(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
27 August 2009 (27.08.2009)

PCT

(10) International Publication Number
WO 2009/105618 A1

(51) International Patent Classification:
A61C 11/00 (2006.01)

(21) International Application Number:
PCT/US2009/034645

(22) International Filing Date:
20 February 2009 (20.02.2009)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/030,795 22 February 2008 (22.02.2008) US

(71) Applicant *(for all designated States except US)*: **SMITHKLINE BEECHAM CORPORATION** [US/US]; One Franklin Plaza, P.O. Box 7929, Philadelphia, PA 19101 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **ADUSUMILLI, Prasad** [US/US]; 1500 Littleton Road, Parsippany, NJ 07054 (US). **LECH, Stanley, J.** [US/US]; 1500 Littleton Road, Parsippany, NJ 07054 (US). **LOEWY, Zvi, G.** [US/US]; 1500 Littleton Road, Parsippany, NJ 07054 (US).

(74) Agent: **SMITHKLINE BEECHAM CORPORATION**; 709 Swedeland Road, P.O. Box 1539, King of Prussia, PA 19406 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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(54) Title: AN APPARATUS AND METHOD FOR MANUFACTURING CUSTOMIZED DENTURES

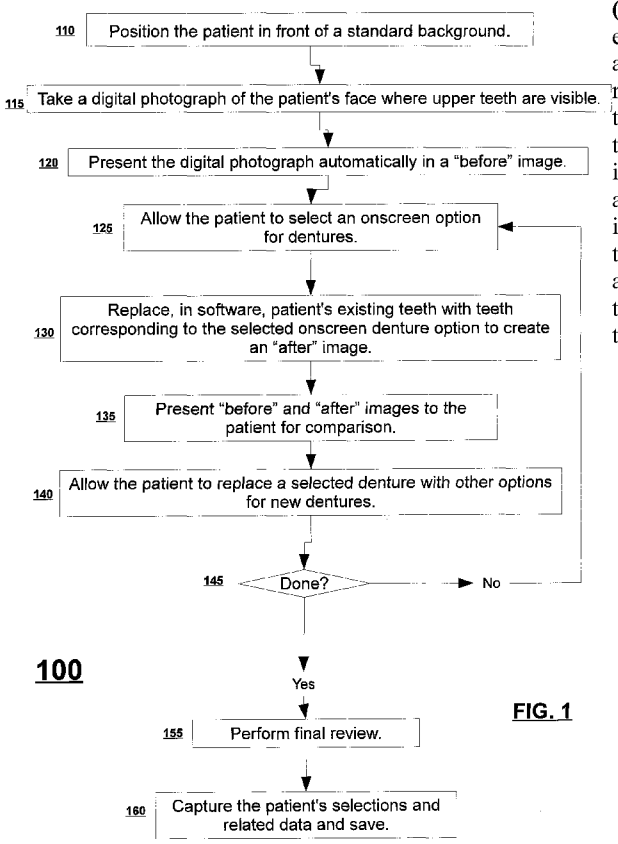


FIG. 1

(57) Abstract: There is provided a method for capturing an edentulous patient's denture preferences, having the steps of : accepting a first digital image of the patient, presenting a plurality of denture options to the patient, receiving a selection of the denture options, and outputting a second digital image of the patient. There is also provided an apparatus for manipulating digital images of an edentulous patient, comprising an image input that accepts a first digital image of the patient, a user interface that presents a plurality of denture options to the patient, and that receives a selection of the denture options, and an image output that outputs a second digital image of the patient. The second digital image represents dentures installed in the patient according to the selection of the denture options.

WO 2009/105618 A1

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

An Apparatus and Method for Manufacturing Customized Dentures

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present disclosure relates to an apparatus and method for digitally utilizing and customizing dental features needed in the manufacture of dentures.

2. Description of the Related Art

[0002] Full or partial dentures are intended to be worn in the mouth to replace missing teeth. Current processes for manufacturing dentures involve multiple steps, including examining the patient, evaluating lip pull and vertical dimension, taking impressions of the oral cavity, boxing impressions, fabricating and placing an orthopedic splint, preparing custom base plates, preparing an esthetic blue print record base, preparing a neutral zone record base and a central bearing device, records, wax try-in, face bow, articulator, indexing and tooth placement, external impression, occlusion, delivery and patient follow-up.

