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Inoue et al.

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[54] METHOD OF SPATULATING PACKAGED DENTAL FILLING

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[21] Appl. No.: **88,738**

[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** ..... **259/72**, 206/47 A, 206/63.5, 259/DIG. 20, 259/DIG. 46

[51] **Int. Cl.** **B01f 13/08**

[58] **Field of Search** ..... 206/47 A, 63.5; 259/DIG. 20, 259/72, 1 R, DIG. 46

[56] **References Cited**

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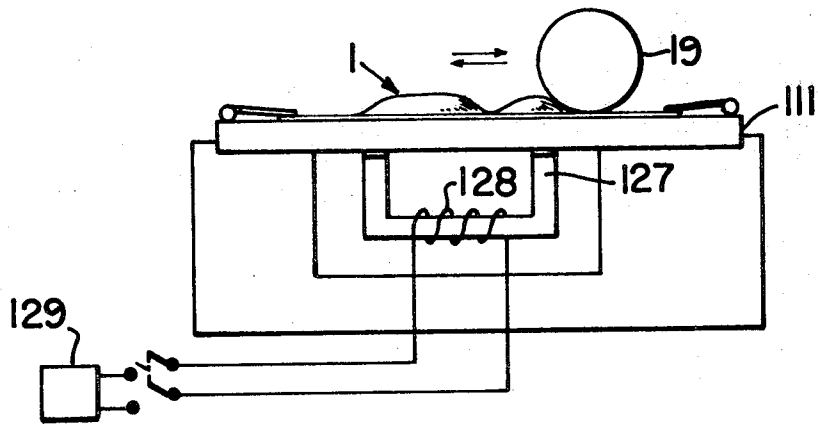
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Assistant Examiner—Philip R. Coe
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[57] **ABSTRACT**

Pre-packaged dental filling ingredients for use by dentists. The ingredients which are in part liquid and in part powder are encapsulated and sealed tightly in a flexible-membrane formed bag and therein separated one from the other which separation is released by the compression of the bag to cause the ingredients to be successively brought into contact and mixed together. The mixture, confined within the bag, is spatulated to form a paste or semi-solid, ready for application to a patient's tooth. The spatulation may be carried out advantageously with apparatus adapted to compressively roll over the flexible bag supported on a surface or squeeze the bag against the surface.

2 Claims, 17 Drawing Figures



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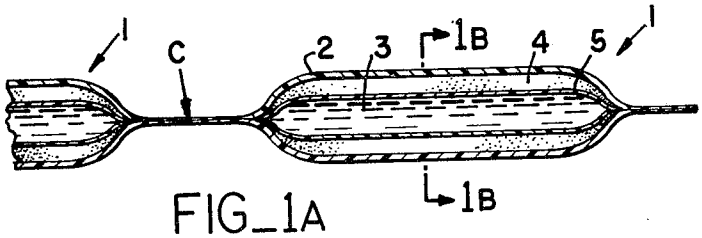


