Dec. 10, 1946. J. G. DAY 2,412,207

PRODUCTION OF ARTIFICIAL TOOTH STRUCTURES

Filed Feb. 9, 1944 2 Sheets-Sheet 1

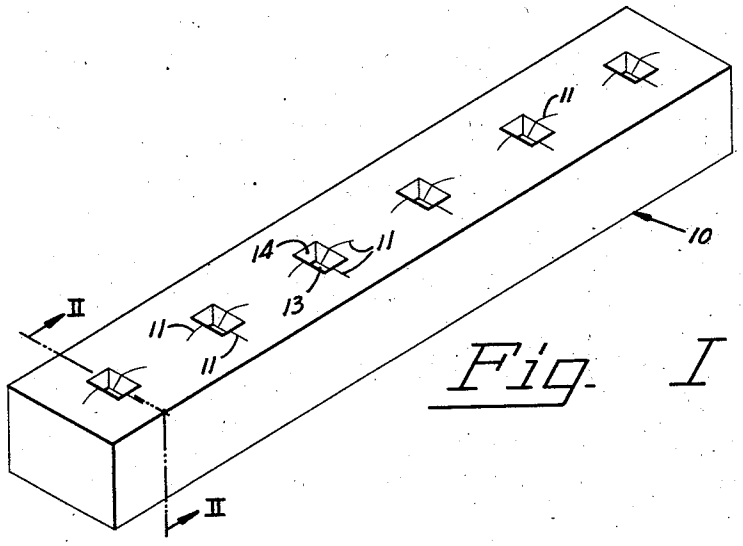


Fig. I

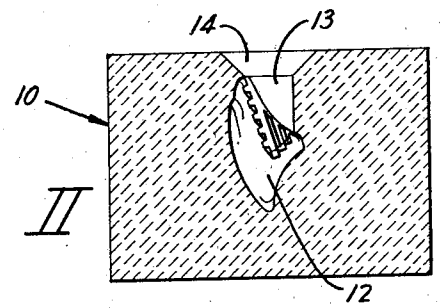


Fig. II

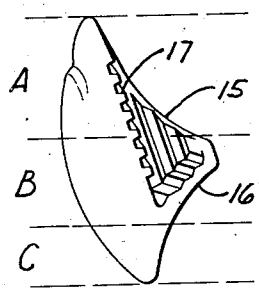


Fig. III

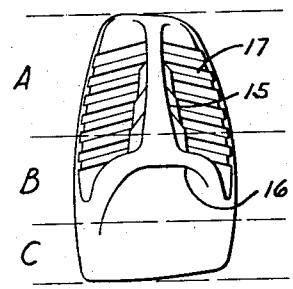


Fig. IV

INVENTOR.
Joseph Glen Day
BY
Marshall & Marshall
ATTORNEYS

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PRODUCTION OF ARTIFICIAL TOOTH STRUCTURES

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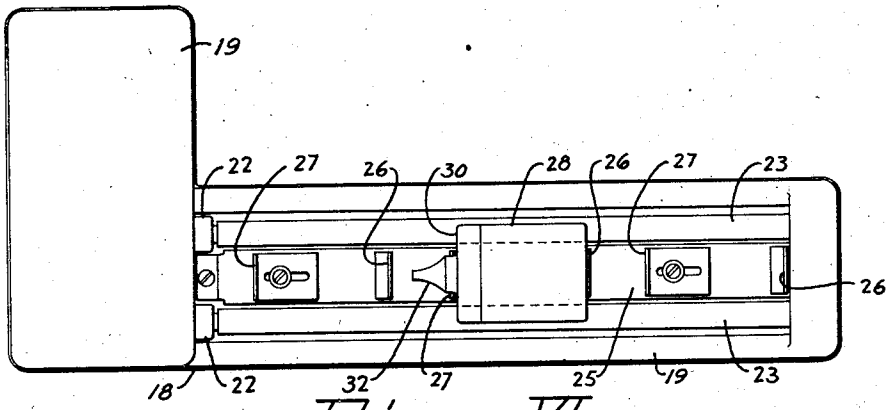


