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[Continued on next page]

(54) Title: ORTHODONTIC ALIGNERS

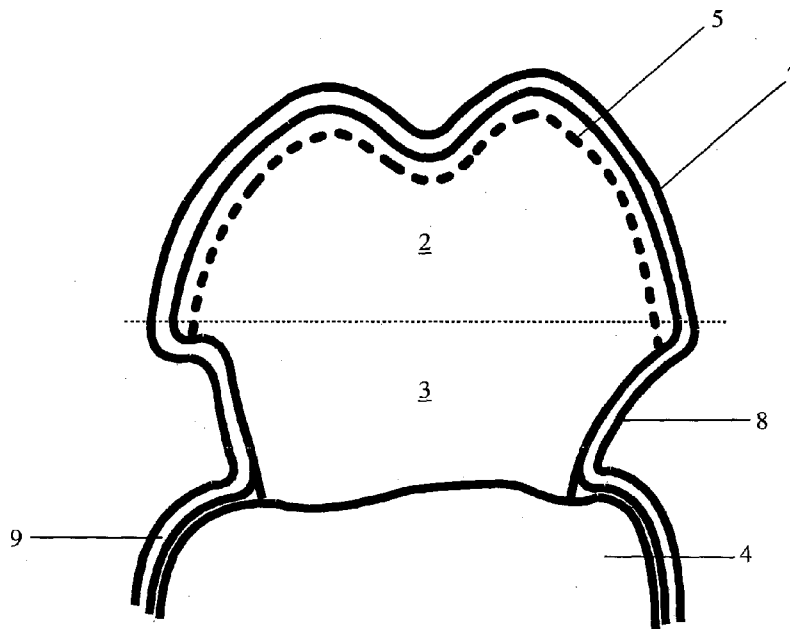


Figure 4

[Continued on next page]



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**(57) Abstract:** An orthodontic aligner is formed by producing a virtual 3D model of the dentition of a patient, modifying the virtual model by enlarging the crown of the posterior teeth so that the dimensions of each tooth is slightly enlarged slightly and depressing the area immediately gingival to the most prominent part of the crown, 3D printing the modified virtual model to produce a physical model for the aligner and using the physical model for forming the aligner.

## ORTHODONTIC ALIGNERS

This invention relates to orthodontic aligners and, more particularly to a method for forming them.

5

### BACKGROUND TO THE INVENTION

Orthodontic aligners have been known for many years as a means for straightening misaligned teeth and other disorders of the dentition and the oral cavity associated with the teeth that can be treated by changing the positioning of a patient's teeth.

10

The first forms of orthodontic aligners were somewhat crude and clumsy devices created from wires, springs and adjustment screws that were inserted in the mouth of a patient and attached to the teeth to apply force to misaligned teeth or other parts of the dentition to correct their position in the mouth. They were most usually used to correct conditions such as over- or under-bite and other dental anomalies that interfered with the eating process.

15

The early devices frequently were uncomfortable and unsightly and caused pain and embarrassment especially to young patients.

Many improvements have been made over the years and nowadays orthodontic aligners are usually made from acrylic or other plastics materials so that they are less visible and more comfortable to wear.

20

Problems still arise, however. Frequently retention means are required to ensure that the retainer remains in the correct position in the mouth of the patient and cannot be dislodged by such normal and necessary actions as chewing or tooth brushing.

25

Such retention methods include wire clasps attached to the aligner externally, for example by use of adhesives, or internally during the forming process, or attachment means cemented to the teeth. These methods are not totally reliable since the both require additional steps either in the manufacturing stage in the case of wire clasps or in the application stage for attachments means on the teeth. Further, wire clasps can be loosened or broken off and possibly swallowed by the patient. A further alternative retention

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method that has been used form the aligner to extend over the gingival area so that retention is achieved by the aligner digging into gingival surface possibly causing pain to the patient and trauma to the soft tissue.

- 5 All orthodontic aligners need to be removed for adjustment as the treatment process proceeds and the position of the teeth changes and this must be done manually. The prior methods of retention may make removal and insertion difficult for the patient.

### **SUMMARY OF THE INVENTION**

- 10 This invention provides a novel form of orthodontic aligner that does not suffer from the problems associated with the prior art and a method for the manufacture of the new aligner.

