set of teeth.

15

Furthermore, in this method step or in block 104, medical aspects can be considered and the dental technician can introduce further aesthetic aspects. It is advantageously possible at any time to be able to observe the future appearance of the set of teeth in the patient's mouth, so that the set of teeth can be advantageously adapted in an optimum manner.

20

After the method step symbolised by block 104 has been concluded, the acquired data are transmitted to a conventional CAD/CAM system. This transmission is symbolised by block 105 and can take place automatically, but it can also be carried out manually by the dental technician. After the data have been transferred to the CAD/CAM system, in said CAD/CAM system, the three-dimensional data record is retrieved which corresponds to the selected set of teeth.

25

In the CAD/CAM system, a corresponding data record is filed for each set of teeth which can be selected. This data record is selected and is processed on the basis of the data determined by the image processing software. This processing is symbolised by block 106. The desired size and/or shape is thus transferred to the CAD/CAM system, so that in the CAD/CAM system, the representation of the set of teeth and the size and shape of the set of teeth conform with the photographic representation.

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Of course, in this method step as well, the dental technician can still process the size and/or shape of the set of teeth in the CAD/CAM system. In the last method step, the processing data which have been finally determined in the CAD/CAM system are transmitted to a conventional milling device to finally produce the desired dental prosthesis. This method step is symbolised by block 107. The production process is thereby at an end and the dental prosthesis which has been produced can be transferred to the dentist to be introduced into the patient's jaw.

It is also advantageous in the method according to the invention that the planning and the shaping of the dental prosthesis, of a possible wax-up, temporary prosthesis, and/or of the definitive dental prosthesis is established at the beginning of the method, and can then be retained over the entire process, in spite of substantial individual/manual method steps.

Fig. 2 shows an image 1 of a patient's face 2. In this case, the image is a digital photograph. Fig. 2 shows the patient's face 2 in a front view, the patient's teeth 3 still being in the situation where the teeth are damaged or are to be replaced. In this case, the teeth 3 of the upper jaw are to be replaced. The teeth of the lower jaw remain unchanged.

In order to measure the face 2, the mouth and the teeth 3, reference lines 4, 5, 6 are drawn on the image. In this case, there is one horizontal reference line 5 and five vertical reference lines 4, 6. The horizontal reference line 5 runs approximately through the point in which the lowest place of the upper edge of the bottom lip is located.

The vertical reference line on the far left passes through the patient's pupil. In this figure, the pupils are not shown for reasons of clarity. The second vertical reference line from the left passes approximately through the patient's canine tooth which is to be replaced. The middle horizontal or vertical reference line 4 approximately corresponds to the centre 4 of the patient's face. The second vertical reference line from the right passes approximately through the patient's further canine tooth which is to be replaced. The far right vertical reference line passes approximately through the patient's further pupil. Fig. 2 represents the starting situation of the patient or the patient's teeth before the dental prosthesis is produced.

Fig. 3, like Fig. 2, shows a front view of the patient's face 2 or mouth in a digital photograph. As in Fig. 2, the reference lines described therein are in the photograph. Fig. 3 shows contours 7 which correspond to the new teeth or to the contours 7 of the selected set of teeth. The selected set of teeth or the selected teeth are superimposed on the original
5 teeth.

Fig. 3 shows the differences which are apparent between the original situation and the situation with the selected set of teeth. According to the invention, the size and shape of the teeth have been adapted such that the desired medical and/or aesthetic aspects are
10 satisfied and the teeth fit appropriately in the patient's mouth. For example, as a further step, the contours 7 of the new teeth could then be measured. These measurement results could then be input into the CAD/CAM system so that the determined measurement results can be implemented in the three-dimensional image of the CAD/CAM system.

15 Like Fig. 2 and Fig. 3, Fig. 4 is a front view of the patient's face 2. In Fig. 4, the selected teeth or the selected set of teeth 8 have/have been introduced into the patient's mouth in that the original teeth 3 have been covered by the selected set of teeth 8. At this point of the method, the patient can decide whether he is satisfied with the future situation of the teeth or set of teeth. If he is not satisfied, a different set of teeth can be selected and the method
20 starts from the beginning.