Fig. VI

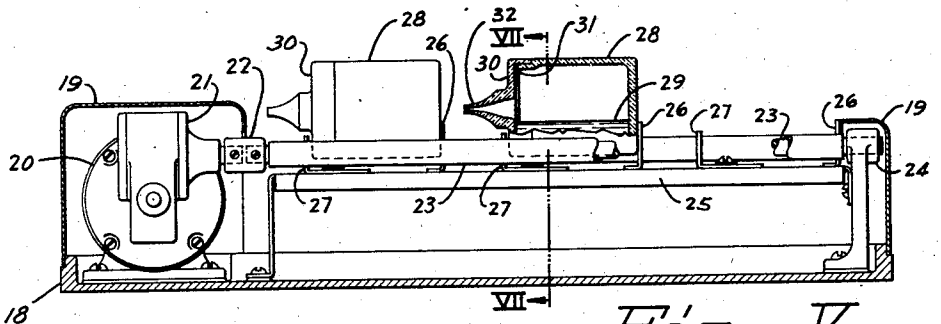


Fig. V

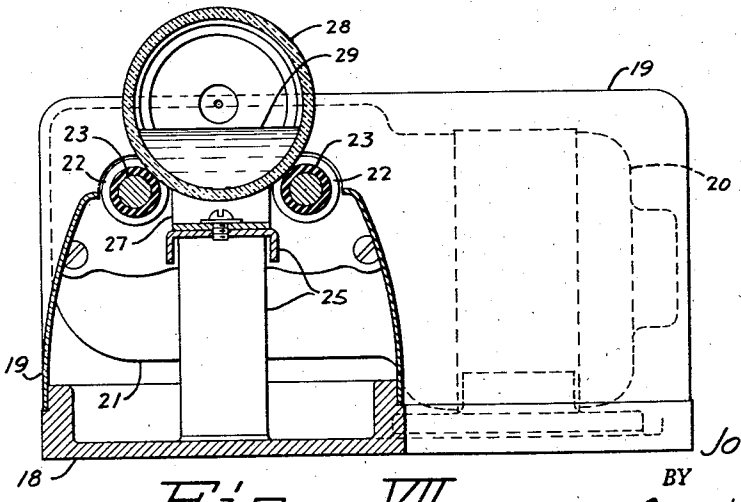


Fig. VII

INVENTOR.
Joseph Glen Day
BY
Marshall & Marshall
ATTORNEYS

Patented Dec. 10, 1946

2,412,207

UNITED STATES PATENT OFFICE

2,412,207

PRODUCTION OF ARTIFICIAL TOOTH STRUCTURES

Joseph Glen Day, Toledo, Ohio, assignor, by mesne assignments, to Dental Research Corporation, Chicago, Ill., a corporation of Illinois

Application February 9, 1944, Serial No. 521,707

1 Claim. (Cl. 259—57)

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The invention relates to the production of artificial porcelain tooth structures of predetermined shades.

Wearers of dentures demand that the portions of the denture which form the teeth provide the same appearance as natural teeth, particularly in the case of the portions of the denture which form the front teeth. Therefore, it is necessary to exercise extreme care in the manufacture of porcelain tooth portions for dentures in order to secure the appearance of natural teeth.

A person who acquires a denture usually demands that the artificial teeth be of the same shade as the natural teeth that are replaced by the denture, so that as little as possible change in facial appearance is produced. Thus, it is necessary for a dentist to procure teeth of different shades for different patients.

In order that artificial teeth may have a natural appearance, it is necessary that the tip or incisal section of each tooth be of a lighter and preferably more translucent porcelain than the remainder of the tooth. The necessity that the incisal section be of a lighter shade introduces another difficulty in the manufacture of porcelain teeth. In order that the tooth may have a natural appearance, the lighter shade of the incisal section must blend gradually with the remainder of the tooth so that there is no sharp line of demarkation between the shades.

It is necessary not only to have an even blending of the lighter shade of the tip with the darker shade of the remainder of the tooth, but also to have exactly the proper shade in every tooth in a denture. Any departure from the shade desired would cause the set of teeth to be rejected by a dentist.

Artificial porcelain tooth structures have been manufactured in considerable quantities for several years. The methods by which such structures have been produced have been laborious because of the necessity of controlling the shades for the reasons stated above, and it often has been necessary to discard as much as twenty-five per cent of each lot produced by such methods because of irregularities in shade. Porcelain teeth produced by the methods heretofore in use have been quite expensive, and because of inadequacy of such methods there exists a great unsatisfied demand for porcelain teeth of correct shade.

The principal object of the invention is to provide an apparatus producing porcelain tooth structures in which the control of shades is substantially infallible so as to eliminate waste. More specific objects and advantages are apparent

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from the description, in which reference is had to the accompanying drawings illustrating apparatus suitable for use in the practice of the invention.

