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IMPRESSION MATERIAL

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This invention relates to an improvement in impression materials, particularly dental impression materials, from which positive models, such as models made of plaster of Paris, are to be taken.

Where the positive model must be exactly like the original model from which the impression was taken, or where only very small tolerances are permitted, it is not only necessary that the impression material be capable of taking an exact impression, but the impression material must yield a durable plaster counterpart of the original model. This means that the finished plaster model must be capable of withstanding considerable handling without being worn more than the tolerances permit. Perhaps the best example of a plaster model which must be perfect in form and also resistant to wear is the model made from an impression of the oral cavity on which the dentist prepares his patient's bridges and replacements. It can readily be seen that an impression material which yielded a perfect plaster positive would be useless if the impression material itself imparted a soft surface to the plaster, rendering it incapable of being handled without considerable wear. The purpose of the present invention is to overcome this difficulty.

Therefore, a principal object of this invention is to provide an improved impression material capable of taking a reasonably exact impression of an original model which impression will yield a substantially perfect, durable counterpart of the original model.

A type of impression material in which my invention may be advantageously used is that in which soluble salts of alginic acid are used as elastic binding materials. These impression materials usually contain (1) a gel forming material, such as the soluble salts of alginic acid, (2) an ingredient to cause congelation of the gel forming material, such as the soluble or slightly soluble salts of calcium, barium, beryllium, strontium, aluminum, cadmium or zinc, (3) an inert, or substantially inert filler to provide the necessary body and structural strength for the resulting congealed mass, such as magnesium carbonate, calcium carbonate, kaolin, powdered silica, titanium dioxide, china clay, diatomaceous earth, calcium citrate, tri-calcium phosphate, and di-calcium phosphate, and (4) an ingredient the function of which is to control the period of congelation within any desired limits. Members of group 4 are, for convenience, called retarding agents; they comprise water soluble salts of acids the anions of which form insoluble or slightly soluble

precipitates with calcium or the other gel accelerators of group 2.

These ingredients, as some or all of them may be used together, perform their functions in the presence of an aqueous medium, preferably water, wherein certain materials dissolve and then react to form a gel or perform other characteristic functions. Prior to forming a complete mixture in the aqueous medium, the said ingredients and the liquid may be provided each individually or in various mixtures, short of the final reacting one. A dry mixture of all of the ingredients is preferred.

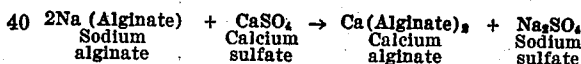
A typical impression material prepared from the above materials is the following:

Example I

	Grams
Sodium alginate.....	4
Magnesium carbonate.....	24
Calcium sulfate.....	4.5
Tri potassium phosphate.....	1.5

The entire mass is finely powdered and mixed to a homogeneous mass and is then mixed with water in the amount of substantially one part by weight of the dry ingredients to about two and one-half parts by weight of water. The mixture is stirred and worked rapidly with a spatula for about two to three minutes to maintain in paste form the homogeneity of the powder. The paste thus prepared is then ready for use in taking impressions and will set to a firmness permitting removal in from about 1½ to 3 minutes.

The principal reacting substances in this example are calcium sulfate and sodium alginate, and the mechanism is that of a double decomposition reaction:



Manifestly, the alginate will gel or "set up" immediately a precipitating ion, such as calcium, is permitted to come in contact with the alginate ion. This period of congelation would be much too short for practical purposes, and the resulting gel would be granular and unsatisfactory. Therefore, it is the practice to extend the period by placing in the field of reaction a material which will precipitate the calcium ions as they are formed until a predetermined period of time has elapsed, after which the congelation reaction will proceed rapidly and completely. The tri potassium phosphate in Example 1 is the retard-

ing agent which exerts this control on the period of congelation of the alginate. The tri potassium phosphate is more soluble than the gel precipitating ingredient (calcium sulfate) and effects its purpose by precipitating the slowly forming calcium ions before they can precipitate the alginate. The delay in congelation is therefore seen to depend upon the quantity of retarding agent used; when practically all of the retarding agent has reacted to precipitate the calcium ions liberated by the calcium sulfate, the subsequently formed calcium ions are free to precipitate the alginate.