[0003] Because this is a labor-intensive process, and has a great deal of subjective measuring and designs, the resulting denture is not user friendly and can be customized only minimally. Also, the resulting denture encounters frequent problems including sore spots, lack of hold and retention, and bacterial growth that may lead to malodor and associated health problems. Aside from these potential physical problems, the aesthetics of the denture

may be compromised due to the multi-step evaluation and process.

[0004] In determining the aesthetic "look and feel" of the end-result denture, the dental practitioner typically shows the patient many images of third parties wearing different dentures and the patient selects one or more images based on their preference. This process does not provide the patient an ability to evaluate how he will appear with each of the various types of dentures.

[0005] Fitting a denture is both a mechanical process and an aesthetic determination that involves physical and emotional sensitivities. This disclosure utilizes digital technology to obtain data about the mouth and then manipulate those data to generate one or more virtual images of the patient with various dentures in place. Accordingly, the patient has an opportunity to choose various aesthetic features for his dentures, and the practitioner has an opportunity to fabricate a denture that is both mechanically and aesthetically acceptable. Since the patient is able to view himself in various configurations and selects the preferred look, the resulting prosthesis will provide much higher satisfaction.

SUMMARY OF THE INVENTION

[0006] The present disclosure relates to an apparatus and method for manipulating one or more digital images of an edentulous patient to provide varying images of dentures viewed within the patient's mouth.

[0007] The present disclosure also relates to a method for providing a virtual image containing one or more denture shapes, within the patient's mouth, from which the patient can choose.

[0008] The present disclosure further relates to a method for providing a virtual image containing one or more tooth shapes, within the patient's mouth, from which the patient can choose.

[0009] The present disclosure still further relates to a method for providing a virtual image containing one or more tooth color, within the patient's mouth, from which the patient can choose.

[0010] The present disclosure yet further relates to a method for providing a virtual image containing one or more gum line colors, within the patient's mouth, from which the patient can choose.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. 1 is a flow diagram of a method for capturing a patient's denture preferences.

[0012] FIG. 2 shows a patient selecting, with a user interface and an input device, options for dentures.

DESCRIPTION OF THE DISCLOSURE

[0013] The term "denture(s)" is used herein to refer to dentures or partial dentures, artificial teeth, removable orthodontic bridges and denture plates, both upper and lower types, orthodontic retainers and appliances, protective mouthguards, nightguards to prevent bruxism and/or temporomandibular joint (TMJ) disorder, and the like. The term "lip pull" refers to the asymmetry of a patient's smile with respect to an axis; when the patient smiles, lip pull causes more teeth to show on one side of

the axis than another. The term "vertical dimension" refers to a difference in the distance between given facial or oral reference points when the patient's mouth is closed and at rest position. In turn, the term "closed position" refers to the condition in which the patient's teeth are fully occluded, for example when the patient has closed his mouth.

[0014] FIG. 1 is a process flow diagram of a method generally referred to as reference numeral 100 of the present disclosure. Method 100 captures a patient's denture preferences. One or more digital images of the patient are taken and provided to a software program. The digital images provide mechanical information about the shape, size, vertical dimension of the mouth, including measurements of any remaining teeth in the mouth of the edentulous patient. The program manipulates the data generated from the digital images and provides multiple images of the patient with different dentures and allows the patient to look at himself, virtually, before and after the dentures are in place. These variations include different denture shapes and sizes and different teeth and gum colors. In addition, customization of teeth placement is simulated such that the resulting denture provides the aesthetics similar to that of natural dentition.

[0015] Method 100 begins at step 110, when a patient is positioned in front of a standard background. Next, method 100 progresses to step 115, in which a digital photograph of the patient's face, with upper teeth visible, is taken. As an alternative to step 115, a pre-existing photograph of the patient may be substituted and inputted in place of a *de novo* digital photograph. A further alternative to step 115 is to substitute a 3-dimensional scan of the patient's face taken while the patient's teeth are visible. The

digital photograph is presented on a screen or other suitable display device in step 120 as a "before" image.

[0016] In step 125, the patient is allowed to select, from a presentation screen, an onscreen desired option for his dentures from a set of options available. The options available may be related to tooth size, shape, color, color of gums, skin tone, amount of tooth show, and amount of gum show, custom variations of tooth placement patterns, buccal corridor or other personal aesthetic features. Then, at step 130, method 100 will replace, in software, the patient's existing teeth with teeth corresponding to the onscreen desired option, to create and output an "after" image. At step 135, the "before" image (of step 120) and the "after" image (of step 130) are presented to the patient for comparison.

