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73 L. R. VOEGELE 3
MOLDING STRUCTURE FOR CASTING ARTICLES HAVING
A NEGATIVE DRAFT PORTION

3,720,397

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2 Sheets-Sheet 1

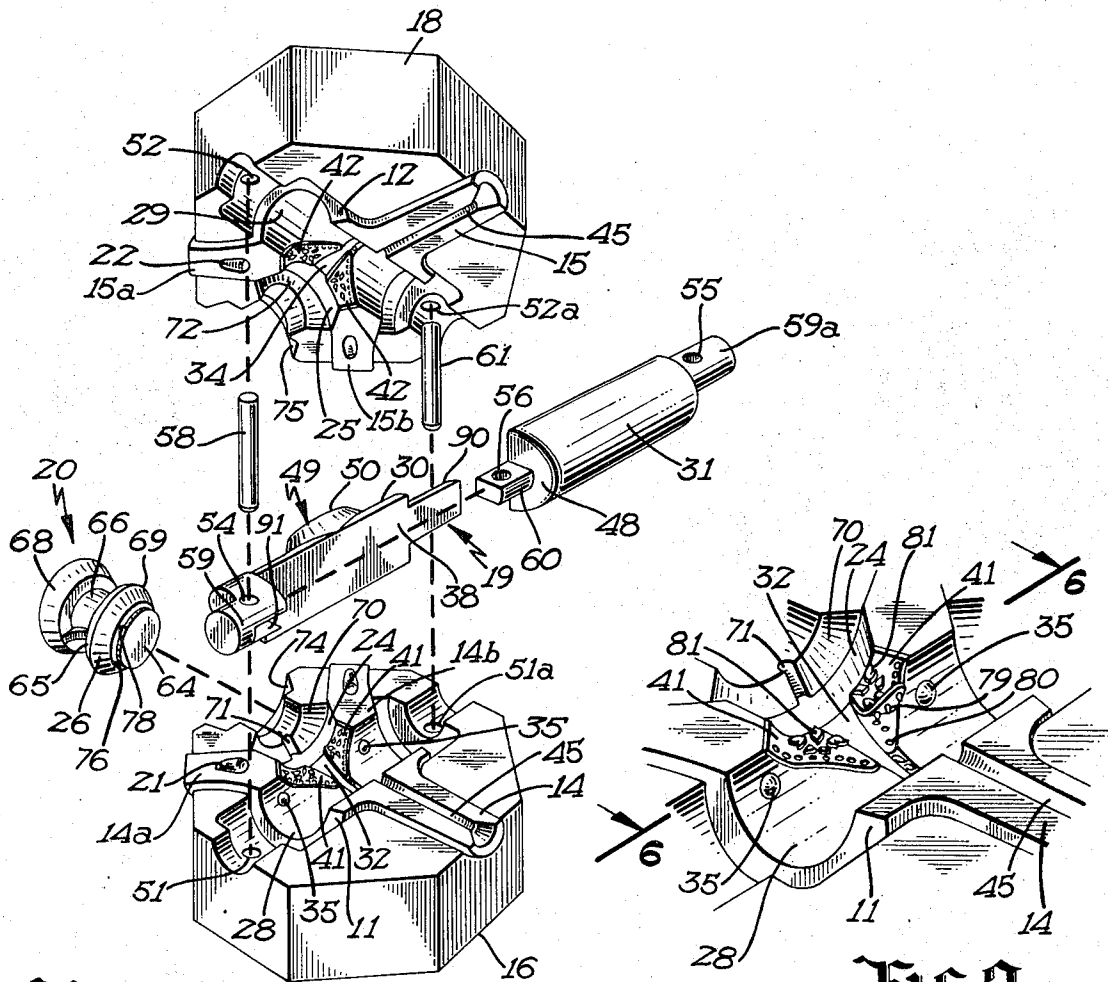


FIG 1

FIG 2

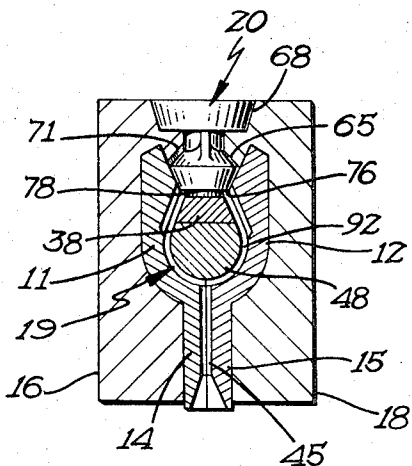


FIG 3

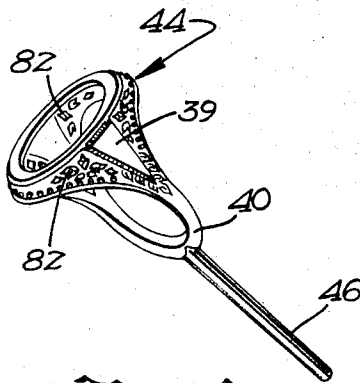


FIG 4

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2 Sheets-Sheet 2

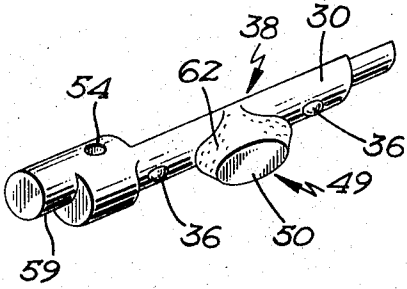


FIG 5

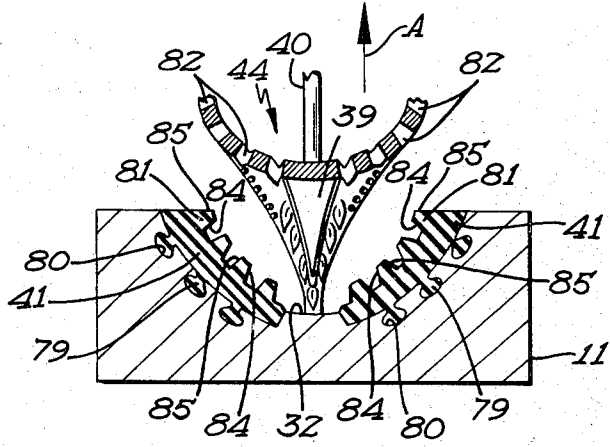


FIG 6

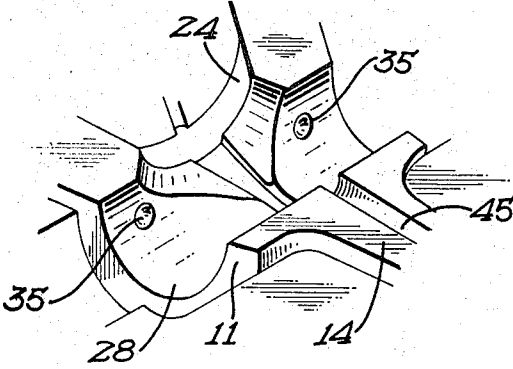


Fig 7

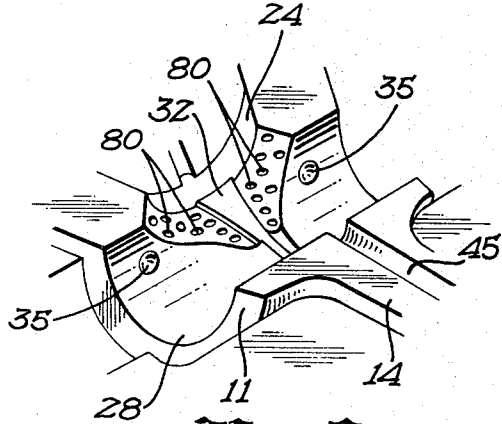


FIG 8

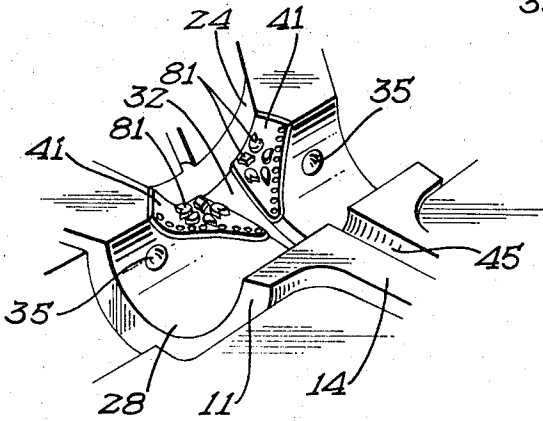


FIG 9

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MOLDING STRUCTURE FOR CASTING ARTICLES HAVING A NEGATIVE DRAFT PORTION

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4 Claims

ABSTRACT OF THE DISCLOSURE

An improved molding structure which includes a molding surface comprised partially of a rigid material and partially of a flexible, resilient material, facilitating the molding of articles having surfaces with a negative draft and the removal of the same from said molding structure without the destruction or permanent distortion of either the article molded or the molding structure which utilizes the desired characteristics of both a rigid material and a flexible material mold.

BACKGROUND OF THE INVENTION

