

PATENT SPECIFICATION

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(54) DENTAL IMPRESSION TRAY AND METHOD OF USING THE SAME

(71) I, KENNETH EUGENE TUREAUD, a citizen of the United States of America, of 213 East Washington Street, Ann Arbor, Michigan 48108, United States of America, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

10 The invention relates to a dental impression tray and to a method of using the same. The trays of the invention may be directly moulded within the mouth or on to a male model thereof and so provide
 15 a method of taking dental impressions of oral tissue.

To form a final impression of a dentulous or edentulous alveolar ridge, in the course of producing a male model of specified oral
 20 tissue, conventional practice involves the use of commercially-available initial impression trays for use with either the maxillary or the mandibular alveolar ridges and contiguous tissues, in either dentulous or
 25 edentulous cases. These trays are available in a range of sizes so that one which is an approximate fit to the patient's mouth area may be chosen for use. The trays comprise a base provided with two walls extending normally therefrom so that they
 30 will surround the ridge of which an impression is to be formed. The contours of these trays are not anatomical in the sense that they are adapted to abut or lie in close
 35 proximity to the gum area surrounding the ridge, but rather a tray is chosen which fits within the patient's mouth and loosely surrounds the tooth or gum section. These stock trays are typically formed of
 40 aluminium or other material that may be bent or trimmed at the edges to improve the fit to an individual patient. Impression material is placed in the tray and a female cast of the required areas is formed. This
 45 cast is then normally used to form a male model of the patient's mouth section either in the dental office or in a separate dental laboratory. The laboratory or dental office then uses this male model to form an
 50 accurate final impression tray out of a

plastics material. This tray is anatomical in that it closely adapts to the male model and is relieved in the muscle attachments and other contiguous tissue areas.

The dentist then uses this final impression tray to form a final impression of the
 55 required area by placing a high-definition, settable, impression material, such as alginate, silicone, or polysulphide into the impression tray.

This conventional practice requires two
 impressions and is expensive. In addition, the initial impression tray may cause discomfort to the patient because of its relatively gross fit, and inaccuracies creep into
 65 the procedure because of the multiple transfer steps required.

A number of proposals have been made for overcoming these recognised inadequacies of the conventional procedure.
 70 For example, several forms of stock trays have been devised which may be shaped outwith the mouth to improve the accuracy of initial impressions. United States Patent Specification No. 3,473,225 discloses a stock
 75 tray formed of a thermoplastic sheet which can be heated outwith the mouth and mould to improve its fit to the mouth. Similarly United States Patent Specification No. 3,654,703 discloses a stock tray
 80 made of synthetic resin which is apparently pliable at body temperature and can be modified to conform better to the mouth.

Several methods have also been proposed for eliminating initial impressions
 85 altogether and forming a final impression tray directly in the patient's mouth. United States Patent Specification No. 1,955,709 discloses an impression tray formed of a woven metal matrix with a soft pliable
 90 covering that may be contoured directly to the patient's mouth. Similarly, West German Patent No. 885,772 discloses a process for making final impressions which does not use a tray for the impression material
 95 but rather employs an impression material which may be moulded into a tray-like shape and then conformed to the mouth.

Each of these proposals has certain deficiencies. The non-anatomical trays which 100

are mouldable, to conform better to the patient's intraoral anatomy still require formation of a male model and the creation of a final, anatomical impression tray using that model. The soft, compliant final impression trays are susceptible to deformation as they are removed from the patient's mouth. The process suggested in the aforementioned German patent suffers from the lack of the material which can form a self-supporting tray yet take a high definition registration of the tissue area.

The present invention seeks to provide an impression tray and a method of using this tray which requires only a single impression, the tray being hardenable within the mouth so that when it is removed from the mouth it accurately retains its new form and does not become deformed. The tray of the present invention is capable of accepting a high-definition impression material for the formation of a final impression.

Accordingly, the invention provides a dental impression tray comprising a sheet of thermoplastic material having a glass transition temperature in the range of from 100 to 135°F, a form approximately to a section of an oral cavity of which an impression is to be made and peripheral borders shaped to cover the adjacent tissue areas with relief for the functioning musculature and related attachments, the tray being such that it may be heated above its glass transition temperature outwith the oral cavity, placed into position adjacent the oral section of which an impression is to be made of manually moulded to approximate the form of that oral section before the tray cools below its glass transition temperature so as to form a rigid final impression tray which is self-supporting.

