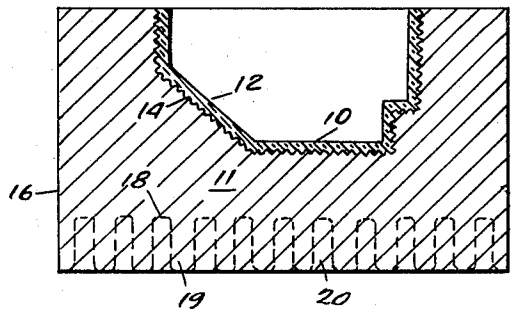
Sept. 15, 1959 E. S. SIRMAY 2,903,761

PERMANENT PRE-CAST MOLD

Filed July 23, 1956



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United States Patent Office 2,903,761 Patented Sept. 15, 1959

2,903,761

PERMANENT PRE-CAST MOLD

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Application July 23, 1956, Serial No. 599,433

4 Claims. (Cl. 22—113)

The present invention relates to a permanent precast mold and the method of making such a mold, and more particularly relates to a mold comprising a shell of refractory material to which is bonded a heat conducting metal.

As is well known in the art, casting operations utilize either (1) temporary molds which consist of an impression in a pliable material such as sand or plaster made by a pattern, or (2) permanent molds, usually made of stainless steel, which are accurately machined so that castings produced therefrom may meet very close tolerances.

One disadvantage of the temporary type mold is that a separate impression must be made with the pattern before each casting operation and, therefore, if a large number of castings are to be made, the process becomes a rather expensive one. Although steel molds are usually permanent and do not encounter this problem, the fine machining which they require in order that close tolerances may be met and the inherent handling problems in forming such molds by casting molten steel at relatively high temperatures makes the use of steel molds economically unfeasible in many instances.

The present invention overcomes these difficulties by providing a permanent pre-cast mold of a refractory material which will withstand the high temperatures of the molten casting metal and a backing for said refractory comprising a relatively inexpensive, low melting, non-ferrous metal.

In accordance with the present invention, castings of molten metal may be made in a mold which is permanent and which, at the same time, is far more economical to produce than permanent molds known to the prior art.

Accordingly, one object of my invention is to provide a permanent pre-cast mold which is simple and economical to form.

Another object of my invention is to provide a method for preparing permanent pre-cast molds which is far more economical than methods heretofore used in the preparation of permanent molds.

Still another object is to provide a permanent mold and a method for preparing the same in which the backing material for said mold may comprise a relatively low melting, non-ferrous, heat conductive metal while said mold is capable of forming castings of metals having the same or even higher melting points than that of the mold backing.

These and other objects of my invention will become apparent from the following description when taken in connection with the drawings in which:

The figure is a cross-sectional view of my novel mold as it would appear when ready for a casting operation.

Essentially, the present invention involves a permanent pre-cast mold which has been made by inserting a pattern comprising a section of the article to be cast into a body of refractory powder, subsequently applying heat through the pattern so that the powder forms a solid refractory body adjacent the surface of said pattern, and then backing the refractory shell with a non-ferrous, heat conductive metal.

The refractory shell is ordinarily of a thickness of at least 0.1 inch and generally in the range of about 0.1 to 0.75 inch, and the contour thereof exactly follows that of the pattern. After the refractory has been baked for a sufficient time, and the shell which forms from the pattern outwardly is of sufficient thickness, the baking operation is discontinued and the shell of refractory material which is then obtained is bonded to a backing of a heat conductive, non-ferrous metal. The metal is of such a mass and has sufficient heat dissipating capacity so that the heat content of the molten metal which is to form the casting is not sufficient to raise the backing to a temperature above its melting point.

At the same time, the refractory shell into which the molten metal is poured readily withstands the temperature of the molten metal and provides sufficient insulation so that the initial contact of the molten casting metal with the mold does not deleteriously affect the surface of the heat conductive, relatively low melting point backing metal.

A sample of the metallic article to be cast is cut and a half section thereof forms the pattern and is placed on a heat conducting metallic plate which is located under a body of the refractory material. Means are provided to heat the plate from below and the body of refractory from above. The type of refractory material which is used in this invention is per se well known in the art. For example, it may consist of carbides of tungsten, silicon, and molybdenum steatite, slag or other refractories which are normally considered waste by-products of steel making, nuclear fission or other high temperature processes.

