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METHOD OF CASTING METAL IN A MOLD CONTAINING VINYL AROMATIC BINDERS

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1 Claim. (Cl. 22—193)

This invention relates to molds for casting refractory metals, such as titanium, zirconium, hafnium, etc., and more particularly to rammed- and pressed-graphite molds, and to methods for preparing such molds. In the past, in the casting of certain active refractory metals, such as titanium, it has been difficult to find suitable materials for molds. This has been because the active metal combines with the mold materials and with the oxygen in the mold materials to produce contamination extending well into the surface of the casting. Best results, in the past, have come about through the use of machined-graphite molds, but such molds are expensive, can only be used once if the design of the casting is intricate, and require preheating to eliminate volatile contaminants or to prevent cold shuts before they can be used to receive molten metal.

It is, therefore, an object of this invention to provide a method for preparing molds for use in the casting of refractory metals.

It is another object of this invention to provide molds for casting refractory metals.

Still another object of this invention is to provide molds for casting refractory metals without contaminating such cast metals.

Still another object of this invention is to provide molds, and a method of preparing such molds, which require no preheating before receiving molten metal.

Other objects and advantages of the present invention will be apparent from the following detailed description thereof.

In general, this invention comprises graphite or carbon molds bonded with a polymerized vinyl aromatic compound for casting refractory metals and methods for making such molds.

It has been found that graphite or carbon molds for use in casting active refractory metals can be prepared by

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methyl styrenes, such as polyorthomethyl styrene, meta-methyl styrene, paramethyl styrene, and combinations of the three. Other useful polystyrene compounds include poly 2,4-dimethyl styrene, poly 2,5-dimethyl styrene, poly 3,4-dimethyl styrene, and 1,3,5-trimethyl styrene. Polystyrene and polydivinyl benzene and combinations of the two also provide preferred binder materials for the present invention.

In selecting bonding resins for the molds of the present invention, it has been found that satisfactory resins are characterized by the fact that they contain no oxygen and, preferably, little or no nitrogen. These characteristics are important because of the extreme activity of the refractory metals to be cast in the molds of this invention, and because of the fact that contamination of these metals, particularly titanium and zirconium, render them unsuitable for many purposes because of the deleterious effect of oxygen and nitrogen on the properties of these metals.

Graphite molds with vinyl aromatic resin binders can be prepared by either the ram method or by pressing. To illustrate the procedure for preparing ram molds, Example I below is given:

EXAMPLE I

A ram mold was prepared as follows:

(1) Powdered graphite was mixed with 4%, by weight, polystyrene. The polystyrene was dissolved in benzene prior to the mixing operation.

(2) The mixture was rammed into a core box.

(3) The rammed mixture was baked in the core box for 16 hours at 100° F.

(4) The resulting mold was stripped from the core box.

(5) The stripped mold was baked for one hour at 175° F.

Casting tests made with the mold of the above example showed that the mold produced castings with freedom of contamination equivalent to that obtained when using machined-graphite molds. It is well known that contamination from carbon, oxygen, or nitrogen causes a rapid increase in the hardness of titanium. Therefore, hardness measurements taken on a cross section of a titanium casting provide a relative indication of the depth and degree of casting contamination. Table I shows the increase in hardness values obtained on titanium castings prepared (a) in the rammed-graphite mold with the polystyrene binder, (b) a machined-graphite mold, and (c) a zircon mold, zircon being the most inert oxide material for making molds for refractory metals.

Table I

Depth Below Surface (inches)	Hardness Increase Over Center Hardness, Knoop Hardness Numbers					
	1-inch Section			1-inch Section		
	Rammed-Graphite Mold	Machined-Graphite Mold	Zircon Mold	Rammed-Graphite Mold	Machined-Graphite Mold	Zircon Mold
0.002.....	+43	+28	219	+2.....	+17.....	118
0.004.....	+1	+15	225	-1.....	+5.....	108
0.006.....	+18	0	205	-2.....	not measured..	97
0.008.....	+7	-3	190	0.....	-1.....	88
0.012.....	-6	+13	172	+2.....	-6.....	58
0.016.....	-14	+2	132	not measured..	-1.....	57
0.024.....	+8	-4	85	do.....	-17.....	41
0.032.....	+2	-4	40	do.....	not measured..	0

bonding such molds with a polyvinyl aromatic compound. For example, satisfactory bonding materials would include polyvinyl anthracene, polyvinyl naphthalene, polyvinyl methylnaphthalene, polystyrene, and certain indene resins. Other examples include the poly-

The values listed in Table I show clearly that castings prepared in the resin-bonded, rammed-graphite mold compare very favorably, so far as surface contamination (as evidenced by increased surface hardness) is concerned, with castings prepared in machined-graphite molds. The

resin-bonded, rammed-graphite mold produced castings considerably superior to those cast in the zircon mold, as evidenced by values listed in Table I above.