The present invention relates generally to an improved method and apparatus for casting, and more particularly, to a method and apparatus for casting rings and other related objects containing surfaces having a negative draft.

The art of casting, one of the oldest arts, generally relates to a process of producing metal shapes by pouring molten metal into molds or dies having a desired design and allowing the metal to solidify. Although there are several methods of casting, the investment or "lost wax" method is probably the most popular method today. The "lost wax" method involves the steps of producing a wax model identical to the desired end product, encasing the wax model in investment plaster, allowing the investment plaster to set and harden, eliminating the wax model by the use of extreme heat in a burnout furnace thereby leaving a pattern chamber in the plaster mold, introducing molten metal into the pattern chamber and allowing it to solidify and removing the plaster from the solidified product. One of the more important steps in the "lost wax" method of casting, the method almost universally used today in the casting of rings, is the production of the wax model which has the same shape and design as the desired finished product.

In the present ring casting art, the wax models are produced by introducing the liquid wax into a cavity between two halves of a mold. When the wax has sufficiently solidified, the two halves of the mold are separated, the wax model removed, and the mold assembled for the production of another wax model. Because the material from which the wax model is made is quite brittle, the mold must be removed very carefully.

The principal limitation of the conventional "lost wax" ring casting method, or for the matter any conventional casting method in which the molding member is reused, is the only rings or other articles having a positive draft can be made. Draft in the casting art refers to the taper of the molding member which allows the molding member to be separated from the pattern without breaking or distorting the wax model or the molding member. More specifically, the draft or taper which allows this separation or removal is called positive draft. A molding member having complete positive draft has all of its surfaces tapered such that removal is accomplished without destruction of either the wax model or the molding member. A molding member having negative draft has some of its surfaces tapered such that removal of the wax model from the molding member is prevented without breaking or distorting either the article or the molding member.

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SUMMARY OF THE INVENTION

In contrast to the conventional method and apparatus used in ring casting, the present invention recognizes the desirability of producing rings and other articles which have portions containing a negative draft. The present invention further enables craftsmen, by the method and apparatus described below, to produce rings having a negative draft without surrendering any of the perfected techniques now present in conventional ring casting methods and apparatus.