The invention also provides a method of forming a final dental impression from a dental impression tray of the invention, the method comprising:

heating the tray above its glass transition temperature outwith the mouth of a patient;

placing the heated tray adjacent an area of which an impression is to be taken; and

manually moulding the tray to conform closely to the said area; and while in the mouth of the patient, allowing the tray to cool below its glass transition temperature to form a rigid structure.

The impression tray of the present invention has a highly anatomical shape, that is to say it contours and margins are designed to conform closely to either a maxillary or mandibular arch, either dentulous or edentulous alveolar ridge

and/or dental appliances or prosthesis, with sections extending over the contiguous tissue areas and with relief for the fibrous tissue and muscle attachments. For example, the mandibular trays may have extensions which cover the retromolar pad, and extend into the retromylohyoid fossae and cover the genial tubercles. Relief may be provided for the interior attachment of the mylohyoid muscle, and for the buccal and labial freni. The maxillary version of the tray may have a U-shaped, ridge-engaging trough bordering a central vault-engaging section having an axial pleat which allows lateral adjustment when softened. The tray thus closely conforms, in an anatomical sense, to the area of which the impression is to be made, as opposed to conventional initial impression trays which are substantially larger and have minimal anatomical contouring or marginal relief.

A preferred embodiment of the invention has a handle fixed to or integral with a convex surface at the labial point so that it may be easily inserted into and manipulated within the mouth. The tray of the invention may also have a plurality of tissue stops projecting from a concave surface of the tray at spaced intervals thereon and adapted to space the tray from the oral surfaces to be recorded accurately by allowing a proper spacing therebetween for a final impression material, which will record the exact detail of the tissue.

Alternatively, the tray may have mechanical retentive devices or materials formed on its concave and/or convex side and adapted to engage and retain final impression material inserted into the concavity of the tray. These devices may also act as tissue stops.

Because the trays of the present invention are formed of thermoplastic which has a glass transition temperature above body temperature but below a temperature that will harm the oral tissues, they may be heated above this glass transition temperature outwith the mouth of a patient and then placed within the mouth, over the impression area, and manually moulded to conform closely to the impression area. The glass transition temperature of the thermoplastic may range from 100°F to 135°F depending upon the tray's exact composition and the temperature at which it is placed in the mouth, the moulding and adjustment of the tray, may proceed for as long as two minutes before the tray cools below its transition temperature. It will then be rigid and self-supporting and may be removed from the mouth without significant loss of shape. The thermoplastic used is very desirably formulated so that it has no appreciable memory (tendency

to return to its previous shape). The thermoplastic is desirably an acrylic thermoplastic and preferably a methylmethacrylate polymer and most preferably a polymer of polymethylmethacrylate and monomethylmethacrylate. This material has a glass transition temperature of about 105°F.

Preferred embodiments of the invention will now be described, though by way of illustration only, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of a maxillary impression tray of the invention; Figure 2 is a section along the line 2-2 in Figure 1;

Figure 3 is a section along the line 3-3 in Figure 1;

Figure 4 is a perspective view of a mandibular impression tray of the invention, with a part thereof broken away;

Figure 5 is a section through part of the tray shown in Figure 4 showing the tray lying adjacent a dentulous alveolar ridge; and

Figure 6 is a perspective view of part of the tray shown in Figure 4 showing the retentive devices thereof.

The maxillary impression tray (generally designated 10) shown in Figures 1 to 3 is shaped to a close anatomical fit with an edentulous maxillary alveolar ridge and palatal vault. In commercial practice, this tray would be made available in a range of sizes and a similar series of dentulous trays would be provided so that a dentist could select a tray which closely conforms to any particular mouth.

The tray 10 has a three-dimensional shape which closely conforms with the anatomy of the maxillary section. The tray includes a central vault-engaging section 12 surrounded by a ridge-engaging U-shaped trough 14, an outer side wall 16 forming an extension of the trough. The edges of the side wall 16 are shaped to cover the adjacent tissue areas and provide relief for functioning musculature and related attachments; the side wall has a notch 18 to provide relief for the labial frenum as well as a notch 20 for the buccal frenum. A posterior extension 22 of the vault 12 is contoured to extend past the border of the hard and soft palate, through the hamular notches. Rear edges 24 of the side walls 16 are shaped to extend superiorly into the post-tuberosity area.