FIG_1A

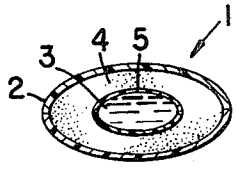


FIG_1B

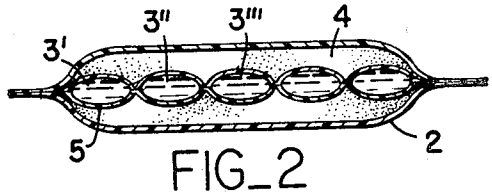


FIG_2

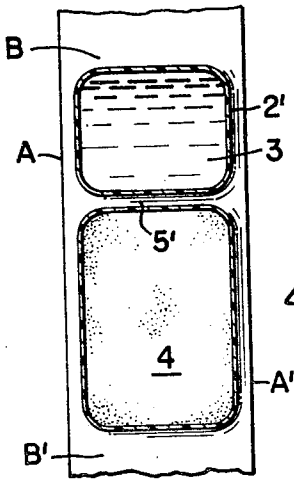


FIG_3

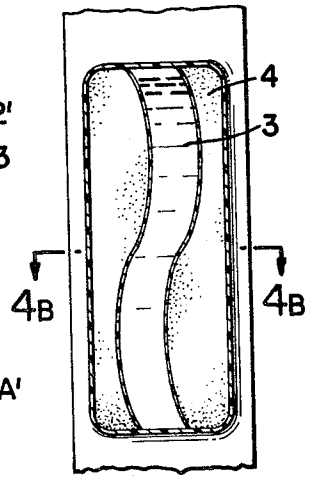


FIG_4A

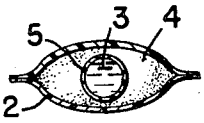


FIG_4B

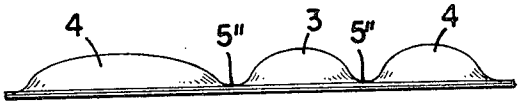


FIG_4C



FIG_6

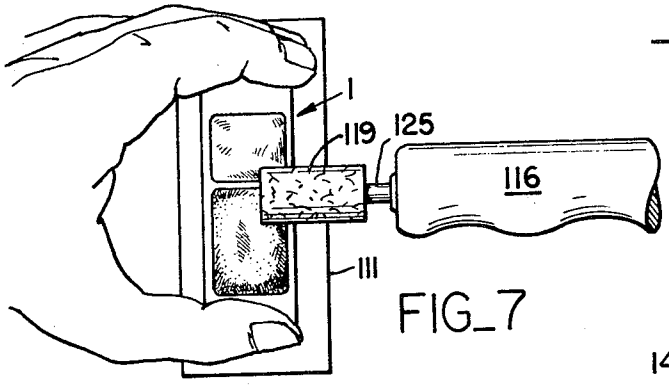


FIG_7

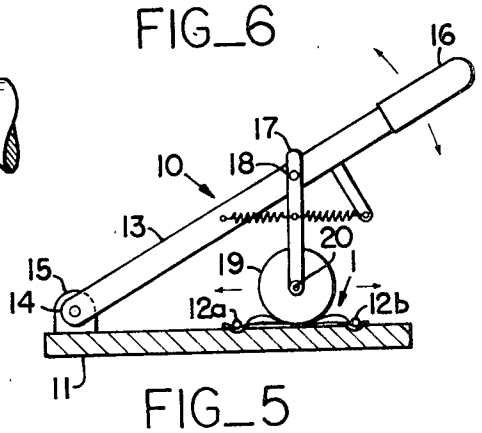


FIG_5

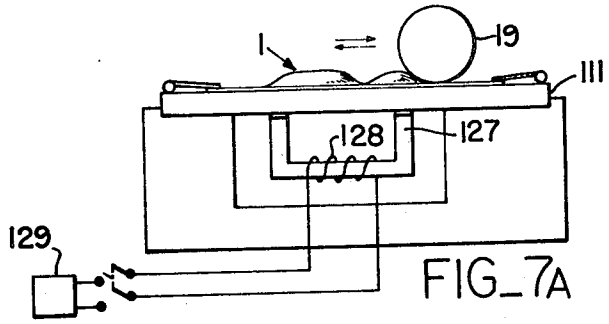


FIG_7A

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3 Sheets-Sheet 2

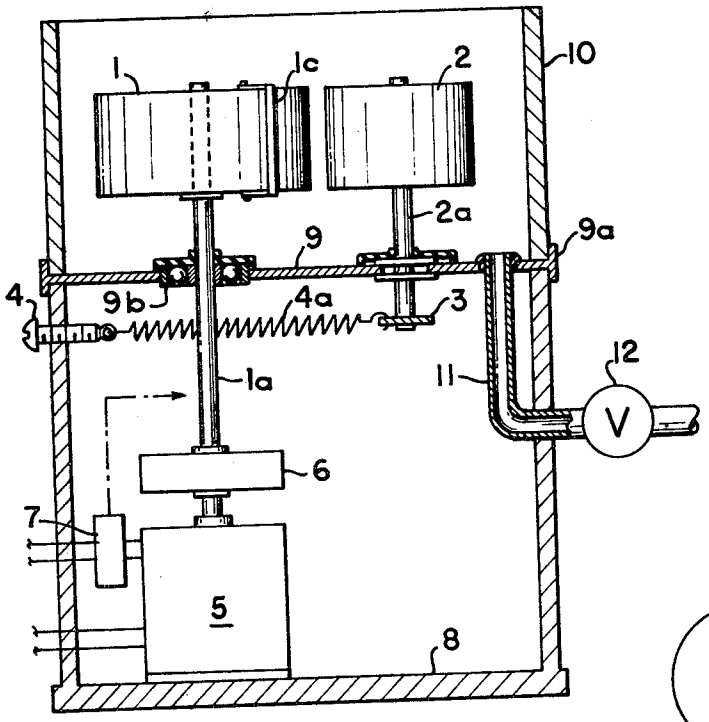


FIG_8