[0017] Next, at step 140, the patient is allowed to replace a selected denture, i.e. that of the "after" image, with still further options and features. At step 145, the patient or clinician decide whether further iterations through steps 125-140 are needed. If not, then method 100 progresses to step 155.

[0018] At step 155, the patient and his clinician perform a final review of features selected by the patient in preceding steps of method 100. Method 100 next progresses to its final step 160, in which the patient's final selections and related data are captured and saved as a record. In an embodiment, the patient's selections and related data are written to an electronic record storage medium, or written to a paper record. The patient's selections form part of a prescription, based upon which a fabricator will later construct dentures for the patient.

[0019] FIG. 2 shows a patient selecting options for dentures (see step 125 in FIG. 1).

[0020] The patient interacts with a user interface 200 using an input device 220. Input device 220 contains hardware, software, circuitry, or a combination thereof, for effecting connection to and communication to user interface 200.

[0021] User interface 200 provides the patient with a "before" image 205, an "after" image 215, and an option-adjusting area 225. The patient uses input device 220 to command adjustment of various options presented in option-adjusting area 225, such as tooth tint, tooth shape, gum color, and other aesthetic parameters.

[0022] In accordance with the adjustment commanded by the patient, after image 215 will take on different characteristics. For example, if the patient has commanded a lightening of tooth tint, then after image 215 will depict lighter-colored dentition. The patient is free to command adjustments until satisfied with after image 215.

[0023] Adjustments, which, in the background art, are typically made manually to vertical dimension and lip pull, are simulated digitally on user interface 200. The selected image is sent to the dental laboratory to ensure that the dental technician constructs the denture to mirror the chosen image.

[0024] The present disclosure has been described with particular reference to certain embodiments. It should be understood that the foregoing descriptions and examples are only illustrative of the invention. Various alternatives

and modifications thereof can be devised by those skilled in the art without departing from the spirit and scope of the present disclosure. Accordingly, the present disclosure is intended to embrace all such alternatives, modifications, and variations that fall within the scope of the appended claims.

WHAT IS CLAIMED IS:

1. An apparatus for manipulating digital images of an edentulous patient, comprising:

an image input that accepts a first digital image of the patient;

a user interface that presents a plurality of denture options to the patient, and that receives from an input device a selection of said denture options; and

an image output that outputs a second digital image of the patient, wherein said second digital image represents dentures installed in the patient according to said selection of said denture options.

2. The apparatus of claim 1, wherein said plurality of denture options comprises denture shape, tooth size, shape and color, shape, gum color, skin tone, amount of tooth show, and amount of gum show, custom variations of tooth placement patterns, and buccal corridor.

3. A method for capturing an edentulous patient's denture preferences, comprising:

accepting a first digital image of the patient;

presenting a plurality of denture options to the patient;

receiving from an input device a selection of said denture options; and

outputting a second digital image of the patient, wherein said second digital image of the patient represents dentures installed in the patient

according to said selection of said denture options.

4. The method of claim 3, wherein said plurality of denture options comprises denture shape, tooth size, shape and color, shape, gum color, skin tone, amount of tooth show, and amount of gum show, custom variations of tooth placement patterns, buccal corridor or other personal aesthetic features.

5. The method of claim 3, wherein said plurality of denture options comprises options that affect vertical dimension and lip pull.

6. The apparatus of claim 1, wherein said plurality of denture options comprises options that affect vertical dimension and lip pull.

7. The apparatus of claim 1, wherein said input device is sized and adapted to be hand-held by the patient.

8. The method of claim 3, further comprising a step of outputting the patient's selections to a storage medium.

9. The method of claim 8 wherein said storage medium is an electronic record storage medium.

10. The method of claim 8 wherein said storage medium is a paper record.

11. The method of claim 3, further comprising a step of incorporating the patient's selections to a prescription.

12. The method of claim 11, wherein a fabrication process is based upon said prescription.

13. The apparatus of claim 2, wherein said plurality of denture options further comprises other personal aesthetic features of the patient.

14. The method of claim 3, wherein said plurality of denture options further comprises other personal aesthetic features of the patient.