Example II below describes a procedure for preparing pressed-graphite molds with a vinyl aromatic resin as the binder. For this particular example, divinyl benzene was used as a binder.

EXAMPLE II

A pressed-graphite mold was prepared as follows:

(1) A mixture of 97%, by weight, graphite and 3% divinyl benzene was prepared.

(2) The mixture was placed in a die and compressed at 2,500 p. s. i.

(3) The die was heated to 350° F. and held at 350° F. for five hours.

(4) The die was cooled to room temperature, pressure being maintained during the cooling process.

A titanium casting prepared in this mold also compared favorably, on the basis of surface contamination, with the similar casting prepared in a machined-graphite mold. Table II shows the increased surface hardness values as compared with the hardness at the center of castings prepared (a) in the pressed-graphite mold with the divinyl benzene binder, (b) in a machined-graphite mold, and (c) in a zircon mold.

Table II

Depth Below Surface (inches)	Hardness Increase Over Center Hardness, Knoop Hardness Numbers					
	1-inch Section			½-inch Section		
	Pressed-Graphite Mold	Machined-Graphite Mold	Zircon Mold	Pressed-Graphite Mold	Machined-Graphite Mold	Zircon Mold
0.002-----	+79-----	+28-----	219-----	+68-----	+17-----	118-----
0.004-----	+67-----	+15-----	225-----	+41-----	+5-----	108-----
0.008-----	+31-----	-3-----	190-----	-5-----	-1-----	88-----
0.012-----	+22-----	+13-----	172-----	+9-----	-6-----	58-----
0.016-----	-1-----	+2-----	132-----	-4-----	-1-----	57-----
0.020-----	-12-----	not measured.	not measured.	+24-----	not measured.	not measured.
0.024-----	not measured.	-4-----	85-----	not measured.	-17-----	41-----
0.028-----	-10-----	not measured.	not measured.	+1-----	not measured.	not measured.
0.032-----	not measured.	-4-----	40-----	not measured.	do-----	0-----
0.036-----	-11-----	not measured.	not measured.	-15-----	do-----	not measured.

It will be apparent that new and useful mold compositions for the casting of reactive refractory metals have been described. Methods of preparing molds from these compositions have been set forth and illustrated. Castings prepared in molds of the present invention have consistently evidenced decreased surface contamination as compared with castings prepared in molds bonded with

oxygen-containing binders. Castings prepared in the molds of the present invention are comparatively as contamination-free as castings prepared in machined-graphite molds.

Various changes in the exact disclosure of this specification may be made without departing from the scope of the new teaching of this invention, which is herein-after more particularly set forth in the attached claim.

What is claimed is:

The method of producing refractory metal castings which are relatively free of surface contamination which comprises casting the refractory metal in a mold prepared from a material selected from the group consisting of carbon and graphite and a binder selected from the group of polymers consisting of polyvinyl anthracene, polyvinyl naphthalene, polyvinyl methanaphthalene, polyvinyl toluene, orthopolymethylstyrene, metamethylstyrene, paramethylstyrene, combinations of ortho-, meta- and paramethylstyrene, 2,4-dimethyl styrene, 2,5-dimethyl styrene, 3,4-dimethyl styrene, 1,3,5-trimethyl styrene, polystyrene, polydivinyl benzene, and combinations of polystyrene and polydivinyl benzene, said binder being present in an amount conventional for binders in refractory molds.

References Cited in the file of this patent

UNITED STATES PATENTS

2,683,296 Drumm et al. July 13, 1954
2,683,669 Coler July 13, 1954

FOREIGN PATENTS

596,837 Great Britain Jan. 12, 1948

Dedication

2,854,715.—*John G. Kura*, Columbus, Ohio. METHOD OF CASTING METAL IN A MOLD CONTAINING VINYL AROMATIC BINDERS. Patent dated Oct. 7, 1958. Dedication filed Aug. 2, 1974, by the assignee, *The Battelle Development Corporation*.

Hereby dedicates to the People of the United States the entire remaining term of said patent.

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