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METHOD OF PRODUCING CASTING MOLDS

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It is well known in the founder's art that due to the contraction upon cooling cast metal bodies are always smaller than the models used. Therefore the dimensions of the models are increased in advance to such extent that the contraction upon cooling is compensated. This procedure, however, cannot be used, if natural models (plants, living beings, etc.) or artificial models of complicated form (for instance wax models for dental purposes) are to be copied in metal, as the contraction or shrinkage cannot be compensated by a corresponding increase of the model dimensions.

In the present specification the term α-quartz means the form in which quartz is stable at a temperature below 575° C. β-quartz means the form in which quartz is stable at a temperature above 575° C. α-cristobalite is the stable form of cristobalite below 215° C., while β-cristobalite is the stable form thereof above 215° C. Tridymite exists as α-tridymite below 117° C., as β-tridymite between 117° C. and 160° C. and as α-tridymite above 160° C. When β-quartz is heated to a temperature around 1000° C. to 1400° C., it is converted irreversibly into cristobalite or tridymite depending on the particular temperature, time and possible catalyst, etc.

In case castings of relatively low melting metals or alloys with a melting point below about 1000° C. are to be made the mentioned difficulty is overcome by making a wax-model of the original model and embedding it in a special mass which upon being heated to the melting temperature of the metal expands as much as the metal casting contracts upon cooling while the wax melts and can be drawn off. In the composition of the mass use is made for instance of the reversible conversion of quartz. By converting α-quartz into β-quartz at 575° C., for instance, a linear expansion of 1.4% is obtained. In practice the quartz is mixed with gypsum which by adding water effects the hardening of the mold. Due to this expansion of the quartz, linear contractions of the metal up to about 1.5% can be compensated.

Such masses, however, cannot be used if castings of high melting metals or alloys are desired, the melting point of which lies above 1000° C. up to 1400° C. and more and the linear contraction of which is higher than 1.5%. Besides this the fire-proof nature of such masses is too small; moreover, the sulphur of the gypsum easily reacts with the metal at the temperature in question.

According to the present invention the mentioned disadvantages and restrictions are overcome. The invention is based upon the conversion of α-quartz into cristobalite or tridymite at high temperatures. This conversion is combined with a very considerable expansion which is sufficient for the purposes in question. According to the invention casting molds of definite thermal expansion for founding bodies of metals or alloys with high melting point are manufactured by forming the mold of a material essentially consisting of SiO_2 wholly or essentially in the form of α-quartz and heating the mold so that the α-quartz is converted into α-tridymite or β-cristobalite.

As the velocity of the α-quartz conversion depends upon a number of circumstances, for instance size of the quartz particles, provenience of the quartz, conversion temperature, duration of heat treatment etc., one uses such kinds of quartz and such conversion temperatures that the desired conversion is finished as rapidly as possible. For instance α-quartz in the form of rock-quartz is used, 90% of which in pulverized form is mixed with 10% of the same quartz in the colloidal state. By adding water to this mixture the colloidal matter effects the agglutination of the mass upon drying. By treating the mass at 1300° C. for one hour the linear expansion amounts to 1.9%.

In order to improve the agglutination of the mass one may use organic binding means, as glue, dextrin etc., which burn at high temperatures and which are soluble in water, or organic binding means soluble in organic solutions, as for instance mastic, rosin, CCl_4 etc. A more rapid drying of the casting mold is thereby obtained. One can also be made of inorganic binding means, provided that they do not lower the melting point of the mass.

The conversion of the α-quartz can be accelerated by adding catalysts which simultaneously increase the expansion obtained by the conversion.

A very satisfactory catalyst has been found to be water glass which also has binding properties. By using a mass comprising

	Parts
Pulverized rock-quartz	80
Rock-quartz in a colloidal state	10
Water glass	10

heating it up to 1300° C. over one hour and holding it at this temperature for ½ hour one obtains a linear expansion of 2.1%. The velocity of conversion and the degree of expansion can still be

improved by adding further catalysts to the mentioned mass. By adding for instance 1% sodium wolframate the expansion is increased under equal conditions to 2.3%, while simultaneously the agglutination of the mass is accelerated.

The expansion can be restricted, if desired, by using catalysts, which decompose at high temperatures, as sodium silicofluoride or other fluorides, salts of phosphoric and boric acid etc., or mixtures thereof.

The increase of the expansion during the conversion process may be influenced by using a mixture of rapidly convertible and slowly convertible quartz modifications. The expansion may further be regulated by the addition of tridymite or cristobalite to the α-quartz.

In view of the considerable and relatively rapid expansion of the casting mold a uniform heating is required in order to avoid the creation of cracks. Therefore the casting molds are indirectly heated by inserting them into muffles consisting of material of high heat conductivity, preferably silicium-carbid. A further advantage is obtained in that the casting molds are only slowly cooled after the muffles are removed from the furnace.

The invention further consists in the avoidance of a chemical reaction between the melted metal and the mass of the casting mold or at least considerably reduced either by composing the mass or by treating the casting mold in a special manner.

