

[54] **MOLD STOOL**

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[58] **Field of Search**..... 249/204

[56] **References Cited**

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[57]

ABSTRACT

A mold stool with an insert made of carbon-bonded-silicon carbide-graphite refractory material having thermal conductivity within a range of 20 - 30 Kcal/mhr°C is provided for casting steel ingot. The stool is not only endurable against severe abrasive actions of the flowing hot molten steel, but is effective in preventing internal defects of ingot metal due to the difference in thermal conductivity between the stool and insert material.

Suitable material and constructions to fix such insert within the stool are also provided.

8 Claims, 2 Drawing Figures

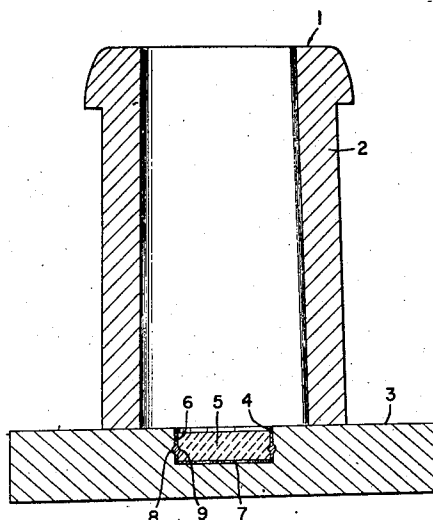


FIG. 1

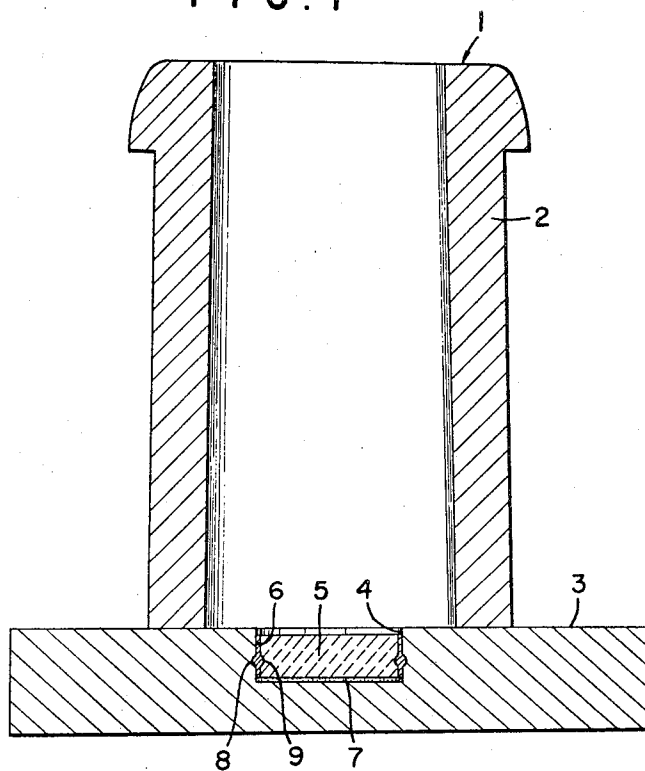
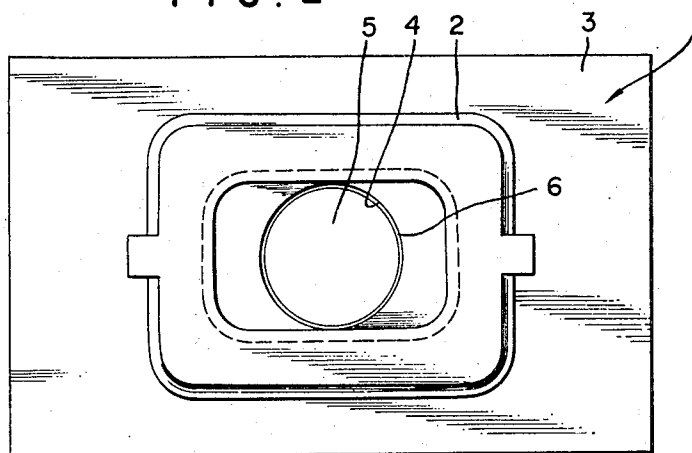


FIG. 2



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MOLD STOOL

BACKGROUND OF THE INVENTION

The present invention relates to molds for casting steel ingots, and more particularly to improvements in mold stools.

In the art, the ingot mold of top pouring type is generally used, in which a cast iron ingot case is rested on a flat cast iron plate so called "stool" with its bottom open end down, and molten metal is cast into the mold through top opening of the ingot case.

Accordingly, the unprotected surface of the stool, especially around the center, is eroded and pitted severely due to vigorous pounding action of the flowing molten metal.

Pitted rough surface thus produced results in sticking of ingot metal to the stool, so that severe and costly operations are required to separate them. Moreover, the life of the stools may be decreased by such severe separating operations.