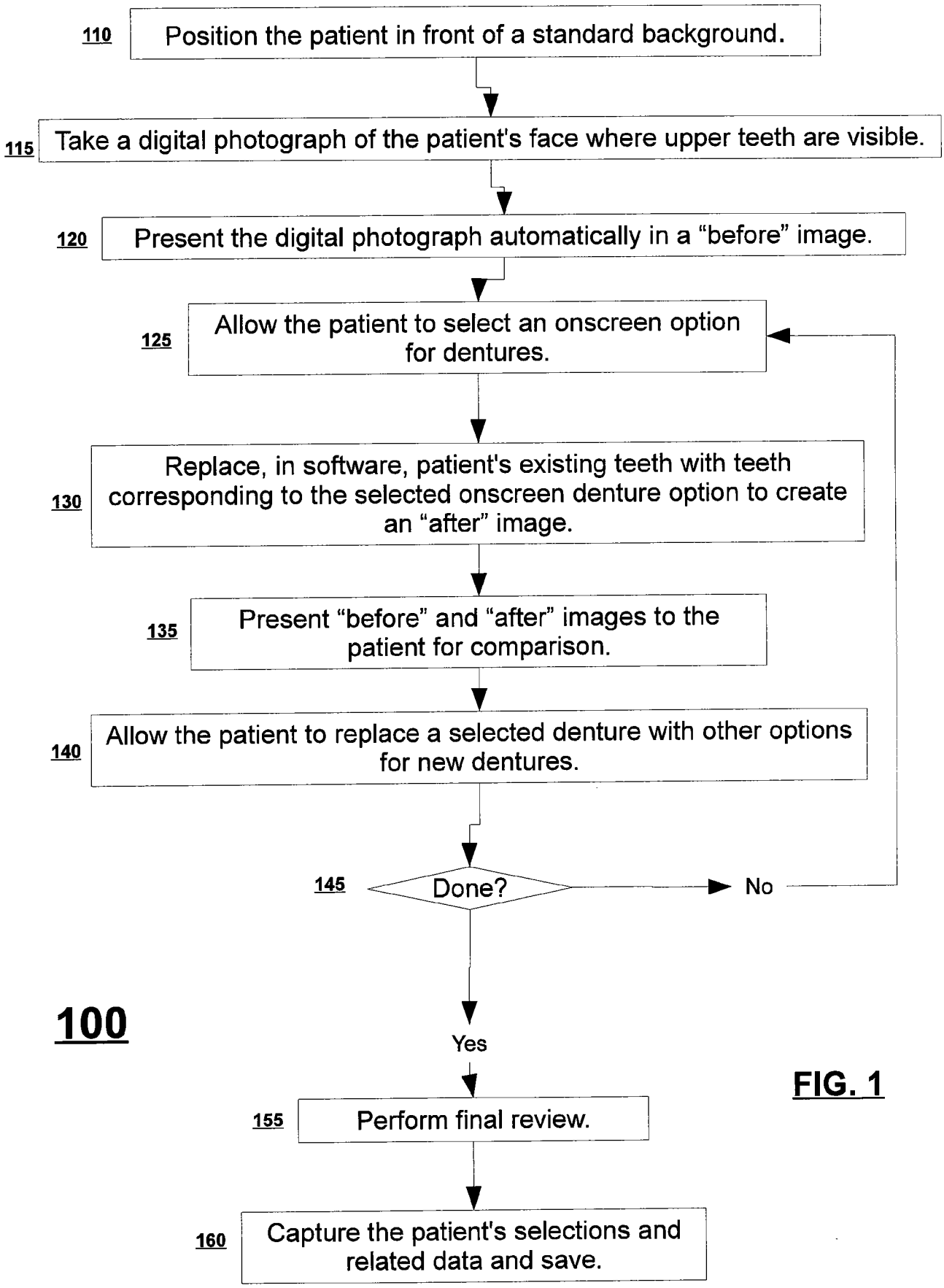

110
Position the patient in front of a standard background.
115
Take a digital photograph of the patient's face where upper teeth are visible.
120
Present the digital photograph automatically in a "before" image.
125
Allow the patient to select an onscreen option for dentures.
130
Replace, in software, patient's existing teeth with teeth corresponding to the selected onscreen denture option to create an "after" image.
135
Present "before" and "after" images to the patient for comparison.
140
Allow the patient to replace a selected denture with other options for new dentures.
145
Done?
No
Yes
155
Perform final review.
160
Capture the patient's selections and related data and save.
100