According to the invention an orthodontic aligner is formed by producing a 3-D virtual model of the dentition of a patient, modifying the virtual model by enlarging the crown or coronal portion of at least some of the posterior teeth, i.e. the molars and premolars, and  
15 depressing the area immediately gingival to the most prominent part of the crown, 3-D printing the modified virtual model to produce a physical model for the aligner and using the physical model for forming the aligner.

- 20 The virtual model of the patient's dentition may be made, for example, by intra-oral scanning, scanning of a dental impression or scanning a stone model.

The aligner itself is preferably made by vacuum forming a sheet of thermoplastics material, preferably a sheet of polyethylene terephthalate glycol modified or another co-polyester, or  
25 other colourless and transparent material, using the modified physical model.

The finished aligner will follow the modified contours of the posterior teeth and, when introduced onto the patient's dental arch, the enlarged coronal portion will allow movement of the posterior teeth to fit fully into the aligner with a space between the teeth  
30 and the aligner. This space allows unobstructed flow of blood within the periodontal tissue. This blood flow is vital for the health of the teeth and the satisfactory progress of the orthodontic treatment. The depressed area allows the production of an in-turned lip on the inner surface of the aligner that allows the aligner to be a snap fit onto the posterior the

teeth without coming into contact with or otherwise affecting the gums of the patient.

The amount of enlargement of the virtual image of the posterior teeth will depend on the size of the patient's teeth but may be as little as 0.2 mm.

5

The virtual image modification of the invention may be carried out one or more posterior teeth on each side of the oral cavity. The teeth involved need not necessarily be the same teeth or the same number of teeth on each side.

10 The invention will now be described in greater detail, by way of example, with reference to the accompanying drawings of which

Fig. 1 is a diagrammatic perspective view of the supra-gingival portion of a posterior tooth;

15 Fig. 2 is a diagrammatic view showing the shape of the virtual model before modification;

Fig. 3 is a diagrammatic view showing the shape of the virtual model after modification;  
and

20 Fig.4 is a section through the posterior teeth portion of the modified aligner produced using a mould produced using a mould according to the invention.

As shown in Fig. 1, the posterior teeth 1 of a human have an upper bulbous crown or corona 2 occupying approximately half of the part of the tooth exposed above the gingiva or gum 4 and a lower part 3 that tapers towards the root (not shown).  
25

As shown in Fig. 2, in a first step of the process of the invention a 3-d virtual image of a patient's dentition is made. Only one tooth 1 is shown together with a portion of the gingiva 4.  
30

As shown in Fig. 3, in the second step of the process the virtual image of the crown 2 is modified by slightly enlarging the boundary 5 of the image above the maximum dimension of the tooth indicated by line A-A and slightly depressing the boundary of the portion 3

below line A-A is to form an indentation 6.

As shown in Fig. 4, the aligner of the invention has a first portion 7 which is larger than the crown 2 of the tooth 1, a second portion comprising an in-turned lip 8 that is a clip-fit on the tooth below the crown 2 and a third portion 9 that fits over the top region of the gingival surface 4.

**CLAIMS**

1. A method for forming an orthodontic aligner, which comprises producing a virtual 3D model of the dentition of a patient, modifying the virtual model by enlarging the crown of at least one of the posterior teeth on each side of the oral cavity so that the dimensions of each tooth is slightly enlarged and depressing the area immediately gingival to the most prominent part of the crown of the same teeth, 3-D printing the modified virtual model to produce a physical model for the aligner and using the physical model for forming the aligner.
2. A method according to claim 1, wherein the virtual model is produced by intra-oral scanning, scanning of a dental impression or scanning a stone model.
3. A method according to claim 1 or claim 2, wherein the aligner is produced by vacuum forming a sheet of thermoplastics material.
4. A method according to any one of claims 1 to 3, wherein the thermoplastics material is a colourless and transparent material.
5. A method according to any one of claims 1 to 4, wherein the thermoplastics material is glycol-modified polyethylene terephthalate.
6. An orthodontic aligner produced by the method claimed in any one of claims 1 to 5.
7. An orthodontic aligner having a first portion (7) which is larger than the crown (2) of the tooth (1), a second portion comprising an in-turned lip 8 that is a clip-fit on the tooth below the crown (2) and a third portion (9) that fits over the top region of the gingival surface (4).

