Jan. 24, 1950 C. L. MILTON, JR 2,495,276

PROCESS FOR MAKING MULTIPIECE MOLDS

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Fig.2.

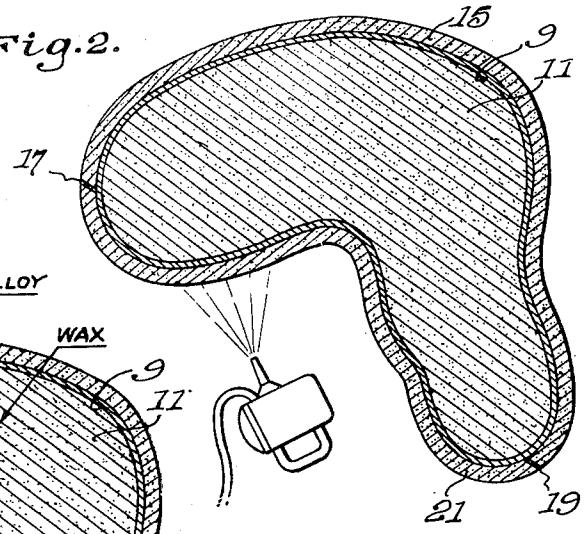

Fig.1.

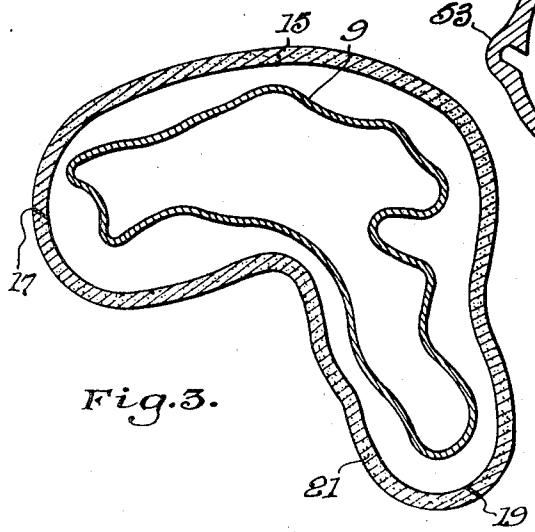

Fig.3.

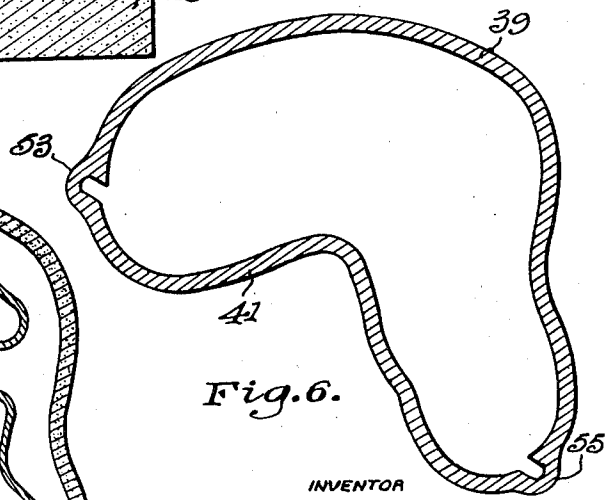

Fig.6.

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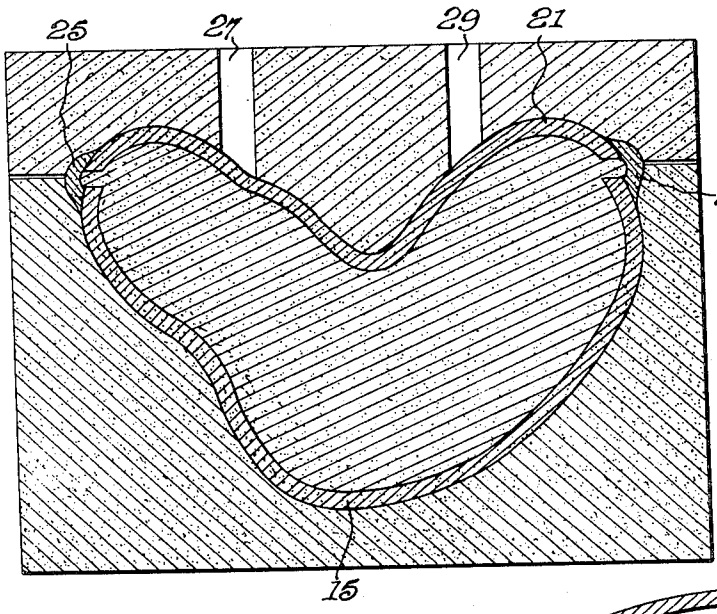


Fig. 4.