More particularly, the present invention includes an improved technique for producing the wax model in a conventional ring casting method and apparatus. In this respect the present invention has combined the desired characteristics of a mold constructed entirely from metal or a rigid material and the desired characteristics of a mold constructed entirely from a flexible material resulting in a mold giving stability when stability is desired, and flexibility when flexibility is desired. One of the desired characteristics offered by a completely flexible mold is the ability of the mold to be flexed slightly when removing the mold from the pattern or the wax model. Thus, with a completely flexible mold, it is possible to produce articles having negative draft since the mold can be sufficiently flexed when removing it from the pattern thereby preventing distortion of the wax model or pattern. A mold constructed entirely from flexible material, however, lacks the perfection and accuracy needed and desired in the production of rings. In comparison, a completely metal or rigid material mold gives the perfection and the accuracy desired in production of rings. However, a mold constructed entirely from a rigid material, as is conventional in the prior art, limits the production of rings to those having only positive draft.

Generally, the apparatus of the present invention, includes a pair of metal frames, each of which supports one-half of the molding member used in producing the wax model. When the two halves of the molding member are secured together in combination with an arbor or mandrel disposed between the molding members, a cavity is formed into which the molten wax is poured for the production of the wax models. Additionally, the molding member of the apparatus of the present invention includes portions which are composed of a flexible rubber material. More particularly, the portions of the molding member containing the rubber part are those portions of the molding surface which correspond to the negative draft portions of the ring being cast. By combining the desired characteristics of both a rigid and flexible material mold, a wax model, and thereby the final ring product, can be produced having negative draft surfaces.

The method of the present invention involves the production of such a molding apparatus. More specifically, the method of the present invention involves the production of the wax model mold itself. As can be seen more clearly in the preferred embodiment described below, the method of the present invention describes a process for producing a rigid material mold, with flexible fin portions in areas corresponding to the negative draft surfaces of the ring.

Accordingly, it is an object of the present invention to provide an improved method for producing a molding structure for producing articles with portions having a negative draft.

It is also an object of the present invention to provide a method for producing wax models of a ring or other articles having surfaces with negative draft.

Another object of the present invention is to provide a method for producing a wax model mold for the production of a wax model ring wherein a portion of the mold

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is constructed from a rigid material, and the remaining portion is constructed from a flexible, rubber material.

It is also an object of the present invention to provide an improved apparatus for producing wax models in the investment or "lost wax" method of casting.

It is also an object of the present invention to provide an apparatus for producing wax models of a ring wherein the wax model has portions with negative draft.

Another object of the present invention is to provide an apparatus for producing the wax model in a "lost wax" casting method in which the apparatus includes both a rigid material portion and a flexible material portion.

A further object of the present invention is to provide an improved mold for producing a wax model in a ring casting process in which the ring being cast has negative draft portions and where a portion of the mold is constructed of a rigid material and a portion, corresponding to the negative draft portions of the ring, constructed of a flexible material.

These and other objects and advantages of the present invention will become apparent from the following description of the preferred embodiment and upon reference to the drawings and the appended claims.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is an expanded perspective view of the molding apparatus of the present invention.

FIG. 2 is a perspective view of a molding member showing the flexible, resilient material secured to a portion of the molding surface.

FIG. 3 is an elevational view partially in section of the apparatus shown in FIG. 1.

FIG. 4 is a perspective view of a wax model of the ring which has been cast in the apparatus of FIG. 1.

FIG. 5 is a perspective view of one of the half arbors.

FIG. 6 is an elevational sectional view of a molding member and a ring being removed therefrom as viewed from line 6—6 of FIG. 2.

FIG. 7 is a perspective view of a molding member after the first cast but before routing.

FIG. 8 is a perspective view of a molding member after routing but before the introduction and casting of the flexible material portion of the apparatus.

FIG. 9 is a perspective view of a molding member after the flexible material has been made a part of the molding surface of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to the above described drawings, FIG. 1 shows an expanded view of the molding apparatus of the present invention which in the preferred embodiment is a molding apparatus for a ring. The apparatus of FIG. 1 generally includes a pair of molding members 11 and 12, a pair of backing members 16 and 18 associated with the molding members 11 and 12 respectively, a mandrel 19, and a plug 20. When combined together in their normal operative relationship, the pair of molding members 11 and 12, the mandrel 19, and the plug 20 form a molding cavity into which the molten material is poured to produce an article having a desired shape and design.