Figure I of the drawings is a perspective view of a mold of a conventional type which may be used, in the practice of the present method, to receive slurries of porcelain particles for casting biscuits to be fired for producing porcelain tooth structures.

Figure II is a transverse vertical section on the line II—II of Figure I.

Figure III is a side elevation of a porcelain insert to be imbedded in a denture to form a tooth portion of the denture, which has been cast in the mold of Figure I.

Figure IV is a rear elevation of the porcelain insert.

Figure V is a longitudinal vertical section of an apparatus for use in the practice of the invention.

Figure VI is a plan view of the apparatus with one of the slurry containers removed.

Figure VII is a transverse vertical section taken on the line VII—VII of Figure V.

These specific drawings and the specific description that follows merely disclose and illustrate the invention and are not intended to impose limitations upon the claims.

In order to form a porcelain tooth portion of a predetermined shade, it is necessary to cast the tooth portion from a slurry of porcelain particles of the proper composition to produce the desired shade. The porcelain for such a slurry is prepared by mixing porcelain particles of different shades in proper proportions.

One of the most serious difficulties in the methods used during past years for the production of porcelain tooth structures has been the extreme difficulty of maintaining a slurry of porcelain particles in a smooth uniform condition long enough to permit the introduction of the slurry into a mold, and preventing segregation of particles of different shades. The porcelain particles of different shades have different specific gravities. Thus as soon as a slurry of porcelain particles is formed, the heavier particles immediately begin to collect in the form of a sediment in the bottom of the receptacle. It is very difficult to prevent the formation of such a sediment and to keep the porcelain particles of different shades uniformly distributed with respect to one another.

If the porcelain particles of different shades are not distributed uniformly with respect to one another, it is impossible to withdraw a part of the slurry that will produce a porcelain tooth

portion of the proper shade. If some slurry for casting a tooth portion is withdrawn from the upper part of the receptacle, the resulting tooth portion will be of one shade, and if some slurry for casting a tooth portion is withdrawn from the lower part of the receptacle, the resulting tooth portion will be of another shade.

Because of the rapidity with which segregation of the poreclain particles of different shades takes place in a slurry, it is difficult to mix up a batch of any substantial size so as to produce even momentarily a uniform slurry. Therefore, it has been the practice during past years to prepare at one time only a sufficient amount of slurry for one tooth portion.

In order to prepare successive amounts of slurry, each of which is sufficient for one tooth portion, it has been the practice heretofore to place a mixture of dry porcelain particles of the proper composition in a small cup and to add an excess of distilled water. The cup is then placed upon a vibrating table where it is allowed to stand for 45 minutes. During this period the poreclain particles of various densities become thoroughly stratified. At the end of the period of vibration, the supernatant water is poured off, leaving the porcelain particles in the form of a solid cake in the bottom of the cup. In this cake the densest particles are at the bottom and the density of the particles decreases uniformly from the bottom to the top of the cake. A sample of porcelain particles in sufficient amount for one tooth portion can be removed from the cake by cutting vertically through the cake so as to separate the same proportions of the heaviest particles at the bottom, the lightest particles at the top and the particles of intermediate density at various other levels in the cake. A sample thus separated from the cake can be mixed with a small amount of distilled water to produce a porcelain slurry in sufficient amount for one tooth portion, which is then transferred to the mold.

The preparation of a separate slurry for each tooth portion is time consuming but has been considered necessary heretofore because of the difficulty of securing a uniform distribution of the porcelain particles of different color in any larger amount of slurry. Even in the method heretofore used the shade of the tooth often is incorrect and a considerable amount of waste is caused by the discarding of teeth on account of incorrect shade. The small amount of slurry used in making one tooth portion is difficult to handle, and lumping of the porcelain or entrapment of bubbles often occurs so as to produce defects in the product which result in additional waste.

