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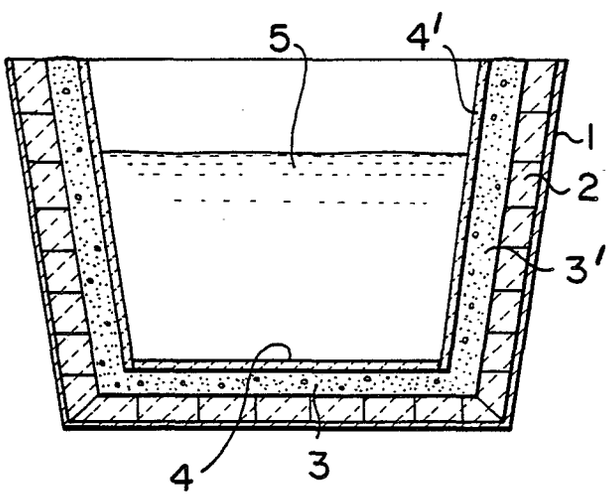
(54) A vessel for molten metal.

(57) A vessel for molten metal particularly a tundish for the continuous casting of steel, having a metal shell (1) with a refractory brick layer (2) and a refractory adiabatic — heat resistant — lining (4, 4¹) on the inner side. In contact with the lining (4, 4¹) is a refractory layer (3, 3¹) in loose form which is sintered at a temperature higher than 500°C.



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TITLE

"A vessel for molten metal."

This invention relates to an improvement in or relating to the structure of a vessel for molten metals, particularly a tundish used in the continuous casting of steel and which requires heat retention properties.

A known tundish for continuous casting of steel has a steel shell provided with a refractory non-consumable durable lining and an adiabatic (heat resistant) consumable lining. Japanese Patent Publication No. 8448/79 describes a technique in which between the consumable lining and the non-consumable lining there is provided a refractory material which is of dispersed and not of solid form, thereby making a heat insulating layer or lining.

A consumable lining is a temporary lining and is required to have strength enough to endure for the time of a single pouring operation only, based on adiabatic properties. Therefore, except for low temperature melts such as molten aluminium, there is usually used a base of brick or a mouldable refractory layer which forms a non-consumable lining so that even if the consumable lining is damaged during the pouring process due to the high temperature of the melt, or if in extreme cases the consumable lining is used up, leakage does not occur due

to the protection from the strength of the non-consumable lining. In the said Publication No. 8448/79 there is provided a space between the durable lining and the temporary lining whereby the space is filled with a refractory which consists of dispersed particles and which is not solid, the intention being to lessen the thickness of both linings; the space filled with a refractory is convenient for removing the temporary lining after the completion of pouring. Owing to the fluidity of the particles of the refractory layer, however, the vessel will no longer have resistance to the entry of melt when the temporary lining is damaged or partially peeled away. If protection against such occurrence is required it is not possible to decrease the thickness of the temporary lining or the durable lining.

An object of this invention is to obtain heat resistance and heat retention by preventing the refractory in a dispersed (loose) form from collapsing and by sintering the refractory using the temperature rise and heat from the molten metal, thereby forming an integral shell of a refractory or heat insulating solid layer over the external surface of the layer in the region of the contact point with the rear portion of the innermost refractory adiabatic lining as a temporary lining or over the layer completely.

According to this invention there is provided a vessel for molten metal characterised by a metal outer shell with a refractory adiabatic lining on the inside spaced from the shell, a refractory layer in loose form which is sintered at a temperature higher than 500°C being provided in contact with the lining between the lining and shell.

In the vessel the outermost side is provided with a steel or other metal shell with the innermost part in contact with the melt having a refractory and heat insulating lining, the inside being provided with a durable lining which, in the case of comparatively low temperature melts, can be omitted.

If a durable lining is used it is preferable for the lining to be based on refractory bricks or a castable refractory or like material. If bricks are used sufficient joints are applied to prevent entry of refractory in loose form into the joints. The refractory adiabatic lining provided on the innermost side is a moulded layer which is conventionally employed and based on a refractory powder, an organic or inorganic fiber and a binder. Such material is consumable, light and highly adiabatic and is used in the form of thin board.

Between the refractory adiabatic lining and the shell or the durable lining a space is provided which is filled

with a refractory in loose form. The refractory in loose form is one which does not melt or is not shrunk to any great extent when used, and may comprise siliceous sand, olivin sand, chromite, zircon sand, chamotte, alumina, magnesia, brick, slag or the like in the form of powder or grain mixed with a known binder, the mixture being sintered at a temperature above 500°C. The sintering temperature is a temperature to which the refractory layer in the loose form is subject through the refractory adiabatic lining at comparatively low temperature of molten metal, and for molten metals lower than this temperature it is unnecessary to select refractory material with particular care. Depending upon sintering temperature and the kind of refractory to be used, powders or liquids can be added to promote sintering. Use can be made of sintering agents such as glass and iron oxide, flux such as boron compound, fluoride and alkali compound, and binders such as paste, resin, pitch and rubber, the amount being such that the fluidity of the mixture does not adversely affect the filling operation into the space.