Theoretically, all of the phosphate ions liberated by the tri potassium phosphate should be precipitated from solution by the calcium ions before the latter are used to precipitate the alginate. However, in practice it appears that this is not true and that some phosphate ions are left in solution after the gel has set. The practical drawback to such a condition is that such ions work their way to the surface of the impression mold and there react with calcium ions liberated by the plaster of Paris poured into the mold with the resultant formation of insoluble calcium phosphate. When the plaster of Paris model is removed from the impression mold it carries with it the layer of calcium phosphate thus formed; subsequent handling of the plaster model will remove this soft, powdery layer of calcium phosphate, rendering the plaster model smaller than the original model. Consequently, when it is required that the plaster model be substantially identical in size and contour with the original model, as in the case of a dentist's impression of his patient's mouth, impression materials prepared as outlined above are not satisfactory.

It is believed that the above difficulty arises somewhat as follows: When the ingredients of Example I are placed in the specified quantity of water, the tri potassium phosphate quickly dissolves and distributes itself rather evenly throughout the mass of the paste which is formed. The calcium sulfate is much less soluble and is distributed through the paste as a solid, rather than in the ionic form; it, however, is continuously supplying calcium ions to the solution which are theoretically precipitated by the phosphate ions. As a matter of fact, some of the calcium ions are first met by the alginate ions and are precipitated as calcium alginate, although the gelling effect of this precipitation is not pronounced as long as many of the calcium ions are taken out of the field of reaction by the phosphate ions.

The retarding agent is gradually used up, and as its concentration becomes less, its rate of reaction becomes much slower, whereby the gelling occurs before complete disappearance of the phosphate or equivalent anions. Also, the concentration of calcium or equivalent cations from the gel-precipitant always remains low, because it is constantly being removed by the alginate in forming gel. These two low concentrations of calcium ions and of phosphate ions, or their equivalents, operate to delay the formation of the insoluble form of calcium phosphate or other salt of a metal cation from the gel-precipitant and an anion of the retarding agent.

Of course, the purpose of the tri potassium phosphate is not entirely defeated—a given quantity of tri potassium phosphate will effectively delay the formation of a stiff gel of calcium

alginate—but the character of the medium in which the tri potassium phosphate and calcium sulfate are expected to react prevents the complete precipitation of phosphate ions as calcium phosphate.

The remaining phosphate ions are then free to work their way to the surface of the impression and to form calcium phosphate at the plaster-mold interface resulting in the soft, powdery plaster surface above adverted to.

Where the retarding agent used is a soluble carbonate, citrate or oxalate instead of the phosphate, the same difficulties arise, the only difference being that instead of calcium phosphate, the corresponding carbonate, citrate or oxalate is formed at the plaster-mold interface.

I have discovered that the soft, powdery surface of the plaster model can be completely corrected by the use of a quantity of ignited calcium sulfate instead of an equivalent quantity (bulk) of inert filler. Ignited, or "dead-burned" calcium sulfate does not have the pronounced gel-precipitating properties of ordinary calcium sulfate (hydrated) since the ignition lowers its solution-rate considerably, thereby permitting release of only relatively few calcium ions in a given time. However, ignited calcium sulfate does ionize sufficiently to precipitate all stray phosphate ions in the impression mixture before the mixture takes a permanent set, and in so eliminating stray phosphate ions assures a hard, smooth, durable surface on the plaster model made from the impression.

It is seen, then, that the present invention is directed particularly to improving the quality of the plaster model made from the impression mold, which improved quality is not attainable with known impression materials.