FIG. 1

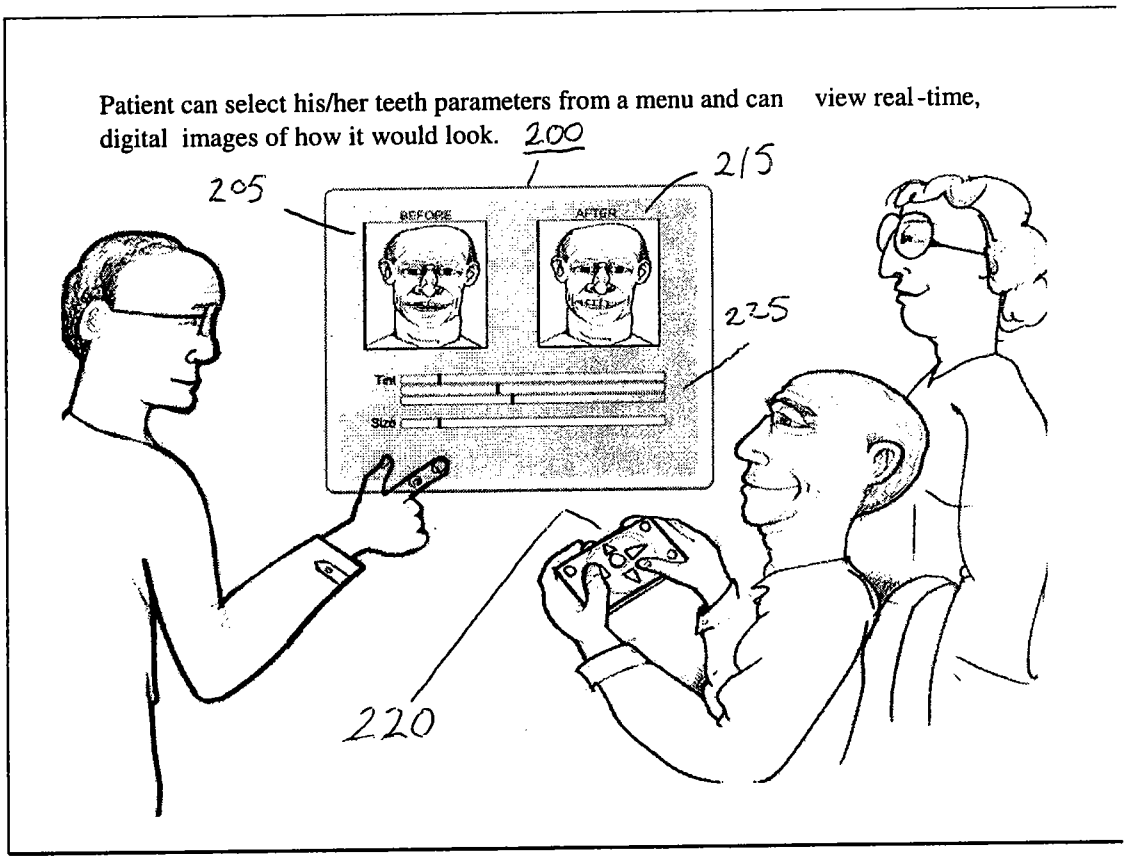

Patient can select his/her teeth parameters from a menu and can view real-time, digital images of how it would look.
200
205
215
225
220
BEFORE
AFTER
Tint
Size

FIG 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 09/34645

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A61C 11/00 (2009.01)
USPC - 433/213
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8): A61C 11/00 (2009.01)
USPC: 433/213

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
433/167; 433/214; 700/117; 433/213; A61C11/00

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WEST: PGPB,USPT,USOC,EPAB,JPAB; Google Scholar;
Search Terms: edentulous, dentures, tooth, false teeth, dental plate, show, observ#, view$, color, shape, gums, lip pull, patient, user, subject, options, display

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ---------- Y	US 7,153,135 B1 (Thomas) 26 December 2006 (26.12.2006); col. 11, ln 47-54; col. 12, ln 50 to col. 13, ln 58	1-4, 8-9, 11 and 12 ---------- 5-7, 10, 13, 14
Y	US 2007/0190492 A1 (Schmitt) 16 August 2007 (16.08.2007); see paragraphs [0020], [0097], [0151]-[0153] ; Fig. 36C	5-7, 10, 13, 14

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
03 April 2000 (03.04.2009)	22 APR 2009
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774