Title: DELIVERY DEVICE FOR APPLYING DENTAL MATERIALS TO THE ORAL CAVITY

Abstract: A delivery device for the application of a dental material contained within a preloaded capsule to the oral cavity includes a handpiece having means to removably accept the preloaded capsule. The handpiece has ultrasonic or sonic energy and heat energy generating means such that energy is selectively applied to the dental material in the preloaded capsule. A method includes applying sonic or ultrasonic and heat energy to such a capsule.
DELIVERY DEVICE FOR APPLYING DENTAL MATERIALS TO THE ORAL CAVITY

TECHNICAL FIELD

[0001] The present invention relates to the application of dental materials. More particularly, the invention relates to improvements in placing such materials in the oral cavity. Specifically, the invention relates to improvements in such uses while employing heat in conjunction with vibration or other mechanical actions.

BACKGROUND OF THE INVENTION

[0002] Dental professionals use a wide variety of materials in maintaining, improving or otherwise treating dental health. These include for example, dental restorative composites and amalgams, adhesives, cements, veneers, impression and registration materials, endodontic obturation materials, and the like. It is often the case that a successful dental procedure requires precise and complete application of such materials to fill spaces and voids, to flow properly, to maintain a suitable viscosity and to otherwise maintain a proper consistency for adequate handling and application by the practitioner.

[0003] The present invention provides for improvements in such techniques and the handling of such dental materials.

DISCLOSURE OF THE INVENTION

[0004] It is therefore, an object of the invention to provide for improvements in the application of dental materials to the oral cavity. The invention has a broad range of application to a variety
of dental materials, but is particularly suited for the application of dental restoratives and endodontic obturation materials.

[0005] In general, the present invention imparts suitable vibrational and heat energy to the material to be applied, such that a proper viscosity is achieved allowing the material to flow from the application instrument to the site of application in the oral cavity, where it is otherwise treated in a conventional manner, such as for example, by then being cured. Optionally, other mechanical forces may be applied to move or otherwise place the dental material, such as by using a spatula, a piston, a nozzle or any other such mechanical devices providing a mechanical force upon the material to move or deliver it.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] Fig. 1 is a side elevational, partially broken view of a delivery device embodying the concepts of the invention, shown for environmental purposes, as being affixed to a handpiece.

[0007] Fig. 2 is an alternative embodiment of the delivery device as in Fig. 1.

[0008] Fig. 3 is another embodiment of a delivery device according to the invention, and particularly suited for endodontic use.

[0009] Fig. 4 is an alternative embodiment of a delivery device particularly suited for endodontic use.

[0010] Fig. 5 - 23 show embodiments of the invention.

PREFERRED EMBODIMENTS FOR CARRYING OUT THE INVENTION

[0011] The present invention uses heat and vibration to make otherwise non-flowing or flow-resistant materials flow by reducing their viscosity. The required viscosity which must be achieved will vary depending upon the particular material being used and the dental procedure being carried out. Therefore, the viscosity reductions are not an absolute limitation of the invention. However, a practitioner will know by training and experience what consistency is
useful for his or her particular technique. Such viscosities will also vary between practitioners even when they use the same materials and equipment. Therefore, again, viscosity is not an absolute limitation. The operative objective of the invention is to reduce viscosity by applying heat and energy to the point where the practitioner can properly, precisely and completely place the material as desired.

[0012] Vibrational energy is imparted by any suitable means, but is preferably imparted by operative connection of the delivery device to an ultrasonic generator. Such devices are well known in the dental art, and include for example, the CAVITRON line available from DENTSPLY INTERNATIONAL INC. of York, Pennsylvania. The actual energy supplied will vary depending upon the viscosity reduction required, which as discussed above, is not an absolute limitation of the invention.

[0013] For example, there is depicted in Fig. 1, a delivery device 10 which may be a preloaded capsule or the like, or which may be individually loaded as need by the practitioner, and which is operatively connected to a handpiece 11. Handpiece 11 is in turn connected by operative connector 12 to an ultrasonic generator 13. Handpiece 11 preferably contains elements such as magnetostrictive or piezo elements 14 for accepting energy from generator 13 and translating the energy into vibration-inducing ultrasonic energy applied to delivery device 10. The translation of such energy is of itself, conventional and well known for example, in the dental prophylactic scaling art, and need not be further described here.