The invention is described further by way of example with reference to the accompanying drawings, in which:-

Figure 1 is a schematic sectional view showing one form of vessel for molten metal, and

Figure 2 is a schematic sectional view showing another form of vessel.

In Figure 1 a durable lining 2 is arranged on the inside and in contact with a metal shell 1 and a refractory 3 in loose form is laid on the bottom. The top of the refractory 3 is lined with a refractory adiabatic bottom lining board 4, and a refractory adiabatic side lining board 4^1 forms a gap almost of the same thickness as the bottom refractory layer 3, and the board lies parallel with the side walls with the space between the lining 2 and the board 4^1 filled with the refractory in the loose form from the top to form a refractory side layer 3^1. The filling operation may be carried out manually or by a blowing machine.

Figure 2 shows another embodiment of the invention in which the durable lining has been omitted, and the refractory 3, 3^1 in loose form is applied in the same way as in the first example. When joining the refractory adiabatic lining board it is possible to coat the edges with a binder or a jointing agent. The vessel for molten metal thus produced with the linings is subject to the molten metal, either with preheating for a short period of time at temperatures from 300 to 800°C or without preheating. If the temperature of the molten metal is comparatively low as in molten aluminium it is preferable to make the refractory adiabatic lining board as thin as possible (such as 5 mm) because there is less lowering

of the temperature of the metal by heat absorption of the lining board. The refractory in loose form is sintered at low temperatures and therefore if a powdery refractory mixed with thermo-setting resin is used, such as resin-coated sand, the powdery refractory is solidified due to the heat of the molten metal though the board when the surface area brought into contact with the board is carbonized for solidification to form a solid lining layer, thereby maintaining an adiabatic heat-retaining layer for one casting operation. Further, if the temperature of the molten metal is high as in steel the thickness and type of lining layer can be made the same as for molten aluminium or greater by using a high quality refractory material, according to the capacity of the vessel, the working time, the kind of working etcetera.

Besides the lining as described herein, the lining may be provided with a specifically high grade refractory at the pouring point and with an exothermic moulding around the lip.

Examples of the invention are described hereunder.

Example 1

a 65 mm thick lining of refractory brick (chamotte brick) is applied in contact with a shell of steel tundish (in which the upper portion width is 650 mm, the bottom width is 420 mm, the depth is 750 mm and the length

is 5,800 mm), the inside of the vessel is lined with a 25 mm thick refractory adiabatic lining board moulded with quartz sand, kaolin fiber and silica sol, the space between the refractory brick and the lining board is 10 mm wide and filled with a powdery mixture of 99% siliceous sand and 1% anhydrous borax. However, at the melt outfall a corundum of 500 mm x 100 mm thick is secured with alumina cement on a chamotte brick. The vessel was preheated to 800°C for about two hours and molten steel was immediately poured into it while carrying out continuous pourings of four charges from a 200 ton ladle. The melt temperature is maintained at 1570°C. When removing the refractory adiabatic lining board after the finish of the four-charge pouring, most parts of the siliceous sand layer could be removed being adhered to the lining board while leaving an adhering layer of about 2 mm to the surface of the durable lining made of chamotte brick. It was possible easily to remove said adhering layer by using a steel wire bruch.

Example 2

In a tundish of the same size as in Example 1, the siliceous sand layer as a refractory layer in the loose form was made 115 mm thick and pouring was effected under the same conditions. In removing the refractory adiabatic lining board an adhering layer of about 30 mm thick on

average fell down together with the residue of the board, and the remaining siliceous sand layer also fell down in the form of powder or mass. Nothing was stuck to the endurable lining of chamotte brick and the brick was not damaged and contaminated in any way and was ready for a subsequent lining operation.

CLAIMS

1. A vessel for molten metal characterized by a metal outer shell with a refractory adiabatic lining on the inside spaced from the shell, a refractory layer in loose form which is sintered at a temperature higher than 500°C being provided in contact with the lining between the lining and shell.

2. A vessel for molten metal as claimed in Claim 1 wherein the refractory layer is a mixture of a granular refractory and a sintering agent, flux or binder in the form of powder, solution or a suspension.

3. A vessel for molten metal as claimed in Claim 1 or 2, wherein a cast refractory or brick lining is provided on the inside surface of the shell.

