speak cleanliness and an idea of purity never associated with an alloy, hence gold-filled teeth are of healthier appearance than are the amalgam-filled. Impression of refinement and of delicacy as conveyed by teeth golden strikes all; amalgam lacks in affording social classification; it impresses disagreeably. We place our individual opinion in a single line by saying that gold, when not contraindicated, is the material with which human teeth are always to be filled. Saying this, we are to be understood as recognizing the existence of conditions constantly being met with where gold is flatly unable, however well worked, to preserve teeth.*

Gutta-percha.—Like amalgams, various preparations of gutta-percha are

* Chemistry of Amalgams.—To some extent most metals are capable of combining with each other in definite proportions. Their chemical affinity is for the most part very feeble and easily disturbed. The more unlike metals, the more stable their compounds.

Amalgams, as understood, are alloys containing mercury. Combinations of mercury with other metals result in a liquid or varying solid, according to the proportions. Heat decomposes all amalgams. In ordinary use iron and platinum are the only metals which can be brought in contact with mercury without being corroded by it; however, quicksilver adheres to platinum. It is found that if a little amalgam of sodium be added to metallic mercury, it gives to it the power of adhering much more readily to other metals; even it will adhere to iron.

By experiment it has been found that the following definite proportions can be obtained:

Amalgam of Iron, FeHg.
" " Silver, AgHg.
" " Lead, Pl_2Hg.
" " Zinc, Zn_2Hg.
" " Copper, CnHg.
" " Platinum, $PtHg_2$.

There is a native amalgam of silver found associated with mercurial and silver ores, $AgHg_2$, in dodecahedral crystals. Beautiful crystals of amalgam of silver, having the composition Ag_2Hg_3, are to be obtained by dissolving 400 grains of nitrate of silver in 40 measured ounces of water, adding 160 minims of concentrated nitric acid and 1840 grains of mercury; after a few days crystals of from two to three inches in length will be deposited.

As an illustration of proportions in amalgam one or two formulæ may be cited: 1. To promote the action of electric machines, mercury 6 parts, zinc 1 part, tin 1 part. 2. For the silvering of glass, mercury 1 part, tin 4 parts.

Mercury combines very readily with bismuth. Heat a mixture of 497 parts of bismuth, 310 of lead, 177 of tin, 100 of mercury. This makes an amalgam solid at ordinary temperature, melts at 171.5° F., and solidifies at 140°. This is often used in injecting delicate anatomical preparations.

Whenever mercury is combined with potassium and sodium there is always a disengagement of heat; the resulting amalgams have a pasty consistence, and decompose water.

Tin, lead, and mercury, when heated together and left to cool slowly, yield a solid crystalline amalgam of definite constitution.

Gold unites peculiarly with mercury; even a large quantity of gold does not affect its fluidity. Where mercury is saturated with gold the result is a mass of waxy consistence.

When 1 part of gold is dissolved in 1000 of mercury, the combination being pressed through chamois leather and the residue treated with dilute nitric acid at a moderate heat, there is obtained a solid amalgam, Au_8Hg, in shining, four-sided prisms which retain lustre in the air.

There is also a ternary combination of hydrogen, mercury, and nitrogen.

used in dental art for the purpose of stopping carious teeth. Two varieties are white and red; of these there are sub-varieties, having their distinctive features either in the temperature at which they become plastic or by reason of admixture with other substances.

Compatibility with tooth-bone is markedly characteristic of gutta-percha. The article assuredly has an advantage over the metals in that it is purely a non-conductor of thermal changes. While gutta-percha is in a tooth cavity there is no interference with nature's process of recalcification, even if there is little excitation of the act. Were it not because of an inability to resist the wear of mastication, no plug would surpass one made of gutta-percha as a tooth preserver.

Gutta-percha is resistive in proportion as it is tough and of high softening point. In proportion as it is resistive, it is adapted to the office of a tooth-plugging material.