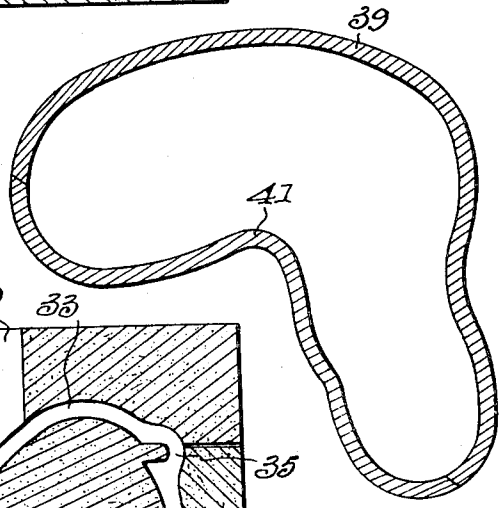
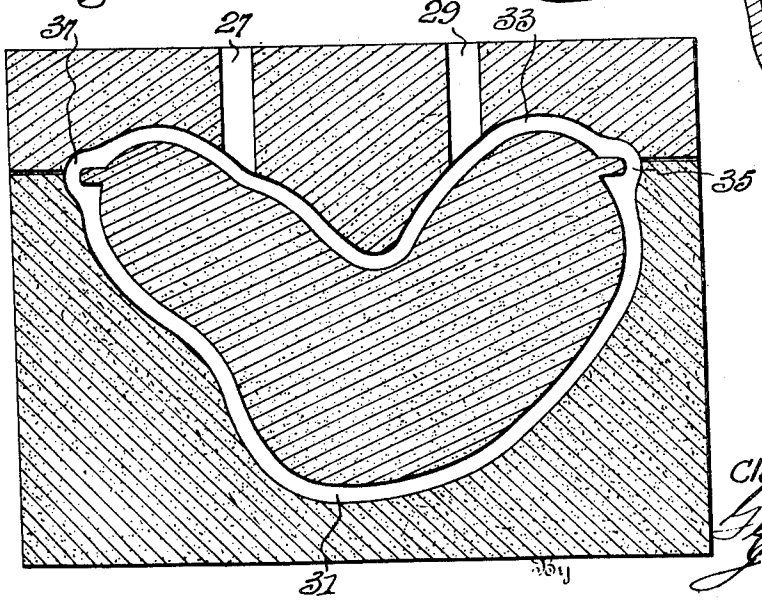


Fig. 7.

Fig. 5.



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UNITED STATES PATENT OFFICE

2,495,276

PROCESS FOR MAKING MULTIPIECE MOLDS

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4 Claims. (Cl. 76—107)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without payment to me of any royalty thereon.

The present invention relates to the production of multi-part molds for use in molding articles, such as high-fidelity replicas of a given article or object, the molds constructed in accordance with the present invention being obtained by a process of precision casting.

The art of precision casting has reached a very high state of development, in which small pieces, up to two or three inches across, can be duplicated successfully to within a few thousandths of an inch, particularly if the pieces are regular in shape. The extension of the art to larger objects and its use where accurate registration of mating surfaces is required, as in the case of a high grade mold, has not been accomplished prior to the present invention.

More particularly, prior to the present invention, it has been impossible to cast objects as large, for example, as the sections of a mold for a glove to simulate a human hand, with such precision that, on bringing the separate pieces together, they will mate within one or two thousandths of an inch. This has been especially true when the pieces are dissimilar in shape.

Failure to mate exactly even when perfectly matched patterns are invested may be attributed in large part to differential shrinkage due to differing shapes, although if extraordinary precautions are not taken, such factors as differentials in pouring temperature, investment—water ratio, or degree of dehydration of the investment, also will affect the result. Most of these causes of variation in the final castings can be reduced significantly by investing and pouring the matching pieces simultaneously, but still under these conditions mold parts sufficiently accurate for use without a great deal of hand-fitting are not obtained.

The objections and difficulties heretofore encountered are obviated by the process of the present invention, the invention having for its principal object the provision of a multi-piece mold for producing large articles, such as, for example, cosmetic gloves for covering prosthetic hands, although the process is not thus limited, as will become apparent as the description proceeds.

Further objects of the invention will become apparent from the following description and the features of novelty will be pointed out in particularity in the appended claims.