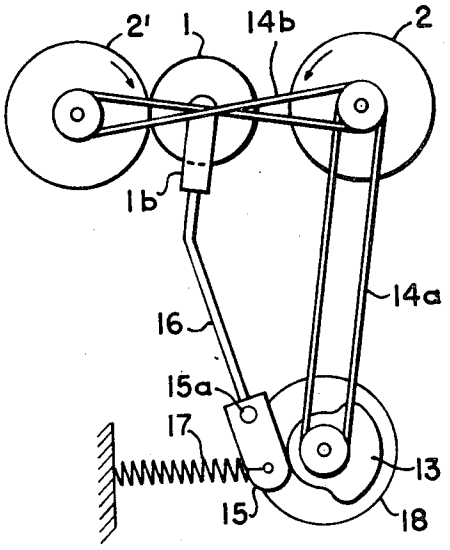


FIG_9

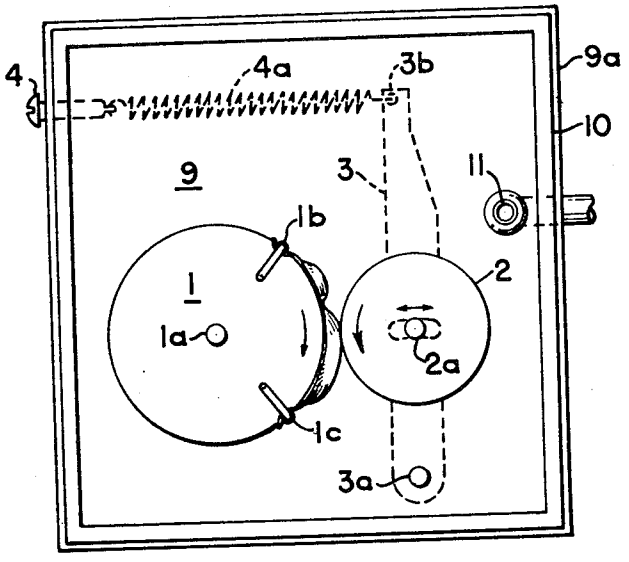


FIG_8A

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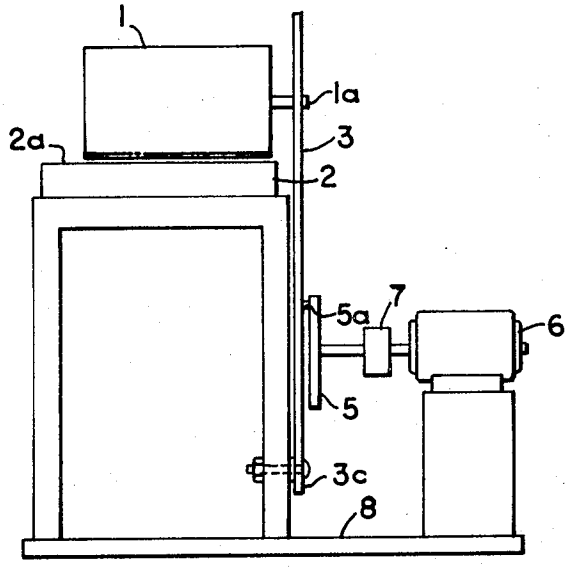


FIG_10

FIG_10A

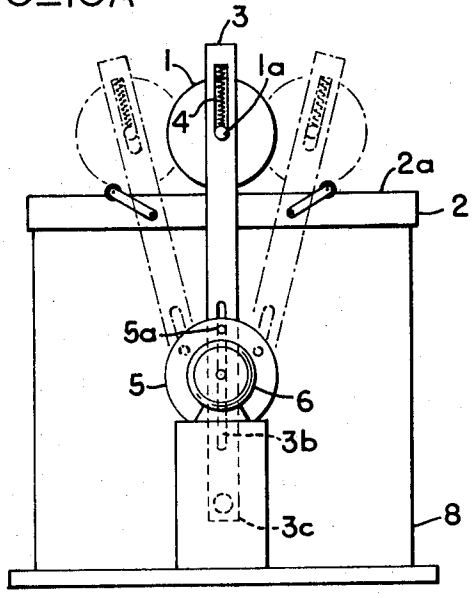
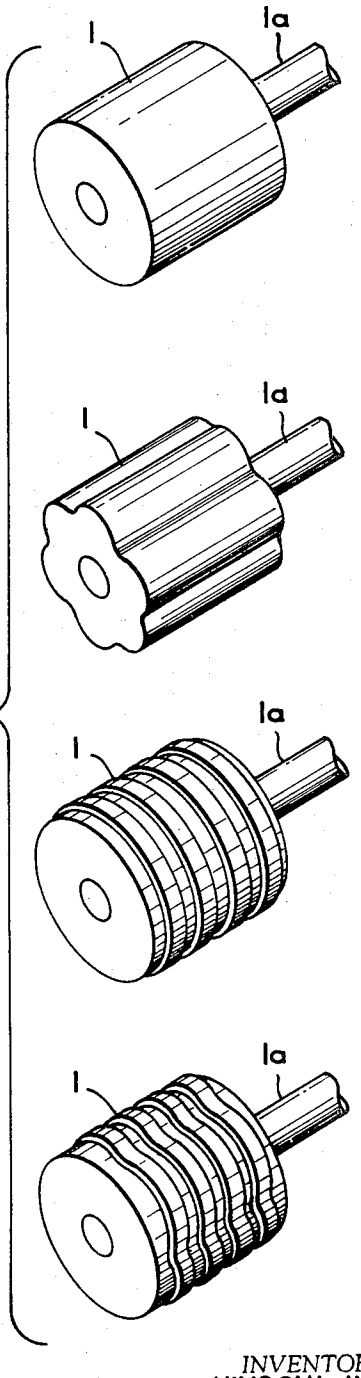


FIG_11



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METHOD OF SPATULATING PACKAGED DENTAL FILLING

BACKGROUND OF THE INVENTION

The invention is in the field of dentistry and especially relates to a method of preparing a dental filling in paste or semi-solid form based on the new concept.