More specifically, each of the molding members 11 and 12 includes a flat smooth surface area comprised of surfaces 14, 14a and 14b and surfaces 15, 15a and 15b respectively, which are designed for cooperative engagement when the molding members 11 and 12 are placed together to form the molding cavity. As shown in FIG. 1, the surfaces 14a and 14b each include an alignment tab 21 which is designed to cooperate with an alignment recess 22 located in a corresponding position on the surfaces 15a and 15b. When the surfaces 14a and 14b are placed in contact with the surfaces 15a and 15b, the tabs 21, 21 engage the recesses 22, 22 to properly align the molding members 11 and 12.

Each of the molding members 11 and 12 further in-

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cludes a semi-annular beveled surface 24 and 25 respectively for cooperation with a beveled surface 26 of the plug 20 when the members 11 and 12 are engaged, and a semi-cylindrical interior surface 28 and 29 respectively which form a relatively cylindrical interior surface when the members 11 and 12 are engaged. The semi-cylindrical surface 28 includes a pair of alignment recesses 35, 35 which are designed to engage a pair of alignment tabs 36, 36 (FIG. 5) of the half arbor 38 and which when so engaged, serve to properly align the mandrel 19 with respect to the molding surfaces 11 and 12.

The molding portions of the members 11 and 12 which actually contact the moldable material and form that material into an object having a desired shape and size include the metal surfaces 32 and 34, a portion of the beveled surfaces 24 and 25, the sprue hole 45, and the flexible, resilient material 41, 41 and 42, 42 more fully described below. The metal surfaces 32 and 34 associated with the members 11 and 12 each includes a relatively flat portion, which, during the molding process, forms the sides 39 of the finger ring shown in FIG. 4, and a curved channel portion which forms the band portion 40 of that ring. A portion of the beveled surfaces 24 and 25 together with the plug 20 forms the top portion of the ring 44. The sprue hole 45, half of which is contained in each of the members 11 and 12, is a cylindrical hole communicating with the channel portion of the surface 32 when the members 11 and 12 are in a molding position. The hole 45 during the molding process, is used to introduce molten molding material into the molding cavity formed by the above mentioned molding portions and to form the sprue 46 (FIG. 4).

Referring again to FIG. 1, the mandrel 19 includes a pair of half arbors 38 and 48. The half arbor 38 includes a partially cylindrical center portion defined by the surface 30, a partially cylindrical end portion 90, and a relatively cylindrical end portion 59. The end 59 further includes a pair of spaced apart portions defining an alignment groove 91 and a hole 54 passing through the spaced apart portions. The half arbor 48 includes a partially cylindrical center portion defined by the surface 31 which when placed adjacent the center portion of the half arbor 38 forms the cylindrical center portion of the mandrel 19. The half arbor 48 further includes a partially cylindrical end 59a which contains a hole 55 and which is disposed at one end of the center portion of the half arbor 48, and a tongue 60 which contains a hole 56 and which is disposed at the other end of said center portion.

When the half arbors 38 and 48 are engaged, the tongue 60 is disposed within the groove 91 between the spaced apart portions of the end 59 to properly align the half arbors 38 and 48. To further align the half arbors 38 and 48, a pair of pins 58 and 61 extend through a portion of the half arbors 38 and 48 and into the backing members 16 and 18. The pin 58 passes through the hole 54 in the end 59, through the hole 56 in the tongue 60, and into holes 51 and 52 contained respectively in backing members 16 and 18. Similarly, the pin 61 passes through the hole 55 in the end 59a and into holes 51a and 52a in the members 16 and 18.