Brittleness in gutta-percha expresses porosity, the cause being an over-admixture of foreign inorganic substances, such as oxide of zinc, silex, quick-lime, etc.; on this account, if on no other, a brittle preparation is to be refused. Great attention is being paid at the present time to the manufacture of the material. To secure the best quality, one is to apply to a reputable maker, or, what is still better, test each purchase for himself by means of a spirit-lamp and water-box. Stickiness in a specimen, when hot, is one of its greatest virtues.*

* Test of Quality.—Dental preparations of gutta-percha are reasonably to be divided into grades, these grades referring to degrees of solidity. The form of preparation most in use is procured from the depots under the name of base plate; of this there is much that is very good for the purpose of filling teeth and plenty that is not so good. Base plate, lacking admixture with other substances, is valuable in proportion to its possession of a high softening power; this refers more especially to preparations made particularly for plugging purposes. Plasticity of gutta-percha, and of its dental combinations, is secured at a temperature varying from 112° Fah. to 235°. Easy plasticity is attained at the expense of durability; it expresses over-softness. Resistance to softening implies over-combination with inorganic substances, which is quite as inimical to satisfactory results as is over-softness. The best gutta-percha for filling teeth lies in a quality that approaches 180° and is unmixed with other material.

The grade of a gutta-percha is measured, as the unmixed variety is concerned, by using a flat boiler, or any convenient means representing one, and after laying the specimen to be tested upon it, heat the water by use of a spirit-lamp; a thermometer bulb related to the water of the cup or boiler shows the extent of heat. Plasticity obtained below 150° is not acceptable for surface plugs, but is found useful in filling canals. Plasticity standing at 180° allows of the making of a plug which, while not as resisting as the mixed gutta-perchas of higher grade, is eminently conducive to tooth preservation.

Dry testing, a manner that has to be used with the mixed varieties, the grade of which is above the boiling-point of water, is to be esteemed as injurious to the specimen; hence a conclusion that grades of gutta-percha requiring to be softened by means of hot plates are not apt to prove serviceable. It is not, however, to be understood that the material may not be softened after this latter method without injury, but it seems to be a quite common experience that it is likely to get burned or otherwise deteriorated.

To dry test gutta-percha, take a specimen and lay it upon a metal, or preferably, a por-

Combinations with gutta-percha are illustrated in a very familiar tooth-plugging material, known as Hill's stopping. In this agent the gutta-percha has worked into it definite proportions of quicklime, feldspar, or other inorganic material. As an agent for filling children's teeth it is in much favor. It is also used freely in frail adult teeth.

Gutta-percha, alone or in combination, recommends itself in that multitude of cases where patients are undergoing what might be called a season of dental metamorphoses. These seasons are familiar to every observing practitioner of the dental art. A set of teeth, good for previous years, suddenly, and without observable change in the constitution, take on decay. To fill such teeth with expensive material is to incur great cost to the patient, with a certainty as well to the operator that what is done will prove of little avail ; that it will require quickly to be done over. Such failure certainly comes to the dentist who fails to appreciate that his operations are directed alone to effect, not to cause. The inexpensiveness, the easy manner of introduction, and the quickness with which gutta-percha is to be removed from teeth and replaced, render the material one of pre-eminence for selection in such cases.