When a dentist prepares a dental filling from a plurality of ingredients, it has hitherto been a common requirement that he accurately measure out such ingredients from vials or the like containing individual ingredients and mix them together with instruments or utensils. This has been necessary because of the fact that they must be mixed together immediately before use. One of such ingredients is commonly a liquid or a number of different liquids and the other is a powder or a number of powders or different materials which are reactable or complementary to such liquid appropriate to the kind and type of a desired filling, and a suitable procedure must be made during the mixing stage to accomplish reactions uniformly over the entire region of the powder and liquid in a relatively short time. For example, when such a filling as zinc-phosphate, silicate or silico-phosphate cement is to be prepared, the liquid is an aqueous solution containing phosphoric acid, and the powder is made up from one or more of zinc oxide, silicon oxide and aluminum oxide, along with one or more additives, the exact composition depending on the particular cement desired, and the powder and liquid are mixed together and spatulated fully until the mixture becomes a paste which can be applied to a patient's tooth or teeth. In phenomenon, when the powder and liquid are brought into contact, exothermic reactions are brought about to form phosphate, acid phosphate and other products in crystal and noncrystal forms, with the local crystalization being apparently followed by the solation and gelation of the mixture while the paste commences and proceeds setting or curing with a final structure in which unreacted cores of powder are distributed among the reaction formed crystals.

Quantities of starting materials to be measured out and control of these complex reactions which are to be accomplished in a relatively short time are critical inasmuch as these are factors largely governing the final structure of the fully set product which determines the quality thereof as a dental filling. However, heretofore, these factors have been left to dentists who will attend to mixing or spatulation procedure in various conditions and at various levels of skill for such procedure. Moreover, it has been common, especially where spatulation procedure and the like is essential, that such is carried out with the mixture exposed to the environmental atmosphere whose conditions vary from season to season and from place to place. As a consequence, the strength and other quality characteristics of the resulting filling have largely varied depending on the humidity and the temperature of the particular environment in which it is prepared. The quality values have been often inferior to required standard values and this tendency is rather common in the humid and hot seasons.

SUMMARY OF THE INVENTION

It is the primary object of the present invention, therefore, to provide an improved technique which

makes it possible to prepare from a plurality of starting materials a dental filling of a superior quality, i.e. compressive strength, hardness, freedom of dimensional change (expansion or shrinkage), adhesiveness and interlockability, practically independently from the environmental conditions in which the filling is prepared.

Another object of the present invention is to provide a method of preparing a dental filling which relieves the dentists of the tedious bother of actually measuring out starting materials or ingredients as heretofore required and enables fabrication of a dental filling of superior characteristics to those heretofore obtained in standard conditions.

These objects and others which will become apparent hereinafter, are attained in accordance with the present invention, by our novel concept of packaging in mutual separation until just before use a plurality of premeasured substances adapted to form a dental filling, i.e. paste cement or amalgam, and releasing the separation to cause said separated substances to be successively brought into contact and mixed together and effecting reaction therebetween controlledly and uniformly within a confined space isolated from the atmosphere under compressive or squeeze action applied to the mixture. In accordance with an important aspect of the invention, there is provided a capsule comprising a flexible-membrane formed bag enclosing premeasured amounts of the substances which are tightly separated from one another in the bag, said separation being releasable by the compression of the bag to cause the substances to be successively mixed together within the bag, the latter being of thickness and material adapted to withstand said compression and for rupture or breakage only by the user's purpose to take out the mixture or product for clinical use.

The invention is applicable to any of the dental fillings available and the plural substances for packaging in a bag are those choosen respectively depending on the particular end product desired. For example, for a zinc-phosphate cement, the first substance is a power containing zinc oxide and for a silicate cement, the powder contains mainly admixed silica and alumina. As is well known, various additives may be admixed to these oxides to facilitate and/or control exothermic reactions brought about as the primary constituent and a liquid are mixed together. Common to these particular cements, liquid is constituted by or contains an aqueous phosphoric acid solution. Also for a water settable phosphate cement, the powder may be of phosphate salt and/or acid phosphate salt and the liquid a suitable solvent such as water or alcohol. For amalgam, the liquid is mercury and the powder copper or copper alloy.

The bag may be a thin rubber, plastic, natural or synthetic resin and requisites of the material forming same are flexibility and toughness to withstand the compressive force applied thereto as well as non-destructability by liquid and exothermic reactions. Among others, a polyester has been found highly suitable for this purpose.

