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METHOD OF FABRICATING MOLDS

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The present invention relates to a method of fabricating molds for use in the precision casting of metal parts.

A general type of mold for precision casting of metals comprises a lining of finely-divided refractory material adapted to present a smooth surface to the metal being cast and a strong, porous backing or investment material which constitutes the mold proper. Such molds are made by applying to the surface of a wax pattern a coating comprising essentially a finely-divided refractory material and a settable, water soluble binder. This fine-grained coating containing a water-soluble binder is adapted to form a smooth, continuous interface against which the metal solidifies. After the coating has hardened, the coated pattern is embedded in a hardenable, gelatinous investment material having the necessary strength, porosity, and other properties desired in a mold of this type.

Since the binder of the mold lining material which is applied to the wax pattern is water-soluble, it has been necessary in the past to employ with such linings investment materials containing a non-aqueous or substantially non-aqueous liquid vehicle, such as an alcohol, to prevent disintegration of the lining by the liquid component of the investment material. With the application of precision molds to the manufacture of larger, more complex-shaped parts, for example, parts containing thin, wide sections, from metals of relatively high melting points, such as stainless steel alloys of the nickel-chromium type, it has been found that the usual investment materials containing non-aqueous vehicles are not sufficiently strong to back up or reinforce the precoat or lining material applied to the wax pattern. When the wax is melted out of the unfired mold, it expands and has a tendency to crack the mold lining. If the lining cracks, small pieces of it break off and produce rough surfaces on the cast mold parts or even pits where such broken pieces are trapped in the cast parts. Also, when hot metal enters molds of complex design, the metal erodes the cracked coating even more and penetrates the cracks between the lining material and mold proper.

Investment or mold materials containing water as the liquid vehicle offer the strength and density necessary to back up the lining coat of large complex-shaped molds and in these respects are much superior to investment materials containing non-aqueous binder vehicles. However, when a coated pattern is invested in such mold mixtures, the water tends to dissolve the water-solu-

ble pattern coating and to wash it away so that a smooth surface free from imperfections is no longer presented to the metal being cast in such a mold.

5 The present invention is based on my discovery that the above-mentioned difficulties may be overcome and a strong, durable mold obtained by contacting the coating applied to the wax pattern with a composition comprising an organo-silicon halide. This treatment of the lining material renders the coating sufficiently water-repellent to prevent substantial solution thereof by the aqueous component of the investment material but does not apparently prevent 10 a bonding of the investment material to the lining material sufficient to prevent cracking and scaling of the lining during subsequent heating of the mold. The amount of carbon deposited by the treatment is so small that it does not affect 15 the strength of the mold or cause any trouble due to evaporation or burning during the baking operation.

In the practice of my invention, a wax pattern which has preferably been washed with a suitable solvent, such as denatured alcohol, to remove any oily surface film, is provided with a surface coating of a finely-divided refractory material, such as silica or zirconia flour, which coating may conveniently be deposited by spraying, dipping, etc. Any suitable water-soluble inorganic binder may be used to bond the refractory material. I prefer to use the water-soluble silicates such as sodium silicate, sodium meta silicate, 25 potassium silicate, and the like. The powdered refractory material is mixed with a solution of the silicate and the resultant mixture applied to the wax pattern. If desired, a small amount of any suitable commercial wetting agent and a small amount of starch, gum arabic, or the like, 30 may be added to the mixture to improve its adhesion, cohesion and consistency. For best results the mixture should be of the consistency of thick cream. The coating, which may first be 35 dusted with a refractory material having a particle size larger than the particle size of the refractory material in the coating, is allowed to dry. It is thereafter treated with a composition comprising an organo-silicon halide or mixture of organo-silicon halides adapted to render the surface of the lining material which will come in 40 contact with the investment material sufficiently water-repellent to prevent solution thereof by the aqueous component of the investment material.

Any suitable organo-silicon halide or mixture may be employed in the practice of my invention

and the treatment may be carried out with the organo-silicon halide in vapor, liquid, or solution form. The vapor treatment of water non-repellent materials with organo-silicon halides to render them water-repellent is broadly disclosed and claimed in Patent 2,306,222 issued to Winton I. Patnode. Numerous examples of suitable organo-silicon halides are disclosed in the above-mentioned Patnode patent including alkyl (e. g. methyl, ethyl, butyl, etc.), aryl (e. g. phenyl), aralkyl (e. g. benzyl), alkaryl (e. g. tolyl) silicon halides and compounds containing hydrogen as well as one or more hydrocarbon radicals and halogen atoms attached to silicon. Mixed organo-silicon halides such as methyl phenyl silicon chlorides may also be employed. The compositions employed in the practice of my invention may also contain silicon halides other than the organo-silicon halides. For example, I may employ mixtures of organo-silicon halides and silicon tetrahalides, such for example as the methyl silicon chloride-silicon tetrachloride azeotropic mixtures disclosed and claimed in the copending application Serial No. 476,767, filed February 22, 1943, in the name of Frank J. Norton and assigned to the same assignee as the present invention. I prefer to use compositions containing a mixture of two or more organo-silicon halides containing an average of more than one halogen atom per silicon. A mixture of dimethyl dichlorosilane and methyl trichlorosilane having a chlorine content of about 60 per cent is particularly useful for the practice of the present invention.