Patentkrav**1.** Fremgangsmåde til fremstilling af en tandprotese med de følgende trin:

- 5 -- Fremstilling af et billede (1) af patientens ansigt (2) set forfra, hvor patientens mund er åben og patientens tandsæt (3), som skal erstattes, er synligt,
- Overlægning af patientens tænder (3) i billedet (1) af patientens ansigt (2) med det digitale billede af et valgt tandsæt (8) ved hjælp af billedbehandlingssoftware,
- 10 -- Tilpasning af størrelsen og/eller formen af det valgte tandsæt (8) i billedet til patientens mund og/eller ansigt (2) ved hjælp af billedbehandlingssoftwaren,
- Overførsel af den erhvervede størrelse og/eller form af det valgte tandsæt (8) til et CAD/CAM-system,
- 15 -- Udvælgelse i CAD/CAM-systemet af et tredimensionelt tandsæt, der svarer til det valgte tandsæt (8),
- Tilpasning af det tredimensionelle tandsæt i CAD/CAM-systemet baseret på størrelsen og/eller formen af det valgte tandsæt (8) bestemt i billedet,
- 20 -- Fræsning af tandprotesen ud af en blok af materiale baseret på størrelsen og/eller formen af det tilpassede tredimensionelle tandsæt bestemt i CAD/CAM-systemet.

- 2.** Fremgangsmåden ifølge krav 1, **kendetegnet ved at** billedet af tandsættet (8) vælges fra et tandbibliotek, hvor et stort antal af billeder af forskellige tandsæt
- 25 lagres, hvor tandsættene er forskellige hvad angår deres tandformer og/eller tandstørrelser.

3. Fremgangsmåden ifølge krav 2, **kendetegnet ved at** billederne af tandsættene (8) i tandbiblioteket er billeder af ægte tænder.
4. Fremgangsmåden ifølge et af kravene 2 eller 3, **kendetegnet ved at** udvælgelsen af billedet af tandsættet (8) fra tandbiblioteket udføres baseret på gips- eller plastforme af de fotograferede tandsæt.
5. Fremgangsmåden ifølge krav 4, **kendetegnet ved at** gips- eller plastformene er forme af ægte tænder, der er identiske med de tilsvarende fotograferede tandsæt (8) i tandbiblioteket og det tredimensionelle tandsæt i CAD/CAM-systemet.
6. Fremgangsmåden ifølge krav 5, **kendetegnet ved at** gips- eller plastformene inddeles i forme af mandlige og kvindelige individer.
7. Fremgangsmåden ifølge et af de foregående krav, **kendetegnet ved at** patientens ansigt (2) måles og størrelsen og/eller formen af det valgte tandsæt (8) i billedet etableres baseret på denne ansigtsmåling.
8. Fremgangsmåden ifølge krav 7, **kendetegnet ved at** midten af patientens ansigt (4) bestemmes og størrelsen og/eller formen af det valgte tandsæt (8) i billedet etableres baseret på den bestemte midte af ansigtet (4).
9. Fremgangsmåden ifølge krav 8, **kendetegnet ved at** patientens pupiller anvendes som referencepunkter til at bestemme midten af ansigtet (4).
10. Fremgangsmåden ifølge et af kravene 8 eller 9, **kendetegnet ved at** en optisk indretning anvendes til at bestemme midten af ansigtet (4).

11. Fremgangsmåden ifølge et af kravene 8, 9, eller 10, **kendetegnet ved at** et billede af ansigtet (2), der er tilvejebragt med et gitter (5, 6), anvendes til at bestemme midten af ansigtet (4).