FIG. 1

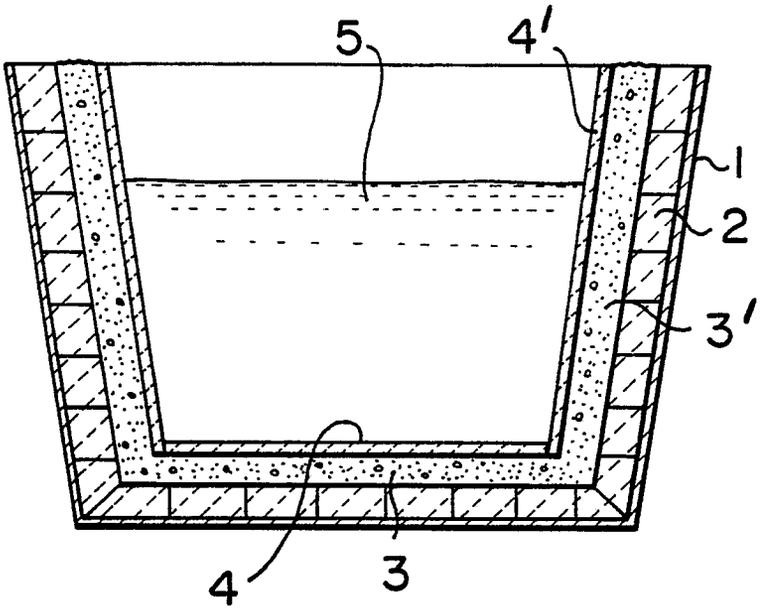
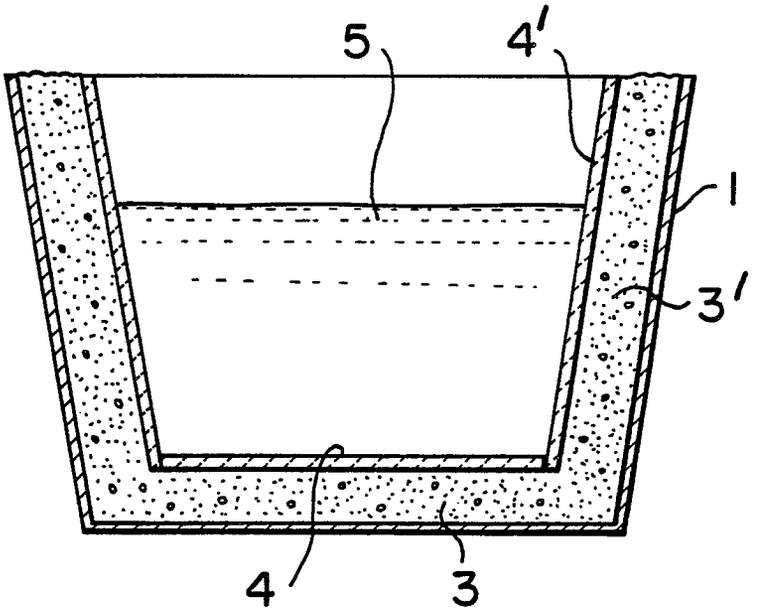


FIG. 2



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EUROPEAN SEARCH REPORT

0051910
Application number
EP 81 30 1838

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
Y	FR - A - 2 239 309 (FOSECO) * Figure 3; page 2, line 35 - page 3, line 9; claims *	1-3
Y	FR - A - 2 330 951 (FOSECO) * Figures 3,4; page 6, lines 8-20 *	1-3
Y	US - A - 3 345 059 (SWINDT) * Whole document *	1
Y	GB - A - 1 569 970 (METALAIDS) * Figures; page 2, lines 114-123 *	1
Y	US - A - 3 203 689 (HALLOWELL) * The whole document *	1
A	DE - A - 2 716 092 (CONTHERM)	
A	DE - A - 1 558 579 (G. LICHTENBERG)	
A	DE - A - 1 433 829 (ALCO)	
A	GB - A - 2 043 221 (DORENTRUPER SAND- UND THONWERKE GmbH)	

CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)

B 22 D 11/10
41/02
F 27 D 1/00

TECHNICAL FIELDS SEARCHED (Int.Cl. 3)

B 22 D
F 27 B
F 27 D
C 22 B
C 21 C

CATEGORY OF CITED DOCUMENTS

X: particularly relevant if taken alone
Y: particularly relevant if combined with another document of the same category
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: earlier patent document, but published on, or after the filing date
D: document cited in the application
L: document cited for other reasons

&: member of the same patent family, corresponding document

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	10-02-1982	OBERWALLENEY

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