For the purpose of the present invention, the package is divided into plural compartments which are filled with a liquid or liquids and powder or powders, respectively, the package being tightly sealed to separate the contents from the environment. To this

end, a pack may be prepared of a diaphragm filled with a liquid for enclosure as a first compartment within the flexible bag with the space between the outer surface of this diaphragm and the inner surface of the bag filled with powder forming the second compartment. In this case, the pack may comprise a plurality of or series of sub-packs filled with liquid and distributed or embedded among the powder. To enable release of the separation between the liquid and the powder, the diaphragm forming the liquid pack may be of material, thickness or character to permit rupture by the compression of the outer flexible bag. Alternatively, the sealed package with plural separated compartments can be prepared by bonding portions of the bag so as to sealingly separate the liquid or liquids from the powder or powders, this bond being sufficiently tight to prevent release of the separation in the absence of such compressive force are applied to the bag for mixing purpose.

According to a preferred embodiment of the invention, a plurality of packages set forth above may be prepared which are disconnectably linked in series to permit the dentist to separate one from the series at his need.

The method of preparing a dental filling in a paste or semisolid form making use of a sealed package with separated ingredients or starting substances, according to the present invention, includes applying a compressive, squeezing force to the flexible package supported on a suitable surface in the atmosphere or preferably within a coolant or temperature-controlled fluid so as to cause the separated substances to be successively brought into contact and spatulated sustaining reactions between them within the confined space of the package. While any known instrument may be used to spatulate the mixture left in the closed space, we prefer to this end the use of a rotary member adapted to unidirectionally reciprocatingly roll over the package against a supporting surface under compression or relatively convex members or surfaces adapted to squeeze the package between them.

DESCRIPTION OF THE DRAWINGS

FIG. 1A is a sectional view of a capsule embodying the principles of the present invention;

FIG. 1B is a cross-sectional view of the embodiment on the line 1B—1B of FIG. 1A;

FIG. 2 is a sectional view of another form of the capsule according to the invention;

FIG. 3 is a plan view of another embodiment of the capsule according to the invention;

FIG. 4A is a plan view of a capsule of the invention embodied in another form;

FIG. 4B is a cross sectional view of the capsule taken on the line 4B—4B of FIG. 4A;

FIG. 4C is a cross sectional view of a similar capsule;

FIG. 5 is a diagrammatic view of apparatus for performing the spatulation procedure according to the present invention;

FIG. 6 is a diagrammatic enlarged view illustrating a spatulating procedure according to the invention;

FIG. 7 is a diagrammatic top view of another form of a hand-operated spatulator according to the invention;

FIG. 7A is a side elevational view of the apparatus of FIG. 7;

FIG. 8 is a sectional view in a diagrammatic form of a motor-operated spatulator according to the present invention;

FIG. 8A is a top view in cross section of the spatulator of FIG. 8;

FIG. 9 is a diagrammatic representation of another form of spatulating apparatus according to the invention;

FIG. 10 is a side-elevational view of still another form of a motor-operated spatulator and FIG. 10A is a front view, partly fragmentary, thereof; and

FIG. 11 shows rotary members of various configuration useful in performing the spatulation procedure according to the present invention.

DETAILED DESCRIPTION

In FIGS. 1A and 1B there is shown one illustrative embodiment of our novel dental capsule packaging a liquid and a powder in tight mutual separation. The capsule 1 is in the form of a closed bag made from a flexible membrane 2 whose interior is divided into multiple compartments filled with individual ingredients or starting substances, here, into two compartments 3 and 4 filled with a liquid and a powder, respectively, and separated by a flexible diaphragm 5. In this example, the latter diaphragm is of a material, thickness and character adapted to tightly separate liquid and powder normally but for rupture to release the separation when compressive, squeezing action is applied to the bag 1 as will be described. The membrane 2 forming the bag 1 is sufficiently flexible, tough and thick to withstand such compressive, squeezing action so as to confine the mixture within the space isolated from the environment. This capsule may be a pair of tubes closed at both ends with the first tube 5 filled with a premeasured amount of liquid and the second tube 2 containing a premeasured amount of powder in the space between its inner wall and the outer wall of the liquid-filled closed tube to form a sausage-shaped container with two compartments filled with liquid and powder respectively. For the user's convenience, a plurality of such capsules may be prepared which are linked in series. Thus, the user can cut the portion c to separate the terminal capsule from the series for his intended use and spatulation procedure. The capsule of FIG. 2 is shown to include a liquid compartment 3 subdivided into plural compartments each filled with a amount of liquid complementary to those filled with the other subcompartments relative to an amount of powder contained in the bag 2 in contact therewith and the subcompartments. Each of the latter is adapted for rupture as compressive, squeezing action is exerted, as will be described.