Ordinarily it is sufficient to contact the coated pattern with vapors of an organo-silicon halide composition for from 3 to 5 minutes. If a liquid organo-silicon halide composition or a solution of an organo-silicon halide is employed, the necessary water-repellency may be obtained, for example, by dipping the coated pattern for a few seconds into either the liquid silicon halide or a solution thereof.

The treated patterns are allowed to set or age in the open air at room or slightly elevated temperatures for a short period of time prior to investment thereof in the mold material proper. In this way the hydrochloric acid, which is a by-product of the water-repellency treatment, is permitted to evaporate so that it does not subsequently interfere with the gelation or setting of the mold material. The coated patterns then are invested in any suitable mold composition containing water as the liquid vehicle. These mold compositions contain essentially a coarser-grained refractory material, such as silica (sand), alumina, zirconia, zircon, and the like, and a water-soluble binder such as an alkali silicate, a water-soluble phosphate cement or the like. A particularly useful mold composition is one containing about 95 per cent sand and about 5 per cent ferric phosphate plus sufficient water to form a mixture which sets or gels within a reasonable time. Such a mixture should remain fluid for a period of time sufficient to expel all of the air entrapped during the pouring or packing of the mold material around the coated pattern.

The mold and embedded pattern are allowed to stand for a number of hours, conveniently overnight, to obtain a thorough setting of the gel bond. They are then heated slowly to about 110° C. to drive out volatile matter and melt the wax pattern. By carrying out this heat treatment with the mold in an inverted position, the

fused wax of the pattern flows out of the mold, leaving a mold cavity. The mold is then further heated to temperature ranging, for example, between 1000° F. and 2000° F. preparatory to casting. This heating may have a threefold purpose, namely, to burn out all remaining wax and volatile matter; to expand the mold so as to compensate for metal shrinkage; and to produce a preheated mold that will enable thin sections to be filled before the metal freezes. During this heating cycle the coating has been found to adhere most tenaciously to the investment proper.

The fused metal or alloy desired to be cast may be introduced into the mold cavity, preferably under pressure, and after the cast metal has solidified, the mold is broken away and excess metal trimmed from the completed casting.

By means of my treatment of the mold lining, it has been possible to cast metal parts of intricate shapes from high melting point metals and alloys without experiencing any trouble due to solution of the mold lining during fabrication of the mold or cracking or breaking away of the mold lining during heat treatment of the mold or during casting of the metal part.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. The method of fabricating a mold which comprises coating a fusible pattern with a mixture of a finely-divided refractory material and an inorganic binding material, at least partially drying said coating, contacting said coating with a composition comprising an organo-silicon halide and thereafter embedding the coated pattern in a settable investment composition comprising a refractory material and an aqueous solution of a binder for said refractory material.

2. In the method of fabricating a mold which includes coating a fusible pattern with a refractory composition adapted to form a smooth, accurate mold lining and embedding the coated pattern in a refractory, settable, investment material, the step which comprises contacting the coated pattern with an organo-silicon halide adapted to render the refractory coating water-repellent before embedding the coated pattern in the investment material.

3. The method of fabricating a mold for the precision casting of metals which comprises coating a fusible pattern with a mixture of silica flour and an aqueous solution of a water-soluble silicate, drying said coating, contacting said coating with a composition comprising a mixture of methyl silicon halides to render said coating water-repellent and thereafter embedding the coated pattern in a settable slip comprising a mixture of a comminuted refractory mold material and an aqueous solution of a water-soluble binder.

4. The method of fabricating a mold for the precision casting of metals which comprises applying to the surface of a fusible wax pattern a coating comprising finely-divided silica, water, and an alkali silicate, dusting the surface of the wet coating with refractory material having a particle size larger than the particle size of the refractory material present in said coating, drying said coating, exposing the dried coating to vapors of a mixture of methyl silicon halides effective to render the exposed surfaces water-repellent and thereafter investing the coated pattern in a slip comprising a refractory material and a water-soluble binder.

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