As more clearly shown in FIG. 5, the half arbor 38 further includes a pair of alignment tabs 36, 36, which are designed to engage a pair of alignment recesses 35, 35 positioned on the interior surface 28 of the molding member 11, and a crown 49. One of the purposes of the tabs 36, 36 and the recesses 35, 35 is to insure that the mandrel 19 will be properly oriented with respect to the pair of molding members 11 and 12 thereby preventing the mandrel 19 from being combined with the molding members 11 and 12 in an inverted position. The crown 49 extends outwardly from the exterior cylindrical surface 30 to form a molding surface for the interior portion of the ring. As shown in both FIGS. 1 and 5, the surfaces of the crown 49 includes a plurality of tiny raised portions 62 which are designed to correspond with the flex-

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ible resilient material 41, 41 and 42, 42 more fully described below. The crown 49 also includes a flat, smooth surface 50 which is designed to engage the surface 64 of the plug 20 when the apparatus shown in FIG. 1 is in an operable position.

The plug 20 includes a relatively cylindrical middle portion 66 and a pair of annular portions 68 and 69 having substantially greater diameters than the cylindrical portion 66. The annular portion 69 includes a pair of beveled faces 26 and 65 which seat respectively against the beveled faces 24 and 25 of the molding members 11 and 12 and the beveled faces 70 and 72 of the mold backings 16 and 18. The annular portion 68 includes a beveled face which seats against the beveled faces 74 and 75 of the mold backings 16 and 18 respectively. The front portion of the plug 20 as shown in FIG. 1 includes a flat, smooth surface 64 for engagement with the flat surface 50 of the crown 49, a radially oriented annular surface 76, and a cylindrical surface 78. The surfaces 76 and 78 define a portion of the mold cavity and thereby serve as a portion of the molding surface. A longitudinal alignment ridge (not shown) is integrally formed on the beveled surface 65 and is designed to engage the alignment channel 71 of the mold backing 16 when the plug is properly aligned with the backing member, thereby preventing the plug 20 from being disposed in an inverted position with respect to the backing members 16 and 18.

With specific reference now to FIG. 2, the molding member 11 is shown as including a pair of members 41, 41 constructed of relatively flexible and resilient material. To more clearly show the flexible nature of the members 41, 41 and the means securing those members to the molding member 11, a portion of one of the members 41 is turned up. The members 41, 41 comprise a portion of the molding surface and include a plurality of flexible fins 81 extending upwardly from the surface. The members 41, 41 are secured to the molding member 11 by a plurality of tabs 79 integrally formed with the back side of the members 41, 41 which extend into the holes 80 formed in the member 11. As shown in FIG. 6, the holes 80 are undercut causing the members 41, 41 to be securely disposed against the member 11. As will be more fully explained below, the flexible fins 81 permit the casting of rings and other articles which have surfaces with a negative draft.

FIG. 3 is a partial cross-sectional view of the molding apparatus shown in FIG. 1 as cut by a plane perpendicular to the surfaces 14 and 15 and passing through the longitudinal center of the sprue hole 45 (FIG. 1). As shown, the molding members 11 and 12, the mandrel 19 and the plug 20 form the molding cavity 92. The molding members 11 and 12 including the members 41, 41 and 42, 42 form the molding surface for the outer portion of the ring shown in FIG. 4. The mandrel 19 including the crown 49 form the molding surface for the interior portions of the ring, and the surfaces 76 and 78 of the plug 20 form the molding surfaces for the top portion of the ring. Also as shown in FIG. 3, the various beveled and cylindrical faces of the plug 20 contact corresponding surfaces of either the molding members 11 and 12 or the member backings 16 and 18.

As pointed out in the summary of the invention, one of the objects of the present invention is to provide a molding apparatus capable of casting articles having a negative draft. To more fully explain this feature of the present invention, reference is now made to FIG. 6 showing an enlarged cross-section of the molding member 11 when viewed along line 6—6 of FIG. 2. Also shown in FIG. 6 is a cross-section of the finger ring being cast as it is removed from the molding member. After the ring has been cast, the molded ring is removed from the molding member 11 in the direction defined by the arrow A. This direction defines the axis of removal of the ring from the molding member.

