Jan. 17, 1967 R. L. TENCATE 3,298,067

MOLD FOR FORMING DENTURES

Original Filed Feb. 1, 1962

FIG. 1

TAKE IMPRESSION OF PATIENTS MOUTH → MAKE MASTER CAST OF IMPRESSION → FIT AND CONSTRUCT TRIAL DENTURE *Trial Base Plate & Teeth* → WAX UP TRIAL DENTURE TO MASTER CAST → CURE FLEXIBLE MOLD FORMING MATERIAL; THEN BOIL OUT WAX AND CLEAN MOLD → CAP WITH UPPER HALF OF FLASK AND FILL WITH A FLEXIBLE MOLD FORMING MATERIAL → INVEST WAXED UP MASTER CAST IN PLASTER IN BOT. HALF OF FLASK → SEPARATE DENTURE FROM MOLD AND CLEAN → TINFOIL ONLY LOWER PORTION OF MOLD AND FILL WITH DENTURE RESIN

FIG. 2

FIG. 3

FIG. 4

INVENTOR.
Raymond L. Tencate

United States Patent Office 3,298,067 Patented Jan. 17, 1967

3,298,067

MOLD FOR FORMING DENTURES

Raymond L. Tencate, 4947 W. Walton, Chicago, Ill. 60651

Original application Feb. 1, 1962, Ser. No. 170,351, now Patent No. 3,217,067, dated Nov. 9, 1965. Divided and this application Apr. 14, 1965, Ser. No. 459,967
2 Claims. (Cl. 18—34.1)

This application is a division of my application Serial No. 170,351, filed February 1, 1962, now U.S. Patent 3,217,067, issued November 9, 1965.

This invention relates to an improved mold in which dentures may be cast.

Dentures, commonly known as false teeth and dental plates are difficult and intricate devices to fabricate. They must be made to extremely close tolerances for slight errors can result in tremendous discomfort for a patient. The dentures produced in accordance with the teachings of this invention are not only more accurate, but the molds from which they are made and the process by which they are made makes possible more rapid fabrication with less chance of breakage and structural deviation than has been possible with conventional molds and methods.

Many steps take place in fabricating a denture. To provide a background against which the improvements made available by this invention may be more readily understood a brief summary of a conventional procedure for fabricating a denture follows.

First an impression of the desired portion of the patient's mouth using any standard impression material is taken. After the impression sets and has been cleaned it is packed with dental stone. When that hardens and cures, it provides a duplicate of the portion of the patient's mouth of which the impression was taken. That positive is known as a master cast and forms the base upon which the desired denture is constructed.

The master cast is then overlaid with a thin layer of dental wax of the same thickness as the final denture will be. The wax is molded to conform to the master cast and at that stage is known as the trial baseplate. Since a trial baseplate is frequently removed from the master cast and fitted in the patient's mouth, some sort of release agent such as talc must be provided between the master cast and the trial baseplate. When the trial baseplate has been properly conformed to the master cast, the cast and baseplate are positioned on an instrument known as an articulator, an adjustable device which simulates the movement and relative positions of a patient's jaws. The articulator is adjusted to simulate a patient's jaw movement by utilizing wax impressions, known as registrations or records, taken in a patient's mouth by the dentist to enable such adjustment to be made in the laboratory. It is upon this instrument in accordance with well known techniques that the individual teeth are fitted to the trial baseplate. When all of the teeth have been fitted to the trial baseplate, a trial denture results. When the dentist and the technician have become satisfied that the trial denture has been properly constructed and aligned for fit and bite, the trial denture is sealed to the master cast with additional wax in a step commonly known as waxing-up.

The master cast is then invested in the lower half of a metal flask, a frame designed for that purpose, by placing the master cast in the flask and filling the flask with plaster of Paris until the entire lower portion of the master cast becomes surrounded with and embedded in the plaster. The trial denture remains free of the investing medium.

As will become more apparent from the following, it is at this point that this invention and conventional practice part company.

When the plaster has set, the wax portion of the trial

denture and the plaster of Paris itself is tinfoiled, that is covered with a very thin layer of tinfoil or a well known substitute therefor. The purpose of tinfoiling is to form a mold lining or resist membrane to prevent the molding material to be described from contacting and sticking to the trial denture and the plaster of Paris. Thus prepared, the lower half of the flask is covered with its mating upper half and the flask is filled with a molding material such as dental stone or plaster of Paris. When that material has hardened, the flask is immersed in boiling water and the wax of the trial denture and that wax used in the waxing-up step melts while the teeth of the trial denture remain embedded in the hardened molding material now to be referred to as the upper mold. The flask is then opened and the molten wax removed. To insure complete removal of all wax and impurities, the upper mold and the master cast are cleaned with boiling water and detergent. With the wax gone, a space between the master cast (lower mold) and the newly formed upper mold exists. This space will define the shape of the final denture.