Normally the refractory is in a finely divided powder form in the range of 200–400 mesh size. Included in the refractory is a binder material which causes it to begin to fuse at baking temperatures. This binder may comprise, for example, thermosetting resins such as urea, melamine or phenol-aldehyde resins, or glass forming bodies such as borosilicates, water glass, or other fusible material which, when heated to the normal range of baking temperatures of from 450° F. to 700° F. will melt and fuse the refractory particles into a solid shell. Normally, the refractory will contain about 10 to 35 percent by weight of binder, although this percentage may range between about 5 and 50 percent. Instead of providing a solidified mass of refractory by baking, it is within the scope of the present invention to add to the binder various amine or other chemical hardening agents well known in the resin art.

The pattern is painted with a boric acid solution, silicone resin or other suitable release material so that after the refractory has fused and a shell of the desired thickness is obtained, the pattern may be easily removed.

The thickness of the refractory shell should be at least 0.1 inch and is ordinarily between about 0.1 and 0.75 inch. In the event that a relatively thick mold is desired, either the amount of binder hardening agent or the time and temperature of the baking operation may be increased. Usually the baking time for the forming of the shell mold will be between about 5 and 10 minutes. The shell, when removed from the refractory mass, will then be baked at about 450° F. and 700° F. for between about 24 to 48 hours.

The inner surface of the refractory mold into which the casting metal is to be poured follows the contour of the pattern and, therefore, presents a smooth surface. Thus, a mold is obtained which can be used to meet specifications requiring extremely close tolerances. The outer shell of the refractory mold is relatively rough,

since the refractory will not always solidify outwardly to precisely the same extent.

After the refractory shell is formed, it is quite brittle and must be bonded to a metallic backing. This metallic backing may comprise heat conductive, nonferrous metals or alloys of aluminum, nickel or copper. Examples of suitable copper-base alloys include brass or bronze with or without other metallic additives.

The bonding is accomplished by suspending the refractory shell within a suitable high-temperature resisting container and thence filling the container with the molten backing metal. The molten metal readily adheres to the outer roughened surface of the refractory and solidifies to form the solid backing.

Because of the fact that the refractory shell of at least 0.1 inch thickness is a good insulator, the backing metal may have the same or even a lower melting point than the metal which is to be cast. If it is to have a lower melting point, there must be a mass of backing metal such that the heat content of the molten metal to be cast in the mold is not sufficient to raise the backing metal to a temperature above its melting point. The initial contact of the molten casting metal with the refractory die cavity surface will not affect the refractory nor will it affect the backing metal. Obviously, this would not be the case if it were attempted to mold directly into a cavity machined out of the relatively low melting, non-ferrous metal itself.

Through the use of the mold prepared by this method, up to two thousand castings of aluminum, brass, bronze or other non-ferrous metals may be made from the same mold. This is in contrast to sand molding methods and may be compared only to castings ordinarily made from the more expensive highly machined steel molds.

Referring now to the drawing, it can be seen that the mold as it finally appears, has the appearance of a lining of a refractory material 10 which is firmly bonded to a block of supporting metal 11. The refractory has a smooth inner surface 12 formed by baking said refractory around a half section of a pattern in accordance with the method hereinbefore referred to. The outer roughened surface 14 of the refractory shell becomes bonded to the metal backing 11 as it cools. The metal backing is poured into a high-temperature resistant container which may either be removed or remain a part of the mold. Thus, the outer surface 16 of the backing is determined by the shape of the container.

In one embodiment of this invention the surface area and, hence, the heat-dissipating capacity of the backing may be considerably increased by providing at least one of the backing surfaces with indentations such as those shown by dotted lines 18. This will result in providing the backing of a given mass with an increased surface area in the shape of "fins" 19 and thereby cause it to more rapidly dissipate the heat of the molten casting metal. These fins may be readily provided for in the casting of the backing by the insertion of steel cores into the indented portions 20. Forming a surface of this type has been found to be a considerable improvement over the difficult control problems inherent in water-cooling methods of the prior art.