It is known that the surface of cast metal bodies produced by founding metals other than precious metals or alloys consisting exclusively or partly of non-precious metals is covered by a more or less thick adhering layer of oxide. This is particularly true with regard to the metals of the iron group and their alloys with metals of the 3rd to the 6th group of the periodical system of elements. Such metals and their alloys having in most cases a melting point above 1000° C. up to 1600° C., are easily converted at the melting temperature into oxide due to their high affinity with oxygen. They are able to withdraw oxygen from other substances, even from silicic anhydrite, and to react therewith to oxide. Therefore by founding such alloys in the casting molds in question one obtains cast metal bodies which eventually are covered by a strong reaction layer of oxides, silicates etc., below which lies a rough metal surface. Besides the fact, that the removal of this layer by grinding, by means of a sand-jet or by chemical means in one or more runs causes a considerable loss of time, the accuracy of the cast metal bodies is essentially reduced. This disadvantage is of particular importance in the manufacture of cast metal bodies which obtain their definite form by the casting process itself, for instance such for dental purposes, which must be very accurate and which would lose their accuracy by subsequent grinding.

The creation of such a reaction layer can be avoided or practically avoided by two different measures.

One way consists in adding in advance to the mass from which the casting mold is built, substances which would be created by the reaction between melted metal and the mass, or the components of such substances which react with each other during the heating period.

The other way consists in that, contrary to the usual practice the temperature of the casting mold does not correspond to the melting point of the metal, but is considerably lower. For instance a melted alloy comprising 30% chromium and 70% nickel and having a temperature of about 1400° C. is founded in a casting mold the temperature of which is only about 700–800° C. It has been found that in spite of the great difference of 600–700° C. between the temperature of the metal and the temperature of the casting mold the metal does not coagulate untimely. For such procedure it is evident only such masses can be used which practically neither expand nor contract within the temperature interval between 700 or 800° C. and 1400° C. The mass according to the invention corresponds to this condition as after the conversion of the α-quartz is completed a perceptible contraction begins below about 700° C. The predetermined expansion of the casting mold is therefore maintained within the temperature interval between about 700° C. and about 1400° C. or more.

What I claim is:

1. Method of producing casting molds of definite shape for forming bodies of metals or alloys with high melting points and compensating for the shrinkage of such metals or alloys comprising forming a mold consisting essentially of quartz in the form in which it is stable below 575° C., increasing the temperature of the mold to a temperature above 870° C., whereby the quartz of said mold is converted, with expansion, into the form in which it is stable above 575° C., and maintaining the mold above 870° C. for a sufficiently long period to convert the quartz, with expansion, into a compound of the group consisting of tridymite and cristobalite.

2. Method of producing casting molds as defined in claim 1 and in which a catalyst of the group consisting of sodium wolframate, silicofluorides, salts of phosphoric acid, and salts or boric acid is added to the material of the mold.

3. Method of producing casting molds as defined in claim 1 and in which a material of the group consisting of cristobalite and tridymite is included in the material of the mold.

4. Method of producing casting molds as defined in claim 1 and in which in the mass substances are included which would be created by the reaction between the melted metal and the mass.

5. Method of producing casting molds as defined in claim 1 and in which in the mass substances are included which by heating the mold produce the reaction product which would be created by the reaction between the melted metal and the mass.

6. Method of producing casting molds as defined in claim 1 and in which the casting mold is reduced to a temperature below the melting temperature of the metal before the metal is poured into the mold, for preventing reaction between the melted metal and the material of the mold.

7. Method of producing casting molds of definite shape for forming bodies of metals or alloys with high melting points and compensating for the shrinkage of such metals or alloys comprising forming a mold consisting essentially of quartz in the form in which it is stable below 575° C., increasing the temperature of the mold to a temperature of about 1300° C., whereby the quartz of said mold is converted, with expansion, into the form in which it is stable above 575° C., and maintaining the mold at about 1300° C. for a sufficiently long period to convert the quartz, with expansion, into a compound of the group consisting of tridymite and cristobalite.

8. Method of producing casting molds of definite shape for forming bodies of metals or alloys with high melting points and compensating for the shrinkage of such metals or alloys comprising forming a mold consisting essentially of quartz in the form in which it is stable below 575° C., increasing the temperature of the mold to a temperature of about 1300° C., whereby the quartz of said mold is converted, with expansion, into the form in which it is stable above 575° C., and maintaining the mold at about 1300° C. for about one-half hour to convert the quartz, with expansion, into a compound of the group consisting of tridymite and cristobalite.

9. Method of producing casting molds of definite shape for forming bodies of metals or alloys with high melting points and compensating for the shrinkage of such metals or alloys comprising forming a mold consisting essentially of quartz in the form in which it is stable below 575° C., gradually increasing the temperature of the mold to a temperature of about 1300° C. over a period of about one hour, whereby the quartz of said mold is converted, with expansion, into the form in which it is stable above 575° C., and maintaining the mold at about 1300° C. for a period of about one-half hour to convert the quartz, with expansion, into a compound of the group consisting of tridymite and cristobalite.

10. Method of producing casting molds of definite shape for forming bodies of metals or alloys with high melting points and compensating for the shrinkage of such metals or alloys comprising forming a mold consisting essentially of rock quartz, increasing the temperature of the mold gradually over a period of about 1 hour to a temperature above 870° C. whereby the rock quartz is first converted, with expansion, into the form in which it is stable above 575° C., and maintaining the mold above 870° C. to convert the quartz, with expansion, into a compound of the group consisting of tridymite and cristobalite.

11. Method of producing casting molds of definite shape for forming bodies of metals or alloys with high melting points and compensating for the shrinkage of such metals or alloys comprising forming a mold consisting essentially of rock quartz, increasing the temperature of the mold gradually over a period of about 1 hour to a temperature of about 1300° C. whereby the rock quartz is first converted, with expansion, into the form in which it is stable above 575° C., and maintaining the mold at about 1300° C. for a period of about one-half hour to convert the quartz, with expansion, into a compound of the group consisting of tridymite and cristobalite.

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