[0014] Because vibrational energy is translated to delivery device 10, the material contained therein, such as dental material 20, is caused to vibrate. This in turn causes a reduction in the viscosity of the dental material 20, sufficient to reduce its viscosity. Materials that reduce viscosity when vibrational energy is applied are known as being thixotropic. Dental material such as Dyract, Integrity, Prisma and SureFil, all available from DENTSPLY are examples of such dental materials. While all of these materials are restoratives, other dental materials as discussed above can also benefit and are therefore useful, with the present invention.
[0015] As stated, delivery device 10 can be preloaded or it can be simply a receptacle which is loaded at the time of use with an appropriate dental material 20. Preferably, delivery device 10 is preloaded with selected material, and is also otherwise configured for application of the material. For example, delivery device 10 may be provided with a nozzle 21 configured to take advantage of the viscosity reduction imparted by the invention. This is useful in a number of ways, including that very small quantities of dental material 20 can be applied than would otherwise be possible without the present invention. Without the reduction in viscosity that the invention provides, the application of small quantities would not otherwise be possible. This allows for increased precision in application to the practitioner.

[0016] Preferably, delivery device 10 is also configured to also supply heat energy to the dental material 20. This may be accomplished by any means, such as by supplying electrical energy from generator 13 to delivery device 10 in a manner to cause delivery device 10 itself to heat. The heating may also be internal of delivery device 10. Further still, the interior walls of delivery device 10 may be heated, or a separate heating element 22 may be provided that accepts electrical energy from generator 13 and translates such electrical energy into heat energy. Heating element 22 would of course, be connected to an appropriate circuit or connector 23 for such purposes. Fig. 2 shows an alternative embodiment of delivery device 10 wherein nozzle 21 is of a different size than nozzle 21 of Fig. 1. This will allow for a different amount and/or viscosity of dental material 20 to be applied. Further, a piston 24 and follower 25 may be employed in delivery device 10 to otherwise impart mechanical forces to dental material 20 to further induce desired movement.

[0017] According to one aspect of the invention, a delivery device 30 is configured for particular use in endodontic obturation procedures. Such procedures known in the art have included use of an obturation material on a carrier, such as the Thermafil obturator available from DENTSPLY. The obturator is placed into a suitable heating device, such as an oven, to warm the
material and make it flow. The carrier is then inserted into the prepared root canal, and the material is cause to move coronally to fill the canal.

[0018] The present invention imparts both heat and vibrational energy to carrier 30 by operative connection via connector 31 to generator 32. Heat and vibrational energy are translated to carrier 30 in a manner similar to that delivered to delivery device 10. Material, such as gutta percha 33 is therefore, caused to be reduced in viscosity and to flow as desired.

[0019] According to another aspect of the invention, particularly suited for the placement of material into a tooth to be restored or for the placement of endodontic material into a root canal, a cannula 40 is employed. Cannula 40 has a passage 41 therethrough, preferably a lengthwise passage, and is operatively connected through connector 42 to a generator for imparting vibrational and heat energy in a manner substantially similar to that provided by generator 32. In this embodiment of the invention, there is also provided a material reservoir or source 50 which while shown separate from generator 43 in the drawings, may be supplied in conjunction therewith. Source 50 supplies a quantity, preferably a continuous or selectable flow of a quantity of dental material 60 to cannula 40 passage 41. By either imparting heat, vibrational energy, mechanical energy (including pressure) or some combination thereof, preferably at least heat and vibrational energy, material 60 can be caused to flow through passage 40 to be applied. This will allow the practitioner to substantially backfill the treated area while the cannula 40 is removed therefrom. Source 50 may be pressurized to help further induce flow through cannula 50. Cannula 40 may be supplied with an outer layer of material 51, such as is the case with gutta percha 33, which is used in endodontic obturation procedures. Thus the root canal is obturated and automatically backfilled at the same time.

[0020] As will be appreciated, heat, vibrational and or mechanical energy may be applied according to the present invention, either sequentially in any combination or at the same time again in any combination. It is to be further appreciated that the present invention carries out the objects thereof and otherwise provides a valuable and new contribution to the art. The invention
has been described and illustrated without attempting to show all of the various embodiments that are within its scope. The scope of the invention will therefore, be determined only by any attached claims.

[0021] Another embodiment of the invention is intended for use to aid the placement, manipulation and finishing of composite materials used in dentistry. Energy is applied to the composite by means of a conventional instrument tip fitted to a drive mechanism. This drive mechanism generates linear oscillations of between 0.2 mm and 3 mm at frequencies between 20 Hz and 200 Hz.