In each single capsule which may be one of various forms as shown before and hereafter, it is of course necessary to package specific kinds of powder and liquid in accurately measured amounts and proportion depending on the type and amount of a particular dental filling. As set forth earlier, phosphate cements make use of a powder containing oxides and a liquid containing an phosphoric acid solution, or otherwise a powder containing phosphate salt and a solvent liquid. The powder may include one or more additives to improve the quality of a final product as formed. While innumerable additives have been suggested by others, one of the joint inventors of the present invention,

Kiyoshi Inoue, has discovered that inclusion up to 5 percent by volume of finely divided fibers (of 0.1 to 3 micron diameter and 0.5 to 20 mm length) of a synthetic resin not detrimental to the tooth body (such as polypropylene, trifluoride resin, vinyl chloride, chlorinated polyester, polyethylene, furan, epoxy resin, polyester, phenol resin and the like) greatly improves the compressive strength and the interlocking strength of any of these cements as applied to a tooth.

Shown in FIG. 3 is another embodiment of our novel capsule which is in the form of a rectangular, relatively flat envelope in which two compartments 3 and 4 sealed tightly from the environment are here again filled with a premeasured quantity of liquid and a premeasured quantity of powder respectively and interdivided by a boundary 5' for isolating the accurately measured liquid and powder from one another until just before a dental filling as the product therefrom is desired for use. This boundary is for the indicated function as well as the function to release the isolation to cause these sealed contents to be mixed together. To this end, the capsule may be prepared by overlapping two flexible, plastic (e.g. polypropylene) sheets for a thickness, say, 0.05 mm and bonding the overlapped sheets permanently except those portions for forming compartments 3 and 4 and boundary 5', the latter being formed by tightly but fluid-pressure releasably bonding the corresponding overlapped portions of the sheets. In this case, the specific manner of bonding the sheets and filling liquid and powder may be that both elongated sides A and A' of the overlapped sheets are permanently bonded and the sheets then semi-bonded along 5' or vice versa. Thence premeasured amounts of powder and liquid (e.g. 1.0 g powder and 0.36 cc liquid, for example, in the case of zinc phosphate cement) are entered into regions 4 and 3 (each with three sides closed) from open ends B' and B, respectively and finally the regions B and B' are permanently bonded to a two-compartment envelope as shown. The semi-bond at 5 is made at an adequate tightness so as not to lose the bond under normal conditions but to do so when a squeezing action is applied to the envelope from region 3 to region 4 at a reasonable compressive force. To make such semi-bond and permanent-bond selectively, a conventional heat sealer is found highly suitable. In the mass production of a number of identical packages as shown, identical bonding or sealing conditions may be followed. To the completed envelope or package, designation of a filling to be made, liquid and powder contents and a specific manner of spatulation procedure may also be printed for the user's convenience.

In FIGS. 4A and 4B, there is shown another form of capsule which is here again a rectangular envelope formed from two plastic sheets permanently bonded along the margin and having releasably separated two compartments 3 and 4 filled with a liquid and a powder, respectively. The liquid-filled compartment 3 may be a tube of a rupturable diaphragm within the outer bag or envelope (FIG. 4B) and in contact with the powder filled compartment 4 as in FIG. 1A, or otherwise may be of membrane integral with the envelope and semi-bonded along boundaries 5'' as in FIG. 4C to separate the liquid from the powder.

Thus, packages for the various types and amounts of various dental fillings can be prepared and distributed to dentists who may merely choose one package adapted for a particular clinical purpose without the need of actually attending to, as heretofore, the work of measuring out starting materials with high accuracy because of high criticality of such accuracy largely influencing the quality of the end product. The package, therefore, eliminates completely not only the dentists' conventional need for such tedious preparatory work but also the deterioration of product fillings due to rough measuring of starting materials or entry of impurity as have been often the case heretofore.

In FIG. 5 there is shown in a diagrammatic view a spatulator 10 for forming a dental filling when used with a package illustrated in the foregoing figures. The spatulator includes a base 11 provided with a planar surface for supporting a package 1 securely in contact thereon with a pair of clamps 12a and 12b. It also is provided with a lever 13 whose one end 14 is hinged at a stand 15 secured to base 11 and its free end 16 is adapted for the user's grip for the spatulation operation. Lever 13 has a cross arm 17 hinged at 18 which serves as a shank supporting a rotary member 19 adapted for free rotation about its axis 20 and the shank is also spring-held with lever 13 as indicated. The rotary member 19 is thus adapted to reciprocatingly roll over the package 1 squeezing the latter against the supporting surface 11 as lever 16 is reciprocatingly swung. The initial compression of the package will rupture diaphragm 5 (FIGS. 1A, 1B, 2 and 4B) or release semi-bond 5', 5'' (FIGS. 3 and 4C) to bring the liquid and powder together within the capsule, with the subsequent squeezing with the roller 19 causing the liquid and powder to be homogeneously mixed together effecting reaction as the compressed zone continuously shifts between the two surfaces 19 and 11, one flat and one convex or round, as shown in FIG. 6. Therefore, unlike the conventional practice, not only is the spatulation advantageously carried out isolated from the humidity of the surrounding atmosphere, but also the heat generated by exothermic reactions is effectively scattered or dissipated by relatively large surfaces which rollingly squeeze the encapsulated mixture between them, with the quality of the resulting product filling bearing practically no dependency on the environmental conditions. Moreover, the spatulation with such an encapsulated mixture permits no entry of any impurity which would be detrimental to the quality of the product filling and does not soil the area used therefor.