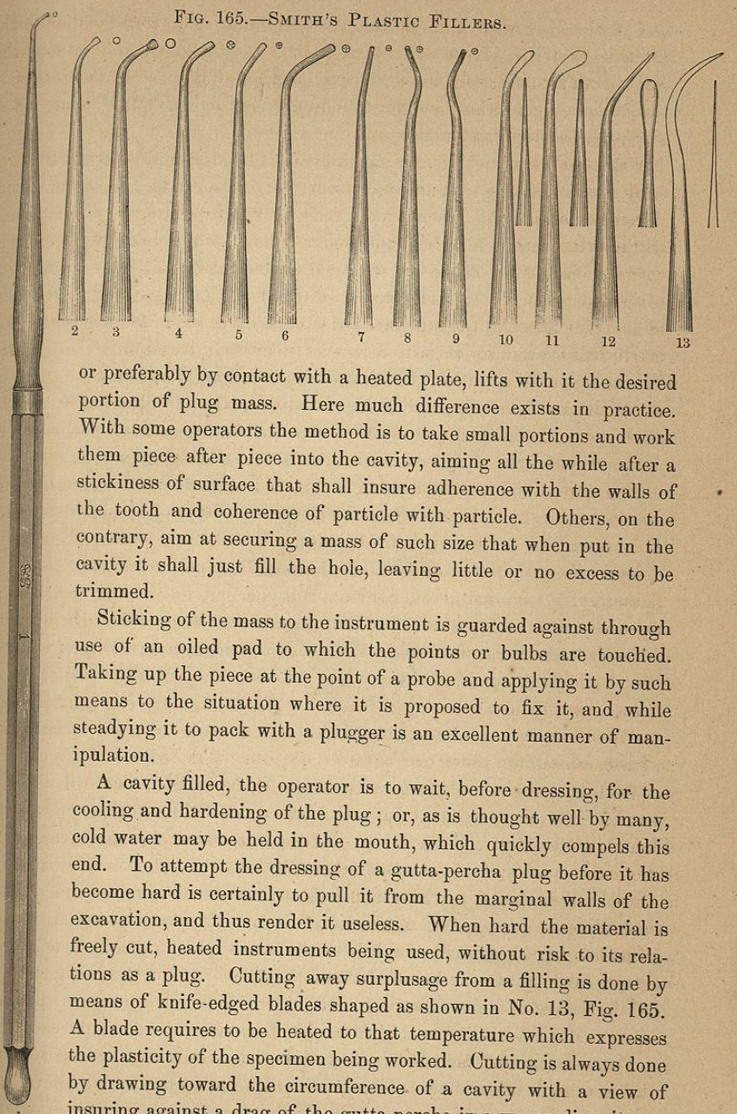
Red gutta-percha has seemed to the writer to possess virtue as a tooth conservator not enjoyed by the white. The latter, however, is commonly selected to be used with front teeth for the reason that it calls less attention to the defect. To prepare the first, it is desirable to heat and soften it by means of hot water. Any convenient means to this end may be adopted, it being understood that the material is not to come in immediate relation with the moisture. A metal cup filled with water, the cover serving as a plate to hold the plastic, a ring and stand to support this cup, a spirit-lamp for purpose of heat, constitute an admirable apparatus. White gutta-percha is made ready for the tooth by exposing it, upon a plate of tin, silver, or mica, to the action of a flame acting on it from beneath. (See foot-note.)

Instruments.—Special instruments are required for a proper use of gutta-percha. Of many different patterns, preference would not unjustly be given the D. D. Smith set. (Fig. 165.) These instruments are employed by the deviser for all kinds of plastics; they are here commended particularly in connection with the material under consideration. Nos. 1, 2, and 3 have smooth heads. Nos. 4 to 9 are dully serrated. No. 6 is for distal cavities in molars and bicuspidati. Nos. 10 and 11 are spatulæ for carrying and inserting the material, and used also as burnishers. No. 12 finds its exclusive use for mesial and distal cavities. No. 13 is a cutting instrument for trimming excess of plug from cervical margins.

Introduction of Material.—A cavity made ready, the operator takes up the selected instrument, and gently warming it by means of his spirit lamp,

celain plate, apply now the flame of a spirit-lamp from the under surface, and bring the heat up in the most gradual manner. The proper place for the relation of flame with plate is the farthest possible point away from the plastic. To apply heat immediately beneath a specimen is almost certainly to bubble or burn it.