All of the examples below illustrate operative forms of my invention, and are prepared and used in the manner set forth in connection with Example I. In the following examples two varieties of calcium sulfate are used: hydrated calcium sulfate, which is the alginate precipitant, and ignited calcium sulfate, which is employed as a substitute for part of the inert filler and which has the function to precipitate stray phosphate ions after the gel has taken its initial set. Of course, the ignited calcium sulfate will also act as a gel precipitant, but only to a small degree because of its slow solution rate.

Example II

	Grams
Calcium carbonate	25.0
Calcium sulfate, ignited	40.0
Potassium alginate	4.0
Calcium sulfate, hydrated	0.20
Tri sodium phosphate	0.2

Example III

	Grams
Magnesium carbonate	12.0
Calcium sulfate, ignited	40.0
Potassium alginate	4.0
Calcium sulfate, hydrated	0.20
Tri sodium phosphate	0.2

Example IV

	Grams
Magnesium carbonate	7.0
Calcium sulfate, ignited	40.0
Potassium alginate	4.0
Calcium sulfate, hydrated	1.0
Tri sodium phosphate	3.5

Example V

	Grams
Magnesium carbonate.....	7.0
Calcium sulfate, ignited.....	30.0
Potassium alginate.....	4.0
Calcium sulfate, hydrated.....	1.0
Tri sodium phosphate.....	3.5

Example VI

	Grams
Magnesium carbonate.....	7.0
Calcium sulfate, ignited.....	50.0
Potassium alginate.....	4.0
Calcium sulfate, hydrated.....	1.0
Tri sodium phosphate.....	3.5

Example VII

	Grams
Magnesium carbonate.....	5.0
Calcium sulfate, ignited.....	40.0
Potassium alginate.....	4.0
Calcium sulfate, hydrated.....	1.0
Tri sodium phosphate.....	3.5

Example VIII

	Grams
Magnesium carbonate.....	10.0
Calcium sulfate, ignited.....	40.0
Potassium alginate.....	4.0
Calcium sulfate, hydrated.....	1.0
Tri sodium phosphate.....	3.5

Example IX

	Grams
Magnesium carbonate.....	7.0
Calcium sulfate, ignited.....	40.0
Potassium alginate.....	4.0
Calcium sulfate, hydrated.....	0.5
Tri sodium phosphate.....	3.5

Example X

	Grams
Magnesium carbonate.....	7.0
Calcium sulfate, ignited.....	40.0
Potassium alginate.....	4.0
Calcium sulfate, hydrated.....	1.0
Tri sodium phosphate.....	5.0

The above formulas produce impression pastes which "set" in from about 3 minutes to about 6 minutes. An increase in the hydrated calcium sulfate content will decrease the "setting" time; an increase in the tri sodium phosphate (retarding agent) content will increase the "setting" time.

While all of the above examples illustrate the application of my invention to alginate impression materials, it is to be understood that the principle set forth is applicable as well to any impression material containing ions, the calcium salts of which are insoluble, when plaster of Paris is to be poured into molds made from such impression material.

Having described my invention, what I claim and desire to protect by Letters Patent is:

1. An impression material capable of yielding durable, hard-surfaced plaster forms cast in molds made thereof, which impression material comprises a soluble alginate, a gel-precipitating quantity of hydrated calcium sulfate, tri sodium phosphate, magnesium carbonate, and dead-burned calcium sulfate.

2. An impression material comprising essentially

	Parts by weight
Calcium carbonate.....	About 25
Calcium sulfate, dead-burned.....	About 40
Potassium alginate.....	About 4
Calcium sulfate, hydrated.....	About 0.20
Tri sodium phosphate.....	About 2

3. An impression material capable of yielding durable, hard-surfaced plaster forms cast in molds made thereof, which impression material comprises a soluble alginate, a gel-precipitating quantity of hydrated calcium sulfate, a gel retarder salt in small quantity providing an anion reactive with calcium ions to form an insoluble salt, dead-burned calcium sulfate, and inert filler, the dead-burned calcium sulfate providing calcium ions of late arrival to cleanse the formed gel of residual anions.

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