Furthermore, the spatulation operation is much simplified and the user may simply repeat such a reciprocating squeeze by a given number, say 50 to 200 times, with substantially a constant time of each reciprocation although such parameters and the entire period for the spatulation are choosen depending on the kind and characteristics of a particular filling desired. Indeed, it has been found that in this manner, fillings of any particular type are prepared practically without variation in quality and of the quality much superior to those having been attainable with standard techniques.

With usual dental fillings as prepared through chemical and curing reactions, the environmental temperature is sometimes or otherwise often critical to the

quality of the filling prepared and applied for a given use where the temperature greatly influence the rates of reactions involved in the paste forming stage. While with the present invention, the heat generated by the exothermic reactions is effectively scattered and thus such reactions are advantageously held to proceed at moderate rates while the individual starting materials are brought into contact and spatulated together, it is sometimes desirable to control the environmental temperature especially where the latter differs much from an optimum or standard temperature at which particular filling materials are made into pastes. For such situations, a temperature control may be made here by maintaining the temperature of plate **11** at a desired value (e.g. circulating a temperature of plate **11** at a desired value (e.g. circulating a temperature-control fluid therethrough of contacting a temperature control electronic element thereto) or preferably immersing in a temperature-control fluid the region of capsule **1** subjected to compressive squeezing action.

In FIG. **7**, there is shown another form of hand-operated spatulator according to the present invention. This embodiment includes a rotary member **119** which is rotatably supported by a grip **116** via a shaft **125** which is journaled either on roller **119** or grip **116** and secured with the other. On a spatulating plate **111**, there is secured a package **1** such as is shown in FIG. **3** with a pair of spring clamps **112a** and **112b** stretching the package between them and the user may hold the package in a position and in contact with a supporting surface **111** with two fingers of his left hand. The operator may hold grip **116** with his right hand, bring rotary member **119** upon the package **1** and squeeze the package against surface **111**. The peripheral surface of the rotary member is here made sufficiently frictional relative to the surface of package **1** and forming this member of a rubber and providing cracks thereon as shown are found highly advantageous to promote the squeezing action.

The spatulation process according to the present invention may also be carried out, when the economy permits, while passing an electric current of microampere order through the mixture subjected to compressive and squeezing action. To this end, as shown in FIG. **7A** an electromagnet **127** is provided behind spatulation plate **111** as wound by a coil **128** connectable with an alternating-current or pulse sources **129** via switch **130**. It will be seen that the closure of switch **130** causes electromagnet **127** to create an oscillatory magnetic field which by electromagnetic induction creates an eddy current through the mixture spatulated within capsule **1**. This electric treatment is found to yield 15 to 20 percent increase in hardness of resulting cements.

In FIGS. **8** and **8A**, we show a motor-operated spatulator using a pair of rotary members **1** and **2** for compressively squeezing a capsule between them as they are relatively displaced. In this spatulator, the capsule is clamped on the periphery of first rotary member **1** along **1*b*–1*c*** as shown FIG. **8A**, adapted in contact with the periphery of second rotary member **2** whose shaft **2a** is rotatably secured to an arm **3** which at its one end **3*a*** is hingedly as secured to a cover table **9**. The other end **3*b*** of this arm is biased by a tension spring **4*a*** connected with a biasing means so as to urge rotary surface **2** against first rotary member **1** at a suitable pressure adjusted by biasing means **4**.

The drive means for these rotary members comprises a motor **5** mounted on base **8** and whose output shaft is connected by a reduction transmission **6** with the shaft **1*a*** journaled through bearing **9*b***, to rotate the first rotary member **1** in one direction and to inductively rotate second rotary member **2** in the opposite direction by the friction between the contacting surfaces. Such rotary motion is preferably reciprocal rotary motion and, to this end, a rotation reciprocator **7** is provided for motor **5** and can be such that a predetermined angle of rotation in one direction of motor **5** operates a limit switch to reverse the direction of rotation of the motor.

In order to enable the operation in a temperature controlled condition which, as set forth earlier, is desirable when the environmental temperature differs considerably from an optimum or standard temperature at which the spatulation is to be made, the apparatus may be equipped with a suitable temperature control means. To this end, a housing **10** is here mounted on cover table **9** for reception of a coolant or temperature control liquid as supplied through a conduit **11** and a valve **12** and a suitable gasket **9a** is provided to prevent leakage of the liquid which immerses rotary members **1** and **2** and the region of spatulation.