FIG. 165.—SMITH'S PLASTIC FILLERS.



or preferably by contact with a heated plate, lifts with it the desired portion of plug mass. Here much difference exists in practice. With some operators the method is to take small portions and work them piece after piece into the cavity, aiming all the while after a stickiness of surface that shall insure adherence with the walls of the tooth and coherence of particle with particle. Others, on the contrary, aim at securing a mass of such size that when put in the cavity it shall just fill the hole, leaving little or no excess to be trimmed.

Sticking of the mass to the instrument is guarded against through use of an oiled pad to which the points or bulbs are touched. Taking up the piece at the point of a probe and applying it by such means to the situation where it is proposed to fix it, and while steadying it to pack with a plugger is an excellent manner of manipulation.

A cavity filled, the operator is to wait, before dressing, for the cooling and hardening of the plug ; or, as is thought well by many, cold water may be held in the mouth, which quickly compels this end. To attempt the dressing of a gutta-percha plug before it has become hard is certainly to pull it from the marginal walls of the excavation, and thus render it useless. When hard the material is freely cut, heated instruments being used, without risk to its relations as a plug. Cutting away surplusage from a filling is done by means of knife-edged blades shaped as shown in No. 13, Fig. 165. A blade requires to be heated to that temperature which expresses the plasticity of the specimen being worked. Cutting is always done by drawing toward the circumference of a cavity with a view of insuring against a drag of the gutta-percha in a wrong direction.

Gutta-percha is supplied by manufacturers for tooth-filling purposes in the various forms of squares, blocks, pellets, and disks.

The Oxychlorides.—The oxychloride is a plastic made by mixing dry

oxide of zinc into a watery solution of chloride of zinc. As met with in the dental depots it consists of a powder and fluid, occupying different bottles.

Of this plastic the variety offered is greater even than that of the amalgams. A single formula affords not only an idea of the composition of all, but, as well, a recipe which secures a preparation equal perhaps to any.

Recipe.—For the powder, simple French oxide of zinc.

For the fluid, aquæ, ℥vi; zinci chloridi, ℥j. After mixing water and zinc chloride the solution is to stand uncorked twenty-four hours.

An oxychloride plug, when prepared as above, is absolutely white, or so nearly colorless as not to accord with many teeth in which it may be desired to use it. Shade to suit is secured by addition to the powder of scraped slate, or preferably, in the judgment of others, by ochre. Another element, used in many preparations with a view of increasing hardness of surface, is borax. Still others are feldspar, flint, silex, titanium, alumina.

Taking oxychloride of any formula, that is, taking from a bottle which contains dry oxide of zinc and from another holding a watery solution of chloride of zinc, the preparation of a mass for tooth-plugging purposes is nothing more complex than making a mixture of powder and fluid upon a glass slab, using for the purpose a knife-blade or an ivory or a platina spatula; the consistence is to be that of fresh putty.

For use in frail and poor teeth oxychloride has much to commend it. It will support a weak tooth and harden a soft one. It will whiten one that is dark and purify one that is foul. There is a multitude of cases in which no filling material but this will save a tooth. It is a therapeutical filling; it does very much more than stop a hole. Not understood or properly managed, it becomes quickly an agent of evil.

Viewed mechanically, an oxychloride filling is made very much the same as one of amalgam. It is not, however, necessary to tap-blow it. Preparing the paste, which, for therapeutic reasons, is to be mixed thick or thin, the operator lifts upon an instrument a portion corresponding in size with about a fourth of the cavity to be filled; this he introduces, obtunding the pain which almost instantly follows, and at the same time forcing the material into all the irregularities of the hole by means of a pledget of bibulous paper used as a ball in the grasp of a pair of finger forceps. This use of bibulous paper with the first portion is never to be omitted by a student, otherwise the price paid for his neglect may be the loss of the tooth upon which he operates; the paper takes up any excess of the chloride; which is a powerful irritant.