The vault-engaging section 12 is formed with a central pleat 25 along its midline, this pleat bisecting the trough 14. The pleat 25 extends away from the vault side of the plate so as to avoid interference with the fit of the plate against the vault and reduces in depth as it extends away from the posterior border of the tray, dis-

appearing into the vault at the anterior border, adjacent the central area of the trough 14. The pleat sides are disposed at an acute angle to one another so that the pleat has a V-shaped cross-section. The pleat allows adjustment of the lateral separation between the two sides of the trough when the plate is elevated in temperature, as described below.

A handle 26 projects downwardly from the convex side of the tray beneath the trough 14 and allows the tray to be inserted and positioned in the patient's mouth without tissue distortion or interference with border moulding procedures.

Tissue stops 28 are formed on the concave side of the trough 14, these stops consisting of raised areas and serving to space the concave surface of the tray from the desired tissue areas to allow proper spacing therebetween for a final impression material as well as aid in the proper adaptation and/or placement of the tray.

The mandibular impression tray (generally designated 30) shown in Figures 4 to 6 is intended for use with a dentulous arch. Like the maxillary tray 10 shown in Figures 1 to 3, it has a contoured edge relief which makes a close anatomical fit with the desired impression area.

The tray 30 has a generally U-shaped occlusal ridge 32 formed by an extension of a labial side wall 34 and of a lingual side wall 36. The side wall 34 has an area of buccal and labial frenum relief 40 formed midway along its sides. The lingual wall 36 has a relieved area 42 to accommodate the genioglossus and geniohyoid muscles and is anatomically formed to allow for muscle attachments 44 midway along its length for the anterior attachment of the mylohyoid muscles. At its posterior end, the tray has extensions which cover the retromolar pad and retromylohyoid fossae. The mandibular tray shown does not possess a handle although one could be provided (as shown in broken lines) if desired.

Instead of tissue stops, the tray 30 has retentive devices 46 formed at spaced points on its concave surface, the structure of these retentive devices being illustrated in more detail in Figures 4 and 6. The retentive devices 46 take the form of small spherical balls raised above the surface of the tray 30 on pillars 47. These retentive device extend outwardly from the concave side of the arch 32 and resist displacement of final impression material with respect to the tray. They may also act as tissue stops.

The plates 10 and 30 are formed of a thermoplastic material having a glass transition temperature above 100°F and below 130°F. The glass transition temperature of

a thermoplastic material is that temperature at which the material changes from its glassy, brittle state to a leathery state characterized by a change in stiffness of several orders of magnitude. The thermoplastic material used to form the trays is preferably an acrylic thermoplastic and the presently most preferred thermoplastic is the reaction product of copolyethyl (methyl) methacrylate with a monomethyl methacrylate. This reaction product is formed by mixing copolyethyl (methyl) methacrylate powder and polymethyl methacrylate powder with monomethacrylate liquid, suitable plasticizers, cross-linkers, and accelerators. The formation of other thermoplastic materials having the required mechanical characteristics is within the skill of those familiar with thermoplastics of this type.

In use, after selecting a tray 10 or 30 which makes a close fit with the desired impression area and trimming the margins of the tray if necessary with a burr, the dentist may warm the tray above its softening point by dipping it in warm water or warming it with an air blower. The tray may be then inserted into the mouth and manually moulded to achieve a high degree of conformity with the surrounding tissue area. The width of the tray may be adjusted and (in the case of the tray 10) the angle of the pleat sides to one another can be varied to give up or take slack. The tray will harden within the mouth within a short time, typically thirty seconds to one minute, depending upon the exact thermoplastic used, the temperature to which the tray is heated, and the thickness of the tray. If this hardening occurs before the moulding is completed, the tray may be removed from the mouth and reheated and the moulding thereafter continued. After the moulding has been completed and the tray fully hardened, it may be removed from the mouth without deformation, providing a close approximation to the tissue and surrounding muscle attachments.

After the tray has thus been removed from the mouth, conventional, commercially-available border moulding compounds of the type employed with prior art customized final impression trays are added to the peripheral borders of the tray. The tray is then again placed in the mouth and the border moulding material adjusted to the musculature of the mouth.