It is, in any event, highly desirable that the mass, surface area, and heat-dissipating capacity of the mold be predetermined on the basis of the specific heat, temperature and mass of the molten casting metal so that the backing material can remain at a desirable equilibrium temperature during rapid successive molding operations. Typical equilibrium temperatures would be 600° F. for the casting of steel parts, 400° F. for bronze and 200° F. for making aluminum castings. It is desirable that the mold be designed so that the casting metal be solidified in about 5 to 30 seconds. Shorter cooling times will not allow for proper crystallization of the molten metal, while longer cooling times become uneconomical.

As a specific example of my novel mold and method for preparing same, a half-section of a builder's hardware item, e.g. a door knocker, was placed on a steel plate heated from the bottom and inserted in a bed of powdered molybdenum carbide, mixed with 20 percent sodium silicate glass. The temperature of the bed and plate was raised to 600° F. for 7 minutes after which a refractory shell of a half inch had formed around the pattern. The shell was then removed from the powder bed and baked at 600° F. for 18 hours. The refractory shell was then suspended in a steel container, and molten aluminum poured into the container around the said shell. The resulting mold was then used for making 2,000 brass castings and after such use was clearly capable of making further accurate castings. A similar mold was obtained by forming the refractory shell from a mixture of 80 percent steatite and 20 percent phenol-formaldehyde resin.

Molds of this type are obviously suitable for many and varied beneficial uses. For example, they would greatly increase the economy of operations involving the casting of aluminum or copper alloy parts. Particular utility has been found in the casting of builder's hardware, anchor chains, and ship propellers.

In the latter case where accurate balance is needed between the various vanes of a propeller, it has been found that the accuracy provided by the permanent pre-cast mold of the present invention is used to great advantage and eliminates much of the elaborate machining operations heretofore required in the balancing of propeller blades.

Although I have described preferred embodiments of my novel invention, many variations and modifications will now be apparent to those skilled in the art, and I prefer, therefore, to be limited not by the specific disclosure herein, but only by the appended claims.

I claim:

1. The method of making a permanent pre-cast shell mold for forming metallic castings comprising the steps of placing a pattern comprising a half-section of the metallic article to be cast within a heated body of finely divided refractory material containing 10 to 35 percent of a fusible binder, heating the refractory-binder mixture so as to fuse the binder contained therein adjacent the surface of the pattern, thereby forming a shell having a depth of from 0.1 to 0.75 inch corresponding to the shape of the pattern, removing said pattern from the fused refractory shell and bonding to said fused refractory shell a backing of a non-ferrous, heat-conducting metal having a melting point lower than that of the material to be cast, the outer surface of said metal being of increased surface area and including a plurality of fins and indentations so as to increase the heat-dissipating capacity thereof.

2. The method of making a permanent pre-cast shell mold for forming metallic castings comprising the steps of placing a pattern comprising a half-section of the metallic article to be cast within a heated body of finely divided refractory material containing 10 to 35 percent of a fusible binder, heating the refractory-binder mixtures to a temperature in the range of about 450° to 700° F. for from about five to ten minutes so as to fuse the binder contained therein adjacent the surface of the pattern, thereby forming a shell having a depth of from 0.1 to 0.75 inch corresponding to the shape of the pattern, removing said pattern from the fused refractory shell, baking said shell at a temperature in the range of 450° to 700° F. for from about twenty-four to forty-eight hours, and bonding to said fused refractory shell a backing of a non-ferrous, heat-conducting metal.

3. A permanent pre-cast mold comprising a shell of refractory material having a fused molybdenum carbide binder incorporated therein, said shell being of a thickness of from about 0.1 to 0.75 inch, the inner surface of said shell defining a die cavity and the outer surface thereof being bonded to a mass of aluminum, the outer

surface of said aluminum being of increased surface area and including a plurality of fins and indentations so as to increase the heat-dissipating capacity thereof.

4. A permanent pre-cast mold comprising a shell of refractory material having a fused binder incorporated therein, said shell being of a thickness of from about 0.1 to 0.75 inch, the inner surface of said shell defining a die cavity and the outer surface thereof being bonded to a mass of an aluminum, heat-conducting metal or alloy having a melting point lower than the material to be cast, the outer surface of said metal being of increased surface area and including means for increasing the heat dissipating capacity thereof.

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