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The invention will be understood by reference to the accompanying drawings, wherein:

Fig. 1 is a sectional elevation through a form or pattern construction, showing diagrammatically the first stage of the construction of a mold in accordance with this invention;

Fig. 2 is a view similar to Fig. 1, but showing completion of the initial operation;

Fig. 3 is a diagrammatic, transverse, sectional view, showing the core removed, and a flexible replica of an article to be duplicated being shown as partially collapsed for withdrawal from the pattern,

Fig. 4 shows a diagrammatic, transverse, sectional view showing the parts of the pattern produced in Figs. 1, 2 and 3, invested in accordance with the present invention;

Fig. 5 shows, in diagrammatic section, the mold cavity obtained from the invested pattern of Fig. 4;

Fig. 6 is a diagrammatic sectional view of a completed casting obtained from the mold of Fig. 5; and

Fig. 7 is a diagrammatic transverse sectional view of a finished mold, after requisite trimming or machining, and with the parts interfitted to form a finished mold.

Generally speaking, the present invention comprises obtaining a hollow, flexible model of an object or article to be duplicated, rendering the model rigid by filling the model with a readily removable core, coating the model exteriorly with a low-melting point alloy, for example, Wood's metal, Lipowitz's metal, or other readily fusible alloy melting at approximately 100° C. or below. For the production of a multiple-piece mold, a predetermined portion of the surface of the now-rigid model is masked with clay or other suitable masking material, and the exposed portion coated by spraying thereon the molten, low-melting alloy. The masking material is removed, the terminal surfaces of the resulting coating provided with separation strips, and the coating completed. The rigid core material is removed from the interior of the model, the flexible model collapsed and removed from the coating, leaving the resulting sectional coating to be invested as a pattern for the final mold. The resulting sections of the coating are separated while retaining their same relatively aligned relationship, and are interconnected with wax or other readily fusible material, so as to hold this relative position. The parts then are invested simultaneously in a fluid, refractory composition, which upon solidification firmly holds the parts of the pattern. The pat-

tern and connecting links therebetween are melted out, leaving a continuous mold cavity, which is filled with the molten metal that solidifies into the mold. The investment is removed, the connection protuberances between the mold sections removed, and the resulting accurately mating surfaces of the mold surface are brought into engagement to make the assembled mold.

Referring more particularly to the drawings, the reference numeral 9 represents a flexible model of an article to be duplicated, which flexible model is filled with a readily removable, but rigid core material 11, which may be wax or other fusible material. A predetermined portion of the surface of the resulting rigidified model is masked, as indicated at 13, with clay or other suitable masking material, and the exposed surface is coated, as designated at 15, by spraying a low-melting metallic material or alloy thereon. Separator strips 17, 19, are applied to the terminal surfaces of the coating, the masking material 13 is removed, and the resulting exposed surface then is coated, as indicated at 21. The core material is removed, as by melting and allowing the resulting molten wax to drain out, thus permitting the flexible model 9 to be collapsed, as indicated in Fig. 3, and pulled out from the resulting coating.

The sections of the coating, that is, sections 15 and 21, as illustrated, are separated while maintaining the relative alignment therebetween. The extremities of the sections are joined by wax or other fusible material, as shown at 23, 25, thus holding the sections in proper relationship.

Fluid investment material is flowed around the sections 15, 21, so that the entire fusible assembly is enclosed in the investment, which may be a calcium sulphate hemi-hydrate-asbestos mixture, in water, although other refractory investments may be employed. The joined sections 15 and 21 are invested simultaneously, thereby forming a pattern.

Before pouring the investment material around the connected, but spaced, sections, a plurality of clay cylinders are provided, abutting the sections 21 to form sprue holes 27 and 29 extending through the investment. After the investment material has hardened, the sections 15, 21 and connections 23 and 25 are melted out, leaving a continuous mold cavity, the portions 31 and 33 of which correspond to the pattern sections 15, 21, respectively, communicating by way of said passages 35 and 37.

The resulting continuous mold cavity then is filled with liquid mold material, such as molten metal of high melting point, and the two sections preferably are cast simultaneously. Preferably also, a vacuum may be applied to the investment inside the patterns since, in general, the inner surfaces are those comprising the molding faces and are the ones which it is desired to reproduce faithfully. The application of the vacuum is continued until the casting has solidified. By this means, the gases evolved in the casting operation are withdrawn without causing blisters in the face of the casting which, in the absence of a vacuum, would be more likely to form in this process than in one which does not involve the connections between the sections. The completed mold consists of sections 39 and 41, connected by the protuberances 53 and 55, which, when suitably trimmed off, permit exact mating of the sections 39 and 41, as indicated at Fig. 7.

The above-described embodiment of the present invention is to be regarded as illustrative only of

one method of carrying out the invention, and that details of procedure may be varied in accordance with circumstances. Thus, in a manner similar to that described, three or more mold sections may be made that will interfit with great accuracy, and possess a very high-fidelity reproduction of the surface characteristics of the flexible model, which will be reproduced accurately in the finally molded article cast in the mold produced in accordance with the process of this invention.