Further, the bottom surface of the ingot which has been cast from such defective stool, becomes so irregular that the greater part of the bottom must be removed before being subjected to the subsequent operations.

As a result, the cost of the products may be raised unduly by these defects.

Several methods of protecting stools from such defects have been proposed. They may be substantially classified into the following two groups;

1. Coating inside surface of the mold with layers of refractory material such as fused silica.

As the coating is not sufficient to bear upon such severe actions of the molten metal, this method is not satisfactory for protecting large size stools, and can be used only for casting small size ingots of less than about 5 tons.

2. Use of inserts within hollows provided on the surface of stools.

Inserts of fire clay brick, silica brick or the like ceramic bonded refractory material have been used widely even for larger size ingots. However, there are still some problems about their strength and anti-spalling characteristics. They may be broken and included in the steel as non-metallic inclusions.

Further serious defects are caused within the ingot metal cast from this type of stools.

As the thermal conductivity of such refractory material being extremely low (1 - 5 Kcal/mhr°C) as compared to that of cast iron, irregular cooling occurs when the molten metal is cast into the mold, and the defects such as pipings or blow holes are caused within the ingot.

To improve these defects, electrode graphite, which has a high enough thermal conductivity, has also been proposed for the insert. However, they are not useful as being worn rapidly by oxidation.

SUMMARY OF THE INVENTION

Accordingly, a main object of the present invention is to provide a suitable material for the insert, having necessary strength, anti-spalling and -oxidation characteristics, as well as high enough thermal conductivity to prevent occurrence of the internal defects of ingot as aforementioned.

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Another object of the present invention is to provide a suitable material and constructions to join the inserts to the stools.

It has been found that the foregoing and related objects may be readily attained in an insert made of carbon-bonded-silicon carbide-graphite refractory material having thermal conductivity within a range of 20 - 30 Kcal/mhr°C.

The material is made mainly of natural graphite, silicon carbide and silica, bonded together with organic binder such as tar, and comprises 30 - 50 percent by weight of carbon and graphite, 30 - 50 percent by weight of silicon carbide and 5 - 20 percent by weight of silicon oxide.

Physical properties of such insert are as follows:

Bulk Specific Gravity	1.9 - 2.3
Apparent Specific Gravity	2.0 - 2.8
Apparent Porosity (%)	17 - 25
Compressive Strength (Kg/cm ²)	260 - 700

Inserts of higher compressive strength may be obtained from groups of higher silicon carbide content, and these groups may be used suitably for larger size stools.

Inserts of higher thermal conductivity may be mainly obtained from groups of higher graphite content. In these groups, a small amount of iron oxide and zirconium oxide may be added to increase strength.

As will be described below in examples, the inserts of the present invention have shown excellent results in the practical performances.

It has also been found that a material of the following composition may be used suitably to join such inserts to the stools.

	Wt. %
Silicon Carbide	45 - 55
Ferro Silicon	10 - 15
Frit	5 - 9
Colloidal Silica Solution (5 - 20 % solids by weight)	25 - 35

wherein, main components of the frit are as follows:

	Wt. %
Na ₂ O, K ₂ O	20 - 25
B ₂ O ₃	8 - 15
SiO ₂	45 - 55
CaO	10 - 15

Further embodiments of the present invention will be described below in more details with reference to the accompanying drawings, wherein:

FIG. 1 is a sectional view of the ingot mold embodying the present invention.

FIG. 2 is a plan view of the mold shown in FIG. 1.

DESCRIPTION OF PREFERRED EMBODIMENT the center

Referring now to the drawings, the top pouring type ingot mold 1 includes cast iron ingot case 2 rested upon cast iron stool 3. A circular hollow 4 is formed about the center of the surface of stool 3, and an insert 5 of circular plate form is fitted therein and secured firmly with joint material 6 of the composition aforementioned. A thin layer 7 of refractory powder, preferably the powder components of the joint material, is placed on the bottom surface of hollow 4 as a cushion. The joint material 6 should be dried thoroughly after being applied. Any suitable form may be employed for insert 5 and corresponding hollow 4 other than circular.

It is preferable that the upper surface of insert 5, which is to be exposed to molten metal, is about 15 - 40 % of the mold bottom area in case of producing large size steel ingot weighing 10 tons or over. For small size ingot of less than 10 tons, 100 percent would be better.

It is also recommended that the surface of insert 5 is lowered slightly from the surface level of stool 3 - about 30 - 50 mm according to the size of ingot - so as to prevent splashing by providing a pool under the falling molten metal at the beginning of the pouring operations, as well as to facilitate the provision of a support on the bottom of the ingot which may be used conveniently for the subsequent operations.