The present invention, which obviates the foregoing difficulties that have been experienced in the practice of the methods by which considerable quantities of porcelain tooth structures have been manufactured in past years, is based upon the discovery of a much more advantageous method in which a relatively large quantity of a slurry is subjected to substantially continuous agitation during the pouring of successive tooth portions, a small proportion of the slurry being withdrawn for each tooth portion. In order to carry out such continuous agitation, a power agitator is required, but a relatively simple power agitator may be used. It has been discovered that by such continuous agitation the porcelain particles of various shades may be kept very uniformly distributed with respect to one another,

so that a small proportion withdrawn from the slurry always produces a tooth portion of exactly the same shade. A method of casting biscuits to be fired for producing artificial tooth portions, embodying the invention, comprises the steps of preparing a slurry of porcelain particles, adapted to produce a tooth portion of a predetermined shade, agitating the slurry to keep the particles in suspension and to prevent segregation of particles of different shades, casting successive tooth portions from the slurry by withdrawing a small proportion of the slurry for each tooth portion, and maintaining, during the casting of the successive tooth portions, agitation of the slurry that is sufficiently continuous to prevent appreciable segregation of particles of different shades.

One type of mold in which the biscuits may be cast is illustrated in Figures I and II. Such a mold ordinarily is made of a flexible, resilient gelatin composition **10** or of another flexible, resilient composition such as soft rubber. Fissures or cracks **11** are provided in the flexible composition **10** which can be opened by flexing the mold so as to permit the removal of the cast biscuits. Leading into the cavity **12** in which the tooth portion is formed is a narrow sprue passage **13** having a flared entrance **14**.

The cavity **12** may be of such a shape as to form the tooth portion illustrated in Figures III and IV. On the back of such tooth portion is provided a vertical web **15** and a lateral web **16**. The sides of the vertical web **15** and the upper surfaces of the lateral web **16** may be serrated as shown in the drawings. The rear face of the tooth portion proper may be provided with additional serrations **17** which, together with the serrations on the vertical and lateral webs, permit the tooth portion to be anchored securely in a denture so as to resist the forces to which the tooth portion is subjected when the denture is in use.

A tooth portion such as that shown in Figures III and IV should be produced from porcelain of two or three different shades. The lightest shade of porcelain is used for the tip or incisal portion and the darkest shade of porcelain is used for the opposite end or gingival portion. The tooth structure illustrated in Figures III and IV is shown divided into three superimposed sections consisting of a gingival section A, a middle section B and an incisal section C. Although the blending of the porcelain of one section with the different shade of porcelain in an adjoining section should be very gradual so that no definite line of demarkation is visible, the approximate boundaries of the three superimposed sections are indicated by dashed lines in Figures III and IV.

In the use of a mold such as that shown in Figure I, a slurry of porcelain particles of such a composition as to produce the proper shade for the incisal section is first introduced into the mold cavity **12** to the approximate depth of the section C in Figure III. During the introduction of the slurry the mold, which is relatively transparent, is in front of a source of light which permits the depth of the slurry in the cavity **12** to be observed. After the casting of the incisal portion, a slurry of porcelain particles of a composition such as to produce the proper shade for the middle section is introduced to the approximate depth of the section B in Figure III. The remainder of the mold cavity and the sprue passage **13** are then filled with a slurry of porcelain

particles which produces a gingival portion of the proper shade. The successive layers of the different slurries are intended to diffuse into one another to a slight extent so as to produce a uniform gradation of shade from one section to the next. Only two portions of different shade may be employed instead of the three portions indicated in Figures III and IV.

After the mold cavities have been filled, the mold is allowed to stand on a vibrating table for 105 minutes during which the porcelain particles settle so as to produce a relatively firm biscuit, leaving the excess water at the top. The excess water is then sponged off at the entrances of the sprue passages and the mold is allowed to stand on the vibrating table for a few additional minutes. Finally the finished biscuits are removed from the mold by flexing the sides of the mold downward so as to open the fissures 11. The sprue formed in each sprue passage 13 is then removed and the biscuits are fired in the usual manner to produce the finished porcelain tooth portions.

The substantially continuous agitation that is employed in the practice of the present method may be carried out by means of any desired power agitator. Figures V, VI and VII of the drawings illustrate one convenient form of power agitator that may be used. In that device a base 18 carries a housing 19 within which is a driving motor 20. Secured to the front of the motor is a transmission 21 which through couplings 22 drives a pair of rubber covered rollers 23 which are journaled at their opposite ends in a bearing block 24 mounted on the base 18. A bracket 25 is mounted at one end upon the base 18 and at the other end upon the bearing block 24 and carries fixed spacers 26 and adjustable spacers 27. Containers 28 are longitudinally positioned by the spacers 26 and 27 and rest upon the rubber covered rollers 23, both of which rotate in the same direction.