In operation, after a capsule is clamped on the specific location of the periphery of first rotary member **1**, bias means **4** is adjusted to urge second rotary member **2** against the first at a pressure which would be sufficient to release the separation of the divided contents within the capsule when the latter is brought into the interface of these relatively urged members. Container **10** is mounted on cover **9** with gasket **9*a*** and a fluid is fed into the container from pipe **11** by opening valve **12** until rollers **1** and **2** are sufficiently immersed within the liquid. Then, motor **5** is switched into drive and rotary member **1** carrying the package is reciprocatingly turned by an angle while rotary member **2** is inductively turned by the corresponding angle to reciprocatingly squeeze the capsule progressively compressed between them. The pressure increase of the liquid compartment during the initial turn will release the separation between the liquid and powder which are then homogeneously spatulated in situ within the confined space of the capsule by holding motor **5** in operation for a given time period. Therefore, the quality of the resulting product filling is totally independent of the user's skill.

In the embodiment shown in FIG. **9**, a capsule is again held on a rotary member **1** but a pair of other rotary members **2** and **2'** each with a diameter greater than that of rotary member **1** are used to squeeze the capsule as the latter carried on first rotary member is urged against the other two rotary members alternately. Rotary member **2** is rotated in one direction by a motor **18** through a pulley **14*a*** continuously and rotary member **2'** is rotated in the opposite direction by a pulley connecting same with rotary member **2**. A cam **13** is provided driven by a motor **18** synchronously with rotary members **2** and **2'**. First rotary member **1** is rotatably held by a support member **1*b*** which extends through a leaf spring **16** to an arm **15**, these members being hinged at **15*a*** and the one end of arm **15** being in contact with cam surface **13** as urged by expansion spring **17**.

In FIGS. 10 and 10*a*, we show another form of method and apparatus for performing the spatulation of an encapsulated filling material in accordance with the present invention. In this embodiment, a capsule is held on a planar surface 2 as in some of previous FIGURES and squeezed thereagainst by a rotary member 1. The rotary member 1 has a shaft 1*a* rotatably journaled and resiliently held by spring 4 in an aperture 3*a* formed in an upright extending arm 3. The lower end 3*c* of this upright arm is pivotally secured to the lateral face of machine base 8 and hinged to make the arm 3 swingable in a plane perpendicular to spatulation surface 2*a*. Intermediary of the upper end portion 3*a* and the lower end 3*c*, the arm is formed with an elongated aperture 3*b* of a length substantially equal to the diameter of a disk 5 as will be described. The disk 5 is rotated via a reduction transmission 7 by a motor 6 mounted on the base 8 and has on one of its face a protrusion 5*a* as shown which is adapted to be slidably engaged in aperture 3*b* so that the rotation of motor 6 causes protrusion 5*a* to travel along a circle while being slidably held in aperture 3*b* of the arm 3 which thus reciprocatingly swings over an angle about hinge 3*c* to cause rotary member 1 to reciprocatingly roll over surface 2*a* by friction compressing the package thereagainst under a pressure effected by spring 4.

In FIG. 11, there are shown rotary members of various forms which may be used with the foregoing apparatus. Each of these rotary members may be made from a plastic and preferable from a material having a high thermal conductivity such as aluminum to dissipate the heat generated by reactions to the extent that such reactions are carried on at a controlled rate. Also, if desired, a cooling element may be embedded in the rotary member.

We claim:

1. A method of preparing a dental filling in paste form from a plurality of starting materials including a liquid and a powder, comprising the steps of:

encapsulating within a flexible-membrane-formed bag premeasured quantities of said liquid and said powder with one separated from the other therein,

providing a compressive motion onto said bag by squeezing it between a flat surface and a convex surface at a pressure and of character sufficient to release said separation, thereby causing said liquid and powder to be successively brought into contact and mixed together to form a paste within the confined space of said bag, the zone of compression shifting progressively over the bag to cause the paste to be spatulated within said bag, and

applying an oscillatory magnetic field to said bag and the mixture therein as said bag is being squeezed, said magnetic field inducing an electric current of microampere order to pass through said mixture.

2. A method of preparing a dental filling in paste form from a plurality of starting materials including a liquid and a powder, comprising the step of:

encapsulating within a flexible-membrane-formed bag premeasured quantities of said liquid and said powder, providing a separation barrier between them,

exerting a squeezing force on the bag to rupture the separation barrier and to mix the liquid and powder together to form a paste within the confined space of the bag, while shifting the force progressively over the bag to cause the paste to be spatulated within said bag, and

applying an oscillatory magnetic field to said bag and the mixture therein while said squeezing force is being exerted, said magnetic field inducing an electric current of microampere order to pass through said mixture.

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