Generally, the draft of a molding member is the taper

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given to the molding surfaces of the pattern or molding member which permits the molded article to be easily withdrawn from the molding member. More specifically, and for the purposes of the present specification, positive draft is the taper given to a molding surface which permits the molded article to be removed from a rigid molding member without disturbing or distorting in any way either the molding member or the molded article. In comparison, for the purposes of this specification, negative draft is defined as the taper given to the molding surfaces of a molding member which would prevent or retard the removal of the molded article from the molding member. As shown in FIG. 6, each of the flexible fins 81 includes a surface 85 having a positive draft with respect to the axis of removal A and a surface 84 having a negative draft with respect to the axis of removal A.

For example, in FIG. 6, the negative draft surfaces 84 of the fins 81 are such that the ring 44 cannot be removed along the axis of removal A, without disturbing or distorting the fins 81. In comparison, the positive draft surfaces 85 permit removal of the ring from these surfaces without distortion of either the ring 44 or the molding member 11.

The preferred embodiment of the present invention permits the ring to be removed from the molding member 11 even though portions (surfaces 84) of the molding member 11 have a negative draft with respect to the axis of removal A of the ring 44. This is possible because the fins 81 are constructed of a relatively flexible and resilient material. After the ring has been cast, it is removed from the molding member 11, along the axis of removal, without permanent distortion of either the ring or the molding member. While the ring is being removed, each of the fins 81 having a surface with a negative draft 84 is temporarily distorted to allow the ring to be removed. Once it is removed, however, the resilient fins 81 assume their normal shape, with virtually no effect of the ring removal.

Although the specification thus far has emphasized the actual structure of the molding apparatus shown in FIG. 1 rather than its operation, the operation of this apparatus can be summarized as follows. First of all, referring to FIG. 1, the two half arbors 38 and 48 are placed together to form the mandrel 19 which is then placed in contact with the surface 28 of the molding member 11 so that the tabs 36, 36 are aligned with the recesses 35, 35. Next, the alignment pin 58 is disposed through the holes 54 and 56 and into the hole 51 of the mold backing 16, and the alignment pin 61 is disposed through the hole 55 and into the hole 51a of the mold backing 16 to further align the mandrel 19 with respect to the molding member 11 and to retain it therein. Then the plug 20 is placed in its proper position with the ridge (not shown) on the beveled face 65 engaging the alignment channel 71. Finally, the upper mold member 12 is placed against the lower mold member 11 so that the alignment pins 58 and 61 engage their respective holes 52 and 52a in the mold backing 18. This aligns the upper mold member 12 with respect to the lower mold member 11. The entire apparatus is then held together in this position by an external clamp (not shown).

When the casting of an article is desired, molten wax or other material is introduced through the sprue hole 45 and into the mold cavity which is formed by the two halves of molding members 11 and 12, the mandrel 19, and the plug 20. After the mold cavity has been filled and the molten material has solidified, the molding members 11 and 12 are separated, the pins 58 and 61 removed, the half arbor 48 removed by sliding it along the longitudinal axis of the mandrel 19, the half arbor 38 removed, and finally, the ring removed from the remaining mold member. The ring thus formed is used as a pattern or wax model in the investment or lost wax method of casting.

The present invention also relates to a method for

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forming the molding apparatus previously described which is now discussed with general reference to the FIGS. 1-6 and with specific reference to FIGS. 7, 8 and 9. The first step in constructing a casting mold of the type shown in FIG. 1 is to construct a model (not shown) of the desired final product from a metal having a fairly high melting point. For construction of the apparatus shown in the preferred embodiment this model would be identical to the ring shown in FIG. 4. This model, in order to utilize the advantages of the present invention, has at least one surface having a negative draft with respect to the axis of removal of the article from the mold.