A slurry of porcelain particles 29 in each container 28 is continuously agitated by the rotation of the containers which is produced by the rotation of the supporting rollers 23. Each container 28 is provided with a cap 30 having a gasket 31 to make a water-tight connection between the cap and the container. Each cap 30 has a narrow spout 32 through which the slurry can be withdrawn in small quantities.

It has been discovered that when the agitation of the slurry is interrupted, as by removing the container 28 from the rotating rollers 23, the porcelain particles of various shades remain substantially uniformly distributed with respect to one another for about 15 seconds. It has been discovered also that by inverting the container 28 and touching the end of the spout 32 to the flared entrance 14 of each sprue passage 13 in turn, equal quantities of the slurry can be introduced into six or eight mold cavities within such period of about 15 seconds. The container 28 is then replaced upon the rotating rollers 23 to continue the agitation of the slurry in preparation for the casting of additional tooth portions. If the agitation of the slurry is interrupted for more than about 15 seconds, lumps form and segregation of porcelain particles of different shades begins, so that any slurry withdrawn from the container after the agitation has been interrupted for more than 15 seconds may not be of the proper shade and is likely to contain lumps and bubbles which cause the cast tooth portion to be defective.

The present apparatus provides a tremendous improvement in speed, as compared with the apparatuses that have been used heretofore to produce large quantities of porcelain tooth portions. An amateur can cast a set of six biscuits in about 45 seconds by the present apparatus, using slurries of three different shades, whereas it takes an average skilled operator about seven to eight minutes to cast a similar set of biscuits by the apparatuses heretofore used.

The present apparatus insures regular timing in the pouring of the successive portions of slurry. The regular timing afforded by the present apparatus makes it possible to avoid letting each layer of slurry stand too long in the mold cavity before the succeeding layer is added. If a layer is allowed to stand too long in the mold cavity, it settles to such an extent that proper diffusion between such layer and the succeeding superimposed layer does not occur. The result is a sharp line of demarkation between the two shades of porcelain in the two layers, which makes it necessary to discard the finished tooth portion as defective.

The shades of tooth portions produced by the present apparatus are almost infallibly correct, and the formation of bubbles and lumps is avoided so that the present apparatus substantially eliminates the twenty-five per cent loss due to defects and incorrect shading that has been common in the apparatuses heretofore used in the manufacture of porcelain tooth portions.

The specific composition of the slurries used in the practice of the present method may be the same as the composition of the porcelain slurries used in prior methods. Reference is made to Patent No. 2,196,258, issued April 9, 1940, for a disclosure of slurries, molds and general procedure that may be used in the practice of the present method. A slurry prepared by mixing a dry powder with water as described in said patent is preferred. The proportion of water used in making the slurry may vary, but in general is about 11 cc. of distilled water per ounce of the dry powder.

In the preparation of a mold such as that shown in Figure I for the casting of a set of teeth, it is customary to wash the mold with soap and water, rinse and dry thoroughly. The interior of the mold is then moistened with a wetting agent. The excess of wetting agent is removed and the mold is then dried thoroughly to leave a uniform thin film of wetting agent on all interior surfaces. The procedure for preparing the mold for use is the same as the foregoing procedure which is commonly used.

Various embodiments of the invention may be devised to meet various requirements.

Having described my invention, I claim:

In apparatus for charging a mold cavity with a fluid mix of liquid and ground porcelain-like material, in combination, a pair of substantially parallel transversely spaced and generally horizontal rollers, a driving motor mounted in position adjacent one end of said pair of rollers and having driving connection with at least one of said rollers for rotating same, a plurality of containers adapted to be supported in coaxial and endwise spaced relation on said rollers and to be rotated about a generally horizontal axis by contact with said rollers, each of said containers being adapted to contain a fluid mix of liquid and ground porcelain-like material and to set up and maintain the particles of porcelain-like material in a substantially complete and uniform state of

suspension in the liquid throughout the bodies of the fluid mixes by agitating and freely intermingling and moving the ingredients about a generally horizontal axis by the rotation of said containers, pouring spouts on said containers for pouring the fluid mixes from said containers and into the mold cavities while the porcelain-like particles are in a substantially complete state of

suspension in the liquid contents of the fluid mixes, a bracket supported in position extending longitudinally beneath the space between said rollers, and spacers adjustably mounted on said bracket and extending for cooperation with the ends of said containers to assure proper relative positioning of the containers.

JOSEPH GLEN DAY.