The previous tinfoiling step provides a lining for the upper mold. Tinfoil or a tinfoil substitute is then conformed to the lower mold. When used herein the term tinfoil contemplates the use of substitutes as well. Thus prepared, and having had waste gates or escape grooves provided in the land area of the plaster of Paris investing medium, the mold is ready to be filled with denture resin. Most frequently a heat curable acrylic resin formulation having the consistency of a dough is used. The dough is manually packed into the space between the upper and lower portions of the mold and it is usually the case that at least three such trial packings alternated with trial pressings on a denture press are necessary before the mold is finally properly packed. With the trial packings complete the resin is allowed to cure thereby forming the final denture. It is then deflasked, cleaned, polished and made ready for the patient's mouth. Both during curing and during the subsequent removal of the denture from the mold, deflasking, great care must be exercised to avoid excessive pressures or unusual stresses on the mold and its contents.

By following the teachings of this invention a number of the steps just described are eliminated, and more important, generally more accurate, more comfortable dentures are obtained.

Therefore, it is the principal object of this invention to provide a novel mold in which dentures may be fabricated.

It is a further object of this invention to simplify the procedure by which dentures are made and to provide a more accurate means for making them.

Yet another object of this invention is to provide a resilient flexible mold in which dentures may be made.

A further object of this invention is to provide a silicone rubber mold by which more accurate dentures may be fabricated.

The results obtained in the practice of this invention are surprising particularly when it is recalled that it has been the uniform belief in the field of prosthetic dentistry that the harder and less yieldable and flexible a material used as a mold in which to make dentures, the more accurate and reliable would be the dentures themselves. The resilient mold and the resilient mold technique described in this application fly directly in the face of that long accepted belief and practice and makes it apparent that an even higher degree of accuracy is achievable when a flexible resilient mold is used as a medium in which to cast dentures. That is particularly so when the mold is fabricated of silicone rubber.

Of the numerous advantages arising from the practice of this invention, many will be specifically described and

others will become apparent from the following description, discussion and drawings of which:

FIGURE 1 is a flowsheet of the main steps in the preparation of a denture in accordance with this invention;

FIG. 2 is a cross-sectional view of an invested waxed-up master cast in a closed flask which has been filled with the mold forming material of this invention;

FIG. 3 is a cross-sectional view of the mold and flask in which a denture is to be fabricated after all of the trial denture wax has been boiled out; and

FIG. 4 is a cross-sectional view of a flask containing the tinfoiled master cast and the upper mold portion of this invention filled with denture resin.

As has been pointed out, this invention departs from conventional practice after the waxed-up master cast has been invested in the bottom of a flask. It is at that stage that the novel mold in which the final denture is to be cast must be made. FIG. 1 shows all of the major steps followed in fabricating a denture in accordance with this invention.

As best seen in FIG. 2, the mold forming structure includes the lower half of the flask **10**, the master cast **12**, the investing plaster of Paris **14** and trial denture **16** which incorporates trial baseplate **18** and teeth **20**. With that prepared, the novel mold must be fabricated. The upper portion of the lower half of the flask is then filled with a resilient mold forming material **22** and the upper half of the flask **24** is set in place and the flexible mold forming material allowed to cure.

In accordance with a preferred embodiment of this invention, to 100 parts of a room temperature curable methyl polysiloxane of a viscosity of approximately 50,000 centipoises and a specific gravity of 1.13 at 77° F., there is added 0.5 part by weight of stannous octoate, the two ingredients being provided in amounts sufficient to fill the entire unfilled portion of the flask. A methyl polysiloxane and stannous octoate catalyst formulation corresponding to the above description is available from Dow Corning under the designation "RTV 502."

The methyl polysiloxane and catalyst are thoroughly mixed, the proportions stated giving a working period of about 10 minutes and a vulcanization period of about 30 minutes. Those times may be varied by varying the proportion of catalyst used.

A layer of catalyst and methyl polysiloxane mixture is then applied to the entire exposed surface of the invested waxed-up master cast, care being taken to avoid the entrapment of air particularly in the areas immediately adjacent the teeth. Then the entire remaining empty portion of the flask is filled with additional methyl polysiloxane-catalyst mixture and the upper portion of the flask is seated in position. It is to be noted that the laborious, impurity and inaccuracy introducing step of tinfoiling is unnecessary with the mold forming technique of this invention.

When the methyl polysiloxane has cured, the flask is immersed in boiling water for a period of approximately 5 minutes after which it is opened and the wax of the trial denture and the waxing-up step is flushed out with boiling water and detergent, the teeth themselves being retained in the flexible upper mold.