After the completion of this model, all of the surfaces having a negative draft with respect to the axis of removal are plugged with clay or a similar inert material in a manner which causes the resultant structure to be void of negative draft surfaces. In a model having the configuration of the ring shown in FIG. 4, each of the holes 82 would be plugged with the clay material. Before the clay is completely dried, a small portion of the clay is gouged out of the holes 82 on the inside of the ring surface, thereby producing a small indentation in each of the holes 82. As will be seen, the result of this is to form the tiny raised portions 62 on the crown 49 (FIGS. 1 and 5). Accordingly, each of these raised portions will correspond to one of the fins 81 which are produced in the manner described below.

Next, the ring model, with its negative draft portions plugged by clay, is mounted on the mandrel 19 and inserted between the two backing members 16 and 18 which are spaced from each other. Molten metal, having a relatively low melting point, is then poured around the model to form the two molding members 11 and 12. When the molten metal has hardened, the two frame members 16 and 18, now including respectively the newly formed molding members 11 and 12, are separated and the model removed. At this point, the molding member 11 and its respective mold backing 16 are similar to that shown in FIG. 7. Note that at this stage, in contrast to FIG. 2, the member 11 does not include any flexible, resilient material.

Next, the surface of the members 11 and 12 corresponding to the portions of the model which are plugged with clay are routed-out thereby removing a portion of the members 11 and 12. Additionally, several under cuts 80 (FIG. 8) are made into the metal portion of the mold within the routed area to serve as a means for securing the flexible, resilient material to the members 11 and 12. The molding member 11, after the routing step, is shown in FIG. 8.

Finally, the clay is removed from the ring model and the model is again mounted onto the mandrel 19 and replaced between the two molding members 11 and 12. Molten flexible material is then introduced into each of the routed-out areas of members 11 and 12 through a tiny hole passing through the respective molding member and mold backing and communicating with the routed portion of the respective molding member. The molten flexible material flows into the routed-out portions of the members 11 and 12 and into the negative draft areas of the ring model from which the clay has been removed. When the molten flexible material has solidified, the molding members 11 and 12 are separated and the ring model removed, leaving a molding member 11 similar

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to that shown in FIG. 9. The entire molding apparatus is now similar to that shown in FIG. 1 and is in condition for casting wax models which can be used in the "lost wax" method of casting.

Although the description of the preferred embodiment and the method of constructing the preferred apparatus has been quite specific, it is intended that the present invention is not limited to the previously described preferred apparatus and method, nor is it limited to the production of the article shown in FIG. 4. Consequently, the scope of the present invention is not to be dictated by the specific language of the specification, but rather is to be defined by the language of the appended claims and their equivalents.

I claim:

1. A molding structure for molding a finger ring having at least one surface with a negative draft portion, said structure comprising:

a molding member including a pair of molding members each corresponding to a respective half of said finger ring, and each having a molding surface forming therebetween a molding cavity for shaping moldable material into a finger ring of desired size and shape, said molding surfaces including a portion composed of a rigid material corresponding to and for forming the surfaces of said molded article which do not contain negative draft portions, and a portion integrally formed with said rigid material portion composed of a flexible material corresponding to, and for forming at least the surfaces of said finger ring which have a negative draft portion, said flexible material portion allowing for the removal of said molded article from said molding member without the permanent distortion of either said finger ring or said molding members and

means for introducing moldable material into said molding cavity and into contact with said molding surface for forming the moldable material into a finger ring.

2. The molding structure of claim 1 wherein said portion composed of a flexible material includes at least one flexible fin extending outwardly from said molding surface.

3. The molding structure of claim 2 including a mandrel disposed between said pair of molding members, said mandrel and said pair of molding members forming a cavity having the size and shape of said finger ring.

4. The molding structure of claim 3 and a sprue hole for introducing moldable material into said cavity.

References Cited

UNITED STATES PATENTS

2,078,562	4/1937	Cohen et al.	249—57 X
2,712,173	7/1955	Denner	164—137 X
3,302,257	2/1967	Kaplan	249—57 X
3,511,466	5/1970	Kaplan	249—57
3,552,480	1/1971	Harris	164—245

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U.S. Cl. X.R.

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