Of the different filling materials used in dental art, none requires more absolute freedom from moisture, both at time of making a plug and the setting of it, than an oxychloride. It is seldom, however, that the trouble of coffer-damming a tooth is required. The material being easy and quick of introduction, a napkin, aided by a free use of bibulous paper, is all that is commonly found necessary.

A plug in place, setting is to be expedited by pressure with an absorptive pad.

Once solidified, perfect protection against the fluids of the mouth is secured by dropping upon the filling from the point of an excavator a solution of gutta-percha made by dissolving that gum in chloroform. A skin of gutta-percha thus secured remains intact for a period varying from several hours to several days.

A secondary mechanical use is found for the oxychlorides in employing them as a foundation for metal fillings. A great cavity partly filled with this paste is of better promise than where metal alone is used; this applies in every instance where such combination does not interfere with the ability to anchor metals solidly. Still another good service is rendered by this material as a facer of amalgam plugs in anterior teeth. Another use is as a capper of nearly exposed pulps. Cements of this class are prepared particularly for this purpose; they set quickly and may be used so creamy as to be poured into a cavity. One such preparation, known as "Foundation Cement," hardens sufficiently in from two to five minutes to allow of packing gold or other filling material upon it.

Oxychloride fillings are not to be esteemed as of permanent signification. Two years is quite as long as any exposed plug of this class may be expected to last. They continue longest in mouths that are acid. The manner of their disappearance is by crumbling and wearing.

An oxychloride filling when thoroughly dry will take a polish by being burnished gently with heated talc; unfortunately, such polish quickly disappears, consequently is of no service.

Oxychloride is invaluable as a means of strengthening the weak walls of dental cavities. An incisor or other tooth, for example, having the dentine almost completely decayed away from the circumferential enamel walls is fortified satisfactorily by a lining of oxychloride, and is then to be filled with gold without danger of fracture. As a hardener of chalky teeth its value is well known; soft and septic organs are always to have a filling of gold preceded by one of oxychloride. Caries rarely progresses in presence of immediate contact of the part with oxychloride. (See chapter on *Filling Teeth.*)

Zinc Phosphates.—The zinc phosphates closely resemble the oxychlorides in common appearance and manner of working.

A phosphate-of-zinc filling is made by mixing glacial phosphoric acid and basic oxide of zinc in proportions affording a mass of putty-like consistency. The common time of setting is two minutes.

Difference in the quality of this stopping is assumed to be influenced more by the quality of the materials named than by admixtures with other agents, many samples, both of acid and base, being so imperfectly made as to be worthless for purposes of cement. The trouble and uncertainty of preparing the syrup renders purchase, rather than attempt at making, desirable.

Phosphoric acid being less an irritant than chloride of zinc, fillings made with it are less dangerous, necessarily, as well less therapeutic, than those made of the oxychlorides. A claim for superiority on the part of a phosphate-of-zinc plug lies in the direction of hardness.

Forms of phosphate filling material in the market which have attained to most prominence are Flagg's, Peirce's, Fletcher's, Weston's, Poulson's.

It is to be mentioned that there are in the depots forms of cement which claim to be something besides either of these just named. One, Guillois's preparation, is known to the commercial world in the form of imitation coral, sleeve-buttons, shirt-studs, etc. Another, Weston's Insoluble, has prominent claims put forth with it. Both preparations possess worthy indorsement.

Still other articles of the kind are the "Cement Plombe" and the "White Enamel Stopping" of Oehlecker. The former finds many to recommend it; the latter has an advancing reputation. Directions for manner of use accompany the preparations.

From the employment of oxide of zinc as a base manufacturers of zinc phosphates are passing to the employment of the nitrate; this latter is found to secure a greatly increased stableness in the compound.

The syrup used in kneading the powder of fillings of this class is to be fresh and of specific character; when old it is over-thick or otherwise rendered useless by being found separated into fluid and sediment.