FIG. 3 shows the thoroughly cleaned mold ready to receive the denture resin. It is to be noted that the flexible mold **26** holds the teeth **20**. Space **28** is to be filled with denture resin. Conventional waste gates (not shown), areas into which the molding composition to be described may flow outwardly of the mold, are cut in the land areas of the plaster of Paris **14**. Then, rather than tinfoiling the master cast, the plaster of Paris and the upper portion of the mold which holds the teeth, as has been the practice in the past, it is only necessary to tinfoil or apply a resist membrane to the invested master cast and the adjacent land surface of the plaster of Paris.

When the tinfoiling is completed, a self-curing acrylic denture resin is prepared and mixed in a quantity sufficient to slightly overfill the mold. As was pointed out earlier it has been the customary practice in the denture-making art to use an acrylic resin formulation which forms a partially cured dough which must be trial packed several times. In accordance with the teachings of this invention a self-curing fluid acrylic resin formulation which can be poured directly into the mold and which requires no trial packing is used.

One such suitable acrylic denture resin consists of a mixture of a finely screened spherical methyl methacrylate polymer of a molecular weight of approximately 600,000 and a methyl methacrylate monomer solution of a specific gravity of approximately 0.95. The monomer solution contains small amounts of additional materials and curing agents including ethylene dimethylacrylate and dimethylparatoluidene, each in an amount equal to about four tenths volume percent. Three parts of the methyl acrylate polymer by volume are added to 1 part by volume of the monomer solution and thoroughly mixed. This fluid self-curing mixture is then poured into the mold and the excess squeezed out by exerting pressure against the two halves of the flask in a flask press. The completely closed flask is then held in the flask press under pressure for approximately two hours during which time the acrylic resin fully cures and the teeth formerly held by the silicone rubber upper mold portion become embedded in the acrylic resin. FIG. 4 shows the mold at this point with denture **30** including teeth **20** and plate portion **32**, and resist membrane or tinfoil layer **34**. The denture **30** is recovered by carefully prying open the two halves of the flask at which time the cured denture slips easily out of the silicone rubber mold **26**. The cured denture has an unusually smooth and clean surface.

In accordance with the invention herein described 34 pairs of dentures were fabricated. Additional, 25 pairs of control dentures were fabricated in accordance with conventional practice.

The accuracy of the dentures produced with both the resilient mold of this invention and conventional molding practice was measured by a standard test. As was discussed earlier, an instrument called an articulator is utilized in preparing trial dentures. Besides simulating the action of given patients' mouths, the articulator provides a means for measuring variations in vertical occlusion between the trial denture and the final denture. That measuring means comprises a flat plate and a pin known as the incisal pin. When the waxed-up master cast is ready to be invested it is placed on the articulator, if it is not already there, and the incisal pin adjusted so that it just barely touches the flat plate. That is the zero setting. When the final denture has been made it is seated on the master cast and the assembly placed on the articulator in the same position that the waxed-up master cast had occupied. Differences in vertical occlusion between the trial denture and the final denture are reflected in the inability of the incisal pin to reach the zero setting. It is that distance between the plate and the pin that reflects vertical occlusal opening and is trial denture stage and the final denture, which deviation is obviously attributable to the processing.

Almost invariably some deviation from the trial denture stage has occurred with conventional processes. However, using the mold herein described, a number of the dentures showed no deviation, in other words a zero opening at the incisal pin. Furthermore, all of the dentures produced in accordance with this invention, even where some opening at the incisal pin did exist, were well within an acceptable range. A summary of the results obtained by using the resilient flexible mold technique and the comparable conventional procedure are shown in Table I.

TABLE I.—CHANGES IN THE VERTICAL OPENING RESULTING FROM THE FABRICATION OF DENTURES

Type of Mold	Number of Pairs of Dentures	Opening at Incisal Pin (mm.)	
		Average	Most Frequent
Silicone upper mold element	34	0.561	0.0
Gypsum upper mold element (controls)	25	0.672	0.7

The table and the test results show conclusively that the mold technique described in this application results in generally more accurate dentures. That, however, is not the only advantage obtained by following the teachings of this invention.

It is customary when stone is to serve as the upper half of the denture mold to vibrate the flask so that the stone will compact and settle without air bubbles. That vibration occasionally loosens teeth on the trial denture sufficiently to cause them to pull out of the trial denture and become lost in the flasking material. It is also the case that the stone expands in setting changing the position of the teeth in the mold by displacing the softer wax of the trial denture, thereby introducing error in the final denture. By utilizing the fluid polysiloxanes or other flexible mold forming materials of this invention such vibration is unnecessary, the distortion caused by expansion of the stone is avoided, and the loss of displacement of the teeth is also avoided.