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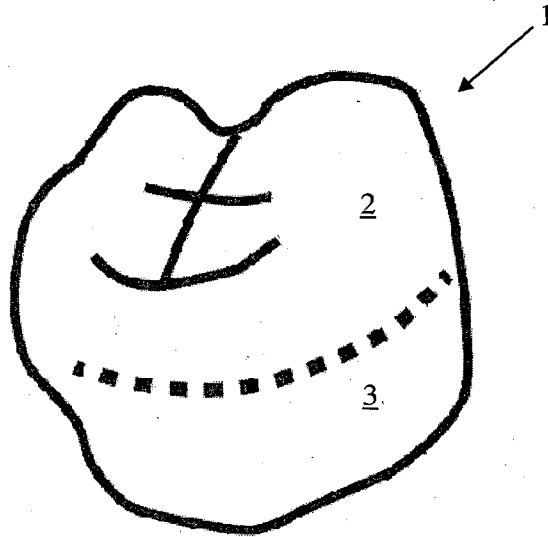


Figure 1

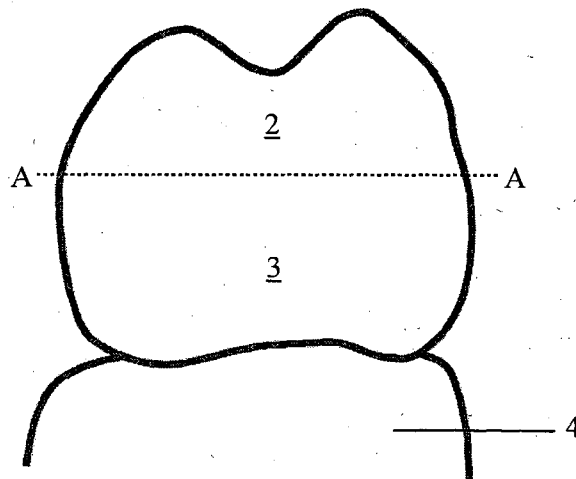


Figure 2

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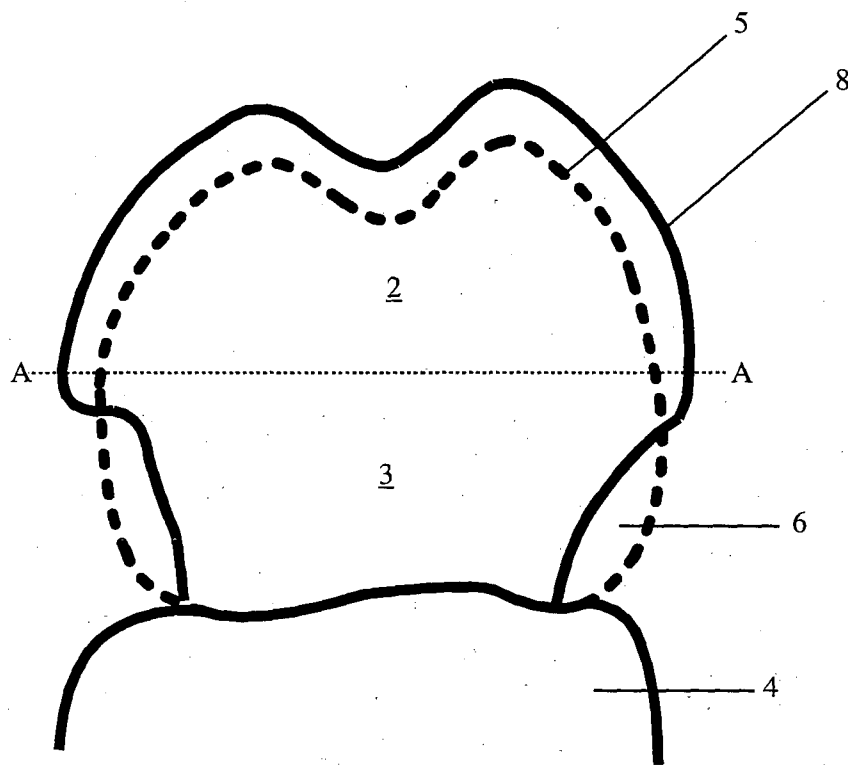