Zinc phosphate is wisely to be dismissed with a suggestion that the material, as at present understood, is commonly found to prove disappointing.

Tin.—Tin is furnished in form of foil. In color this foil is like the metal as met with in commerce. As a filling material quality is in accord with purity. When freed from alloys, tin furnishes the dentist with an agent which serves a wide purpose,—much less wide, however, than previous to the introduction of gutta-percha and the chloride plastics. As the use of metals is concerned, tin is undeniably, in case of soft teeth, eminently superior to gold as a preservative. It is easy of introduction into a cavity, and, as compared with the nobler metal, pre-eminently easy of a required consolidation.

Tin is prepared in sheets of various numbers, these numbers giving the thickness of the leaf. From Nos. 4 to 10 are commonly used; higher numbers are 14, 18, 20, the latter being the highest.

For use in children's first teeth, particularly the molars, tin foil is an admirable article; certainly in every way preferable as irritative qualities are concerned, the metal being peculiarly in accord with tooth-substance.

Tin foil is used precisely as gold foil; forms of it are in the market, both soft and cohesive. (See *Gold.*)

Plastic Tin.—Plastic tin is a preparation of the metal which is used by amalgamating with mercury, employing for the purpose 48 parts of the latter to 100 of the former. It is not to be washed nor squeezed. Neither is alcohol to be used, but it is to find its cleansing through the aid of zinc precisely as directed in the case of amalgam. This preparation makes a solid cohesive plug, and one that is decidedly therapeutical; it is claimed that it has only one-fourth the conducting power of gold, and that on a scale of 100 it stands 40 degrees nearer to tooth-substance than the latter metal.

Another preparation of tin is known as stannous gold. This material comes prepared in the form of heavy, coarse sheets. It is used precisely as cohesive foil, and works with a plasticity not much inferior to amalgam.

All preparations the base of which is tin deserve consideration at the hands of the operating dentist.

Gold.—We come now to gold, a material which is to be accepted as holding the position *par excellence* as a material for filling teeth,—certainly a material which yields the most artistic and beautiful results, in such respects outranking all preparations used in operative dentistry.

Gold is prepared for the hands of the dentist at the present time in such variety as to form, and with such view as to fitness, as indications are concerned, that in reality the operator finds much of his work anticipated.

A division of gold is into soft and cohesive; the first has a kid-like character and is worked by a process of wedging; the second is sticky: plugs are made of it through a process of cold welding.

Varieties of gold are sheets, mats, pellets, cylinders, blocks, ribbons, twists. These are forms fitting the material for the table of the operator; they are prepared both from the soft and plastic gold. A preparation looking not unlike golden sponge and known as Watt's crystal gold is popular; the working of it differs nothing, however, from that of the kinds now to be described.

Sheets.—A sheet is gold in the form of leaf: it comes to the dentist in books marked variously from Nos. 4 to 240. Number designates the weight of a leaf. High numbers express heavy foils; they are comparatively infrequently used. Low numbers distinguish the preparations most easily worked. From Nos. 4 to 8 are commonly selected. Leaf gold is soft, or non-cohesive, cohesive, and semi-cohesive.

Mats.—A mat consists of a square made by folding leaf gold into a strip, and afterwards cutting it into sections.

Pellets.—A pellet is made by compressing a mat into ball form.

Cylinders.—A cylinder is a form of gold secured by rolling a strip about a broach or common pin.

Blocks.—A block differs from a mat only as thickness is concerned; it is made in the same way.

Ribbons.—A ribbon is leaf gold folded upon itself until a desired width is obtained.

Twists.—A twist is a ribbon coiled upon itself.

All these forms are furnished by manufacturers. Fig. 166 represents cylinders prepared of various lengths and diameter. Those known as Peck's are loosely wrapped, and can be used, if desired, as pellets. Fig. 167 shows forms for mats and blocks.

FIG. 166.—CYLINDERS.