It will be come apparent from the foregoing that various operative details of the present improved procedure may be modified in accordance with different existing operating conditions, such as different materials may be employed for the patterns (that is, wax may be employed instead of the low-melting point alloy, or polystyrene), and various investment materials may be employed, such as zirconia cements, the character of the investment material determining whether or not the use of a vacuum is necessary or desirable for evacuation of the investment material during the casting of the mold. The composition of the final cast product determines largely the material forming the investment on the mold. If the final cast product requires a substantial amount of heat, as in the "curing" of cast resinous cosmetic gloves, the mold may be made of a high-melting point metal, such as nickel or copper or iron, and the investment material must have a higher melting point than the metal being cast.

From the foregoing, it will appear that the details of operation in accordance with the present invention may be varied widely without departing from the inventive concept; and accordingly it will be understood that it is intended and desired to embrace within the scope of this invention such modifications and changes as may be necessary to adapt it to varying conditions and uses, as defined in the appended claims.

Having thus described my invention, what I claim as new and wish to secure by Letters Patent is:

1. A process for casting multiple-piece molds wherein accurate mating of multiple surfaces is required for producing replicas of a given object, which comprises filling an open, flexible model of the object to be reproduced with a readily-removable, rigidifying core material until the model becomes rigid, masking predetermined portions of the now-rigid model, coating the remainder of the model by spraying a low-melting metallic material thereon, removing the masking, applying separator means to terminal surfaces of the sprayed coating, completing coating the model by spraying the low-melting metallic material on the now-exposed surface of the model, thereby producing a multiple-sectional coating, removing the rigid core material, collapsing the flexible model and removing the collapsed model from the coating, separating the sections of the coating while maintaining the sections in original relative alignment, connecting the separated sections by bridging them with low-melting connecting means for securing the sections in position, completely investing the separated sections and connecting means in refractory investment material, melting out the invested sections and connecting means, thereby forming corresponding mold cavities connected by bridging channels, substantially simultaneously casting mold material in the mold cavities and connecting channels, removing the investment material, removing the connecting portions

of the mold material from the channels, and assembling the resulting mold sections into a complete mold.

2. A process for casting multiple-piece molds wherein accurate mating of multiple surfaces is required for producing replicas of a given object, which comprises coating an open model of an object to be duplicated by spraying a readily fusible metallic coating in separable sections on the model, removing the model from the coating, separating the sections of the coating while preserving original relative alignments between the sections, securing the sections in their aligned positions by bridging the sections with readily fusible connecting members, completely investing the sections and connecting members, providing sprue holes in the resulting investments, melting and draining from the investments the sections and connecting members, thereby forming a continuous mold cavity, filling the mold cavity with liquid, high melting point metal as mold material, allowing the mold material to solidify, removing the investments from the solidified mold material, removing connecting bridging portions from the resulting mold sections, and assembling the mold sections.

3. A process for casting multiple-piece molds, wherein accurate mating of multiple surfaces is required, for producing replicas of a given object, which comprises coating an open model of the object to be duplicated by spraying a readily fusible metallic coating in separable sections onto the model, removing the model from the coating, separating the sections of the coating while preserving the original relative alignment between the sections, connecting the sections, while separated, with readily fusible connecting members to secure them in separated but aligned relation to form a pattern for a mold, investing the connected sections and connecting members, fusing the resulting invested pattern and draining the fused material from the investment thereby producing a mold cavity composed of connected sections, casting mold material in the mold cavity to produce a mold composed of sections connected by bridging means, removing the bridging means, and assembling the sections into a complete mold.

4. A process for casting multiple-piece molds, wherein accurate mating of multiple surfaces is required, for producing replicas of a given object, which comprises making a predetermined portion of the surface of a rigid positive model of the object to be duplicated, spraying a readily fusible metallic coating on the remainder of the surface of the model, removing the mask, applying separating means to terminal surfaces of the applied coating, continuing to spray the readily fusible metallic coating onto the now-exposed remaining surface of the model, removing the model from the coating, separating the sections of the coating, rigidly connecting the sections, while separated with connecting members of readily fusible material to maintain the separate sections in original aligned relation, completely investing the resulting unitary structure in refractory investment material, heating the invested structure until it becomes molten, draining the resulting molten metal and connecting material from the investment thereby leaving a mold cavity composed of sections connected by interconnecting channels, filling all portions of the mold cavity with liquid, high melting point metal as mold material, allowing the mold material to solidify in the investment, removing the investment, thereby leaving a mold casting consisting of complementary sections interconnected by connecting members, removing the connecting members, and assembling the complementary sections into a complete mold.

CLARE L. MILTON, JR.

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