The use of flexible mold materials avoids the necessity of tinfoiling the lower half of the mold when forming the upper portion of the mold at the trial denture stage thereby preventing tinfoil or tinfoil substitutes from distorting the final denture or from being deposited on the teeth. Better retention of the teeth in the denture resin results and fewer crevices appear around the necks of the teeth.

And, since the wax of the trial denture does not penetrate a resilient rubber mold forming its complete removal is more easily accomplished upon heating and flushing.

In accordance with the teachings of this invention it is possible to use pourable fluid self-curing acrylic resin for forming the denture whereas with conventional processes it is generally considered necessary to use a doughy partially polymerized heat-curing resin. Because of the lesser pressures needed with fluids to fully close the flask, the breaking and displacement of teeth and molds occasioned by the higher pressures necessary to close dough filled flasks is greatly diminished.

Additionally, the time it takes to remove the denture from the mold is greatly reduced from that required by conventional procedure. Also there is a cleaner separation of the external surfaces of the denture, with an absence of plastic debris and roughness, from the mold. That simplifies cleaning and polishing and makes possible wider more economical use of preformed plastic patterns of buccal, labial, palatal and lingual contours.

Other advantages include the lessened tendency for denture teeth to loosen from silicone rubber molds than from plaster molds during the boil out and a decreased tendency of denture teeth, particularly those of porcelain, to break or slip during packing and deflasking.

Another distinct benefit conferred by this invention is the ease with which duplicate dentures may be produced. While it is necessary to destroy plaster of Paris or stone upper molds in removing final dentures, that is not the case with a silicone rubber mold. In fact, the silicone rubber mold may be reused in forming new dentures as well as in the rebasing and relining of dentures which have begun to wear.

While I have specifically referred to only certain compositions in describing a preferred embodiment of my invention, it is apparent that other ingredients, ratios of ingredients, and materials may be substituted therefor. Thus, while various polysiloxane formulations may be used in the practice of this invention, other flexible mold forming compositions may be used as well. Also various other denture resin formulations other than the specific methyl methacrylate compositions described may be used as well.

While I do not intend to be limited to the following explanation, it is possible that the improved accuracy obtainable with the flexible mold of this invention may be due to the tendency of a flexible mold to remain more closely in contact with the denture resin during all stages of its curing. Especially in the case of well known acrylic denture resins, during at least one stage of their curing some expansion occurs forcing the flask to open and driving the upper and lower mold portions apart. If a resilient mold such as that described is used, it can give sufficiently to take up the expansion without the flask being forced to open. In a later stage of its curing, the resins contract and tend to pull away from the mold surfaces. If, as is the case with stone or plaster molds, the mold portions have been driven apart, upon contraction of the resin the denture will no longer be firmly seated against both of the mold surfaces. In the case of the resilient mold and during the practice of the technique of this invention, the mold is sufficiently compressible and expandable so that it tends to remain in contact with the denture during all stages of its curing. That of course will tend to produce a more accurate denture than one fabricated in a conventional mold.

It is apparent that many variations from the embodiment described herein are within the scope and spirit of this invention. Therefore I intend to be limited only as may be necessary in view of the claims appended hereto.

I claim:

1. A mold for use in casting dentures in a pressure flask comprising: upper and lower mold portions which are matingly engaged and held under compression in the flask during operation and which confine therebetween a mold cavity definitive of a denture to be cast therein; said lower mold portion comprising a rigid, relatively incompressible master cast having a rigid stable surface reproductive of the denture bearing surfaces of the patient's mouth, and a resist membrane in continuous contact with said rigid surface thereof; said upper mold portion comprising a yieldable, pressure transmitting member formed of elastically resilient, heat and moisture resistent material and having a yieldable shaped portion defining the outer surface of the denture to be cast and means for releasably holding one or more teeth with the root ends thereof extending into said cavity, whereby when said cavity is filled with self-curing denture forming material of the type which characteristically expands and contracts while setting and curing, said upper and lower mold portions confine and maintain said material under compression and said shaped portion yieldably follows and maintains intimate contact with the said outer surface of the cast denture, in response to the expanding and contracting of said material, throughout the casting operation.

2. The mold of claim 1 in which said elastically resilient material is silicone rubber.

References Cited by the Examiner

UNITED STATES PATENTS

173,647	2/1876	Keightleg	18—34.1
2,360,986	10/1944	Taub	18—34.1
2,414,093	1/1947	Cole et al.	18—47
2,859,088	11/1958	Erdle et al.	249—54 XR
2,965,946	12/1960	Sweet et al.	
3,066,351	12/1962	Schriner.	
3,133,978	5/1964	Bartley et al.	

WILLIAM J. STEPHENSON, *Primary Examiner.*