[0022] The instrument uses a miniature DC motor, which rotates continuously in one direction. This motor drives a cam mechanism, which translates rotary motion into linear oscillation. The cam mechanism consists of a slot cut into the surface of a cylinder around its circumference. This slot deflects in an axial direction between 0.2 mm and 3 mm in a form of a translated since wave. Pins in the linear shaft engage with this slot and run within it. As the drive cam rotates, driven by the electric motor, the linear shaft oscillates. The linear shaft is prevented from rotating by an anti-rotation stop, which is fixed to the device housing and engages with a flat machined within the linear shaft.

[0023] The motor can be powered either by internal power cells or by an external power source.

[0024] Alternative drives under consideration for the instrument could include: a conventional rotary air powered motor to replace the electric motor; an AC motor which rotates only half a revolution and reverses direction, thus generating an oscillating rotary motion, translated into linear motion in a similar way to that above; and, an air powered mechanism, which uses a long piston along the axis of the device and directly connected to the tip. This piston oscillates back and forth and is controlled by a system if airways and ports to cycle the mechanism.

[0025] Another alternative format for the device would be a two piece device. The base would contain the drive motor and actuation switch. To this would be fitted the tip section which
contains the bearing mechanism. The two sections are connected by a magnetic coupling, of either a rotary or linear design; thus aiding the post use sterilization of the device.
What is claimed is:

1. A delivery device for the application of a dental material contained within a preloaded capsule to the oral cavity comprising;
   a handpiece having means to removably accept the preloaded capsule; said handpiece having ultrasonic and heat generating means such that ultrasonic energy and heat are selectively applied to the dental material in said preloaded capsule.

2. A delivery device as in claim 1, wherein said ultrasonic energy is generated by a magnetostrictive element.

3. A delivery device as in claim 3, wherein said ultrasonic energy is generated by a piezoelectric element.

4. A method of applying a dental material to the oral cavity comprising the step of selectively applying ultrasonic and heat energy to a preloaded capsule containing the dental material, such that the viscosity of the material is reduced.

5. A delivery device for the application of a dental material contained within a preloaded capsule to the oral cavity comprising;
   a handpiece having means to removably accept the preloaded capsule; said handpiece having sonic and heat generating means such that sonic energy and heat are selectively applied to the dental material in said preloaded capsule.
6. A method of applying a dental material to the oral cavity comprising the step of selectively applying sonic and heat energy to a preloaded capsule containing the dental material, such that the viscosity of the material is reduced.
SHAFT

PINS ENGAGE WITH DRIVE CAM SHOT

TIP FIXES TO M3 THREAD

FLAT ENGAGES WITH ANTI ROTATION STOP
Fig. 4
PRIM.
BEARINGS
SECON.
BEARINGS
Fig. 4
ANT.
ROT.
AXIS
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61C5/06 A61C9/00 B05C17/00

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 7 A61C B05C

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 practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<td>Y</td>
<td>WO 01/17454 A (TILSE RAINEY) 15 March 2001 (2001-03-15) page 4, line 10 - page 8, line 13; figures</td>
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<tr>
<td>A</td>
<td>US 4 704 088 A (NEWMAN MARTIN H) 3 November 1987 (1987-11-03) abstract; claims; figures</td>
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Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

* 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 document but published on or after the international filing date
*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)
*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

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*"* 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: 20 July 2004
Date of mailing of the international search report: 30/07/2004

Name and mailing address of the ISA
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 940-2040, Tx. 31 651 epo nl, Fax: (+31-70) 940-3016

Authorized officer: Vänttinen, H

Form PCT/ISA/210 (second sheet) (January 2004)
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<td>A</td>
<td>WO 02/076323 A (SCHUETZ DENTAL GMBH ;KRANJC JOSEF (DE)) 3 October 2002 (2002-10-03) abstract; figures</td>
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INTERNATIONAL SEARCH REPORT

Box II  Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. □ Claims Nos.: 4, 6
   because they relate to subject matter not required to be searched by this Authority, namely:
   Rule 39.1(iv) PCT — Method for treatment of the human or animal body by therapy

2. □ Claims Nos.: because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. □ Claims Nos.: because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box III  Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. □ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. □ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. □ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. □ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

□ The additional search fees were accompanied by the applicant's protest.

□ No protest accompanied the payment of additional search fees.
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