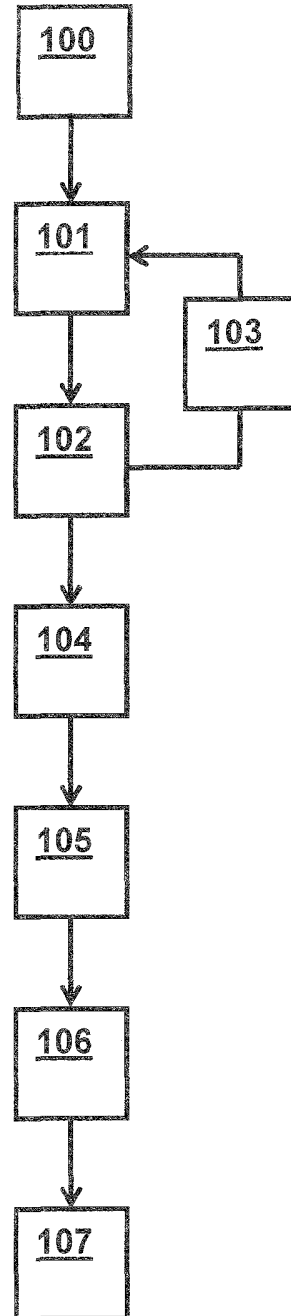


Fig. 1

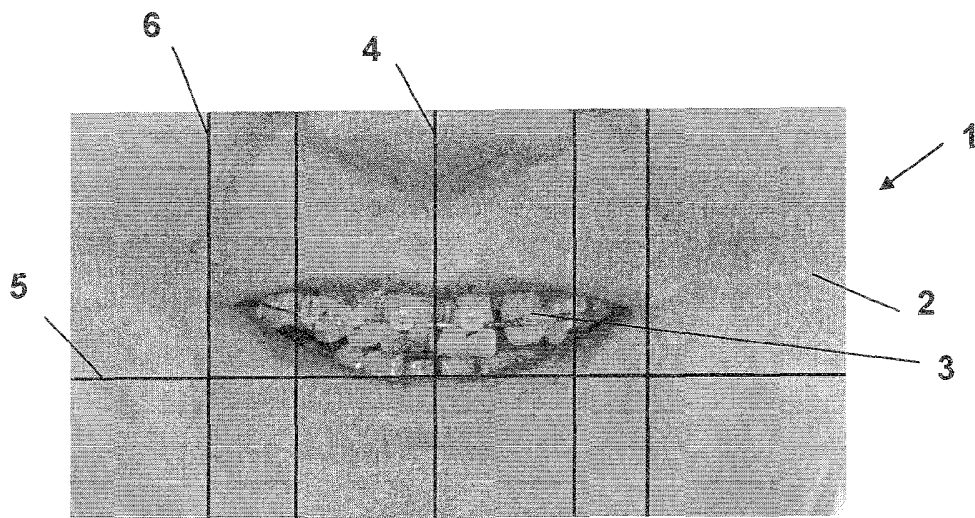


Fig. 2

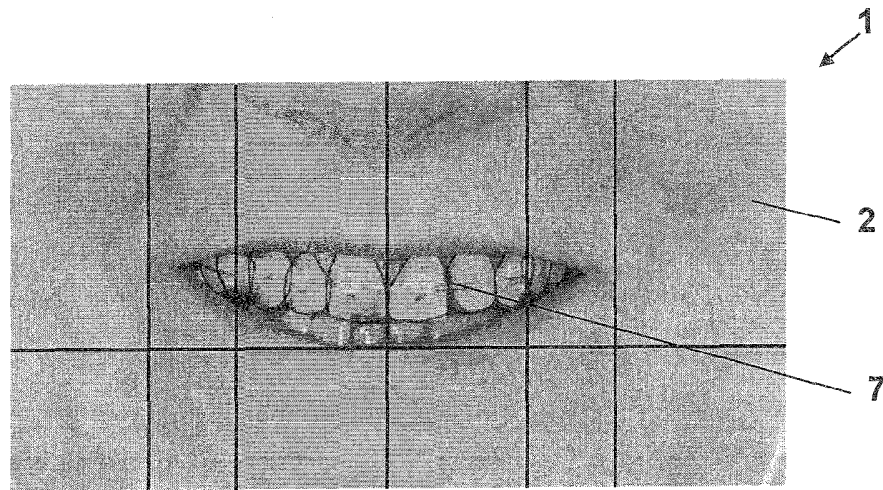


Fig. 3

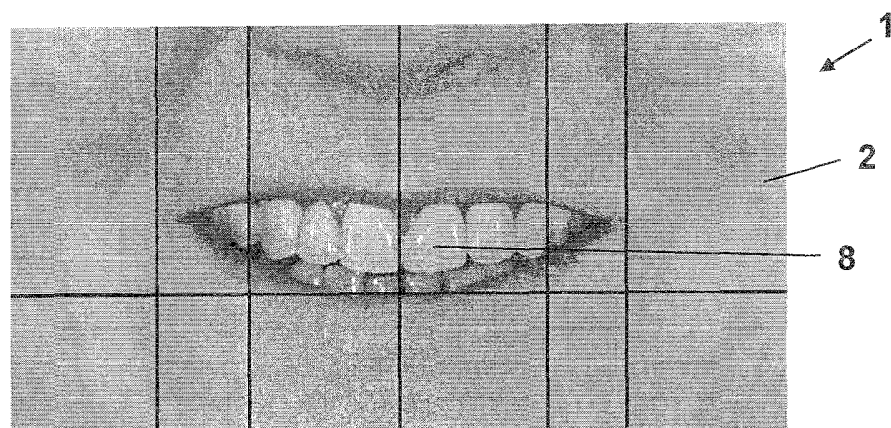


Fig. 4