The final impression tray thus formed is used in the same manner as prior art final impression trays. The tray and the border area are filled with a high registration dental impression material such as alginate, permalastic, or silicone and then placed in the mouth to obtain a detailed

impression of the mouth tissues. After the detailed impression material sets, the thus-completed final impressions are removed and used in the conventional manner.

Since the thermal forming of the thermoplastic, anatomically-shaped impression tray of the invention may be performed in a single procedure, and the laboratory steps of casting a male model and making a final impression tray from a preliminary impression may be eliminated, substantial monetary and time savings result from the use of trays of the present invention.

WHAT I CLAIM IS:—

1. A dental impression tray comprising a sheet of thermoplastic material having a glass transition temperature in the range of from 100 to 135°F, a form approximating to a section of an oral cavity of which an impression is to be made and peripheral borders shaped to cover the adjacent tissue areas with relief for the functioning musculature and related attachments, the tray being such that it may be heated above its glass transition temperature outwith the oral cavity, placed into position adjacent the oral section of which an impression is to be made and manually moulded to approximate the form of that oral section before the tray cools below its glass transition temperature while within the oral cavity so as to form a rigid final impression tray which is self-supporting.
2. A dental impression tray as claimed in Claim 1, in which the thermoplastic is an acrylic thermoplastic.
3. A dental impression tray as claimed in Claim 2, in which the acrylic thermoplastic is a methylmethacrylate polymer.
4. A dental impression tray as claimed in Claim 3, in which the acrylic thermoplastic is a polymer of polymethylmethacrylate and monomethylmethacrylate.
5. A dental impression tray as claimed in any of the preceding claims, further comprising a handle fixed to or integral with a convex surface at the labial point.
6. A dental impression tray as claimed in any of the preceding claims, further comprising a plurality of tissue stops projecting from a concave surface of the tray at spaced points thereon and adapted to space the tray from the oral surfaces to be recorded accurately by allowing proper spacing therebetween for a final impression material.
7. A dental impression tray as claimed in any of the preceding claims, further comprising mechanical retentive devices formed on the concave and/or convex surface of the tray and adapted to engage and retain final impression material inserted into the concavity of the tray.
8. A dental impression tray as claimed in any of the preceding claims shaped to



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a thermoplastic material is that temperature at which the material changes from its glassy, brittle state to a leathery state characterized by a change in stiffness of several orders of magnitude. The thermoplastic material used to form the trays is preferably an acrylic thermoplastic and the presently most preferred thermoplastic is the reaction product of copolyethyl (methyl) methacrylate with a monomethyl methacrylate. This reaction product is formed by mixing copolyethyl (methyl) methacrylate powder and polymethyl methacrylate powder with monomethacrylate liquid, suitable plasticizers, cross-linkers, and accelerators. The formation of other thermoplastic materials having the required mechanical characteristics is within the skill of those familiar with thermoplastics of this type.

In use, after selecting a tray 10 or 30 which makes a close fit with the desired impression area and trimming the margins of the tray if necessary with a burr, the dentist may warm the tray above its softening point by dipping it in warm water or warming it with an air blower. The tray may be then inserted into the mouth and manually moulded to achieve a high degree of conformity with the surrounding tissue area. The width of the tray may be adjusted and (in the case of the tray 10) the angle of the pleat sides to one another can be varied to give up or take slack. The tray will harden within the mouth within a short time, typically thirty seconds to one minute, depending upon the exact thermoplastic used, the temperature to which the tray is heated, and the thickness of the tray. If this hardening occurs before the moulding is completed, the tray may be removed from the mouth and reheated and the moulding thereafter continued. After the moulding has been completed and the tray fully hardened, it may be removed from the mouth without deformation, providing a close approximation to the tissue and surrounding muscle attachments.

After the tray has thus been removed from the mouth, conventional, commercially-available border moulding compounds of the type employed with prior art customized final impression trays are added to the peripheral borders of the tray. The tray is then again placed in the mouth and the border moulding material adjusted to the musculature of the mouth.

The final impression tray thus formed is used in the same manner as prior art final impression trays. The tray and the border area are filled with a high registration dental impression material such as alginate, permalastic, or silicone and then placed in the mouth to obtain a detailed

impression of the mouth tissues. After the detailed impression material sets, the thus-completed final impressions are removed and used in the conventional manner.