Figure 3

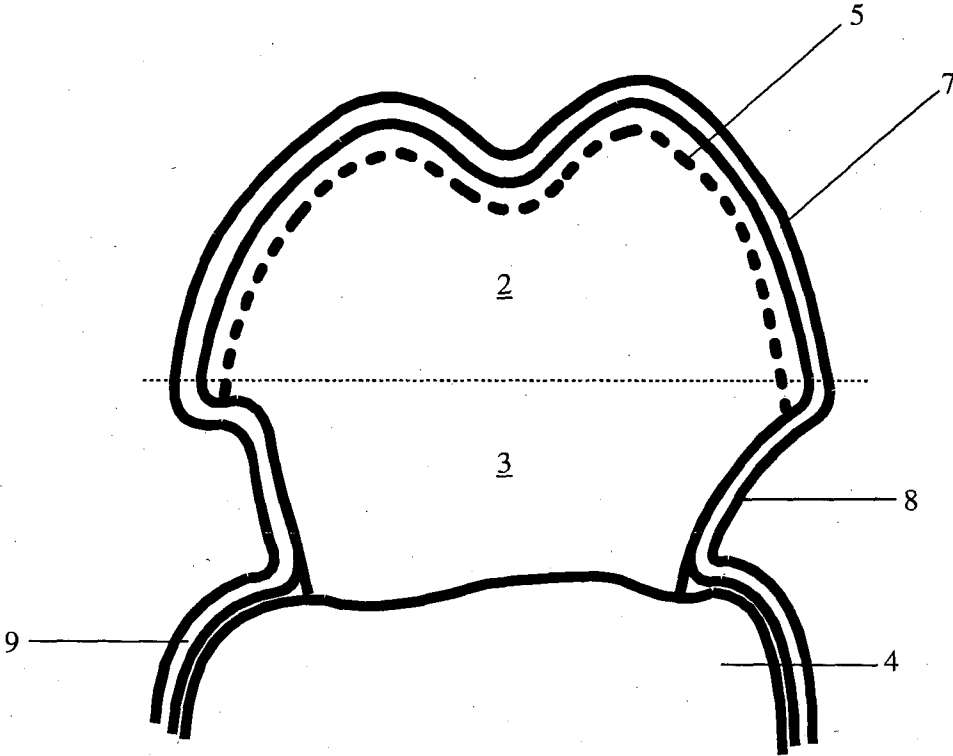


Figure 4

## INTERNATIONAL SEARCH REPORT

International application No.  
**PCT/SG2014/000329**

## A. CLASSIFICATION OF SUBJECT MATTER

**A61C 7/00 (2006.01) A61C 13/00 (2006.01)**

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)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPI, TXTE (TXTUS5, TXTUS4, TXTUS3, TXTUS2, TXTUS1, TXTUS0, TXTEP1, TXTGB1, TXTWO1, TXTAU1, TXTCA1, TXTSG1); IPC/CPC: A61C13/0019/CN, A61C7/LOW/IC/CN, A61C7/002/IC/CN, A61C9/004/LOW/IC/CN, A61C13/LOW/IC/CN; Keywords: Digital, Manipulate, 3D, Aligner, Retainer, Clip, Snap, Lip and like terms.

Espace, Google Patent and Google Scholar: Keywords: Digital, Manipulate, 3D, Aligner, Retainer, Clip, Snap, Lip, Print, Stereolithography, Thermoplastic, Crown, Gingival and like terms.

Espace, Google Patents: Applicant/Inventor Search: "WISEBRACE PTE LTD", WONG, FUNG KI"

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Documents are listed in the continuation of Box C		

 Further documents are listed in the continuation of Box C See patent family annex

* Special categories of cited documents:			
"A" document defining the general state of the art which is not considered to be of particular relevance	"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	
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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"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	
"O" document referring to an oral disclosure, use, exhibition or other means	"&"	document member of the same patent family	
"P" document published prior to the international filing date but later than the priority date claimed			

Date of the actual completion of the international search  
29 October 2014Date of mailing of the international search report  
29 October 2014

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<b>INTERNATIONAL SEARCH REPORT</b>		International application No.
C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		<b>PCT/SG2014/000329</b>
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Information on patent family members

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