To secure the insert more firmly within the hollow, annular or spiral grooves 8 and 9 are provided on the opposed vertical surfaces of hollow 4 and insert 5 respectively, preferably at the lower half of the insert. Joint material 6 filled within grooves 8 and 9 may hold insert 5 securely by its wedge action.

EXAMPLE 1

Inserts of the following composition were made up; by mixing required amount of natural graphite, silicon carbide, silica, iron oxide, zirconium oxide and frit, all in a powdered state; compounding the mixture with a sufficient amount of organic binder such as coal pitch and tar; forming the compounded mixture by pressing; and firing the formed bricks at a temperature of about 1200°C.

	Wt. %
Carbon and Graphite	37 - 46
Silicon Carbide	32 - 40
Silicon Oxide	9 - 12
Aluminium Oxide	2.9 - 3.5
Iron Oxide	2.0 - 2.4
Zirconium Oxide	2.5 - 3.1
Alkali Metal Oxide	0.6 - 1.2
Boron Oxide	0.3 - 0.6

Physical properties of these inserts were as follows:

Bulk Specific Gravity	1.95 - 2.00
Apparent Specific Gravity	2.27 - 2.40
Apparent Porosity (%)	20 - 25
Compressive Strength (Kg/cm ²)	320 - 360
Thermal Conductivity (Kcal/mhr°C)	22 - 28

The inserts were fixed within the hollow provided on the surface of stools with the joint material as mentioned before. The stools were used for casting steel ingots, each more than 10 tons in weight. The stools could withstand more than 70 times of usage. Erosions of stools were extremely decreased and no appreciable defect was observed within the ingot metal.

EXAMPLE 2

Inserts of the following composition were made up by the similar process as described in Example 1, except that iron oxide and zirconium oxide were not added in this example.

	Wt. %
Carbon and Graphite	30 - 32
Silicon Carbide	42 - 48
Silicon Oxide	16 - 18
Aluminium Oxide	1.0 - 1.5
Alkali Metal Oxide	0.6 - 1.2
Boron Oxide	0.3 - 0.6

Physical properties of these inserts were as follows:

Bulk Specific Gravity	2.15 - 2.21
Apparent Specific Gravity	2.60 - 2.71
Apparent Porosity (%)	17 - 18
Compressive Strength (Kg/cm ²)	690 - 700
Thermal Conductivity (Kcal/mhr°C)	20 - 25

The inserts were jointed to the stools by the similar way as described in Example 1, and used for casting steel ingots, each more than 15 tons in weight.

The stools could withstand more than 80 times of usage without showing any appreciable defect. No appreciable defect was observed also within the ingot metal.

While the product herein described constitutes a preferred embodiment of the invention, it is to be understood that the invention is not limited to this precise product, and that changes may be made therein without departing from the scope of the invention.

What is claimed is:

1. A mold of the top pouring type in which an ingot case is received on a stool for casting a steel ingot in which said stool has an insert fixed within a hollow provided on the upper surface thereof substantially at the center thereof, the improvement in which said insert is made essentially of carbon-bonded-silicon carbide-graphite refractory material having thermal conductivity within a range of 20 - 30 Kcal/mhr°C.

2. The mold of claim 1 in which said insert is made principally of natural graphite, silicon carbide and silica, bonded together with organic binder, and comprises 30 - 50 percent by weight of carbon and graphite, 30 - 50 percent by weight of silicon carbide and 5 - 20 percent by weight of silicon oxide.

3. The mold of claim 2 in which said insert comprises 37 - 46 percent by weight of carbon and graphite, 32 - 40 percent by weight of silicon carbide, 9 - 12 percent by weight of silicon oxide.

4. The mold of claim 1 in which said insert comprises 30 - 32 percent by weight of carbon and graphite, 42 - 48 percent by weight of silicon carbide and 16 - 18 percent by weight of silicon oxide.

5. The mold of claim 2 in which said insert further comprises 2.0 - 2.4 percent by weight of iron oxide and 2.5 - 3.1 percent by weight of zirconium oxide.

6. The mold of claim 1 in which said insert is fixed within said hollow with a joint material comprising 45 - 55 percent by weight of silicon carbide, 10 - 15 percent by weight of ferro silicon, 5 - 9 percent by weight of frit and 25 - 35 percent by weight of colloidal silica solution (5 - 20 percent solids by weight), in which said frit comprises 20 - 25 percent by weight of alkali metal oxide, 8 - 15 percent by weight of boron oxide, 45 - 55 percent by weight of silicon oxide and 10 - 15 percent by weight of calcium oxide.

7. The mold of claim 1 wherein the exposed upper surface of said insert comprises 15 - 40 percent of the exposed area of the stool in said case for producing large size steel ingot weighing approximately 10 tons or more.

8. The mold of claim 1 wherein at least one groove is formed annularly or spirally on each of the opposed surfaces of said stool at said hollow and in said insert respectively.

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