Since the thermal forming of the thermoplastic, anatomically-shaped impression tray of the invention may be performed in a single procedure, and the laboratory steps of casting a male model and making a final impression tray from a preliminary impression may be eliminated, substantial monetary and time savings result from the use of trays of the present invention.

WHAT I CLAIM IS:—

1. A dental impression tray comprising a sheet of thermoplastic material having a glass transition temperature in the range of from 100 to 135°F, a form approximating to a section of an oral cavity of which an impression is to be made and peripheral borders shaped to cover the adjacent tissue areas with relief for the functioning musculature and related attachments, the tray being such that it may be heated above its glass transition temperature outwith the oral cavity, placed into position adjacent the oral section of which an impression is to be made and manually moulded to approximate the form of that oral section before the tray cools below its glass transition temperature while within the oral cavity so as to form a rigid final impression tray which is self-supporting.

2. A dental impression tray as claimed in Claim 1, in which the thermoplastic is an acrylic thermoplastic.

3. A dental impression tray as claimed in Claim 2, in which the acrylic thermoplastic is a methylmethacrylate polymer.

4. A dental impression tray as claimed in Claim 3, in which the acrylic thermoplastic is a polymer of polymethylmethacrylate and monomethylmethacrylate.

5. A dental impression tray as claimed in any of the preceding claims, further comprising a handle fixed to or integral with a convex surface at the labial point.

6. A dental impression tray as claimed in any of the preceding claims, further comprising a plurality of tissue stops projecting from a concave surface of the tray at spaced points thereon and adapted to space the tray from the oral surfaces to be recorded accurately by allowing proper spacing therebetween for a final impression material.

7. A dental impression tray as claimed in any of the preceding claims, further comprising mechanical retentive devices formed on the concave and/or convex surface of the tray and adapted to engage and retain final impression material inserted into the concavity of the tray.

8. A dental impression tray as claimed in any of the preceding claims shaped to



(14)

conform to a dentulous alveolar ridge.

9. A dental impression tray as claimed in any of Claims 1 to 7, shaped to conform to an edentulous alveolar ridge.

- 5 10. A dental impression tray as claimed in any of Claims 1 to 8, for a maxillary section, the tray having a U-shaped trough adapted to engage an alveolar ridge and a palatal vault engaging section extending 10 from and supported within the trough, the vault having a pleat extending away from the vault-engaging side thereof to allow the lateral separation of the opposed trough sides to be adjusted when the tray is heated 15 above its glass transition temperature.

11. A dental impression tray for a maxillary section comprising a sheet of thermally mouldable plastics material having a glass transition temperature in the 20 range of from 100° to 135°F and having a form approximating to a section of an oral cavity of which an impression is to be made and peripheral borders shaped to cover the adjacent tissue areas with relief 25 for the functioning musculature and related attachments, the tray having a central palatal vault-engaging section surrounded by a U-shape trough adapted to engage an alveolar ridge, said vault-engaging section 30 being formed with a central pleat extending away from the vault-engaging side thereof for adjustment of lateral separation of the opposed trough sides.

12. A dental impression tray substantially 35 as herein described, with reference to and as illustrated in Figures 1 to 3 or Figures 4 to 6 of the accompanying drawings.

13. A method of forming a final dental impression tray from a dental impression tray as claimed in any of the preceding 40 claims, the method comprising:

heating the tray above its glass transition temperature outwith the mouth of a patient;

placing the heated tray adjacent an 45 area of which an impression is to be taken;

manually moulding the tray to conform closely to the said area, and

while in the mouth of the patient, 50 allowing the tray to cool below its glass transition temperature to form a rigid structure.

A method as claimed in Claim 13, further comprising the step of trimming the 55 peripheral borders of the tray to conform to the surrounding oral tissues and muscle attachments of the patient prior to heating the tray.

15. A method as claimed in Claim 13 60 or 14, further comprising the step of adding mouldable border material to the peripheral borders of the tray and causing the material to be moulded within the mouth of the patient. 65

16. A method of forming a final dental impression tray as claimed in Claim 13 and substantially as herein described.

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SPECIFICATION NO 1587177

By a direction given under Section 17 (1) of the Patents Act 1949 this application proceeded in the name of **BLACK KNIGHT INVESTMENTS LIMITED**, a corporation formed under the laws of the British West Indies, of George Town, P.O. Box IIII, Grand Cayman, Cayman Islands, British West Indies.

THE PATENT OFFICE

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