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(54) Pouring molten metal.

(57) The invention relates to the provision of an insulating covering layer for the surface of molten metal in e.g. a tundish.

The insulation layer is provided in the form of a slab (2) having thickened edge portions (3, 5) extending along at least two opposite edges of the slab. The insulation layer and its thickened edge portions can be formulated to turn to powder under the action of heat from the molten metal. Thus, in a tundish with outwardly sloping walls (8, 9), the thickened edge portions powder to fill the gaps that would otherwise appear between the slab and the walls as the slab rises up with the molten metal.

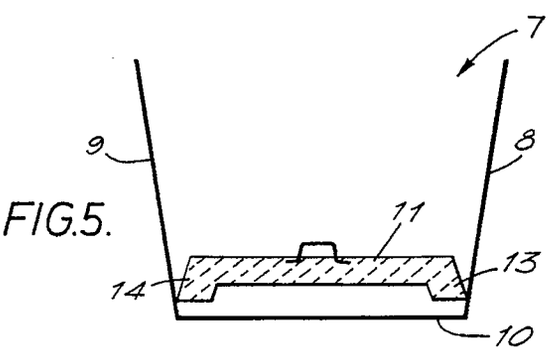

FIG.5.

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This invention relates to the pouring of molten metal from a ladle to another vessel, e.g. a mould. Frequently such pouring is via an intermediate vessel, e.g. a tundish, particularly in the continuous casting of molten metal such as steel.

It has been the practice for many years to apply a covering layer to the molten metal in a vessel such as a tundish in order to provide insulation against excessive heat loss and also to react with the molten metal to remove unwanted inclusions, e.g. of alumina. For example, rice husks are frequently used or other, for example, basic materials formulated for the particularly desired reaction.

Such covering layers have usually been applied in powder form but there have been proposals to apply a covering layer in sheet form. In principle this can be advantageous in reducing dust levels and in containing dangerous splashing of molten metal during the pouring operation. For example, the use of two refractory heat-insulating slabs is described in British Patent Specification No. 1571333. The slabs are pivotally-mounted at an upper edge or in a wall portion of a tundish in spaced apart relationship and extending downward into the vessel. The molten metal is poured between the slabs which can, therefore, contain any splash and, as pouring continues, the slabs rise on the molten metal until they are horizontal. The slabs thereby provide a cover to reduce heat loss and to contain any powder additives.

However, such previous sheet-covering proposals have not been entirely successful commercially and it is still usual in pouring operations to use covering materials in powder form despite their attendant disadvantages. Tundishes, which may be generally rectangular in plan form, usually are frusto-conical in vertical transverse section with the walls sloping outwardly in the upwards direction. One serious disadvantage of covering the molten metal by sheet material, therefore, is that the sheet cannot cover the entire metal surface as the metal level rises and an increasing gap between sheet and tundish wall is unprotected.

Accordingly, in one aspect, the present invention provides an insulating slab for use as a covering layer for the molten metal in a molten metal handling vessel, e.g. a tundish, in which the slab comprises at least a layer of heat-insulating material which is shaped to have thickened portions extending along at least two opposite edges.

In a second aspect the invention provides a method of insulating the surface of molten metal in a handling vessel, e.g. a tundish, which comprises placing a covering layer in the form of a slab of heat-insulating material on the surface of the molten metal, in which the slab is shaped to have thickened portions extending along at least two opposite edges of the slab.

The thickened portion of the insulating material layer will conveniently extend along the two sides of the slab that correspond to the outwardly sloping walls of the tundish. Thus, as the level of molten metal rises in the tundish, the gap that would otherwise appear between slab and sidewall can be substantially filled with powdered material that has been formed by expansion and erosion of the thickened portions under the action of the hot metal.

Thus the composition of the insulating layer of the slab can be particularly formulated to expand and powder under the action of the heat of the molten metal.

For example, the insulating layer may be formed from refractory fibres, e.g. calcium silicate or aluminosilicate; refractory filler, e.g. silica, alumina, magnesia or refractory silicates; and a binder, e.g. colloidal silica sol, sodium silicate, starch, phenol-formaldehyde resin or urea-formaldehyde resin. Expandable materials e.g. expandable graphite, perlite or vermiculite may conveniently be included in order to give the desired expansion and powdering properties.

In a preferred embodiment a second layer, which can be a reactive flux layer of lesser insulating properties than the insulating layer, is attached to the underside of the insulating layer so that the slab can be chosen to optimise the insulation and reaction properties that are desired.

The second layer may be formed from any desired flux composition. Such compositions are well known and may be based on various metallic oxides, e.g. mixtures of oxides of calcium, aluminium and magnesium, with other additives, e.g. carbon and calcium fluoride.

Preferably, the thickened edge portions of the slab extend downwardly from the plane of the slab when considered in its horizontal position in a tundish.

In use, it will normally be convenient to use two or more covering slabs of the invention in a tundish. For example, if the entry point for molten metal is disposed centrally in the tundish, then two slabs may be positioned in the empty tundish, one to each side of the entry zone.

The invention is further described with reference to the accompanying drawings in which:

Figure 1 is a representation of a prior art slab;

Figure 2 is a representation of an insulating slab of the invention;

Figure 3 is a representation of a further insulating slab of the invention;

Figure 4 is a representation of a slab of the invention showing a second layer in position beneath the insulating layer;

Figure 5 is a section through a tundish showing the position of a slab before filling the tundish

with steel;

Figure 6 is a section through a tundish showing a slab after filling the tundish with steel; and

Figure 7 is a section through a part of a tundish in the region of an outlet.

In Figure 1, a flat conventional slab 1 is made of fibre, filler and binder. In contact with molten steel the slab will expand and form powder, the powder and any residual slab forming a layer on top of the rising level of molten metal.

In Figure 2, slab 2 has a thickened, depending edge 3. This edge is of frusto-conical or wedge shape. It too will expand and form powder under the action of contact with molten steel.

Figure 3 shows a slab 4 having a thickened depending edge 5 of different, parallelopiped shape.

Figure 4 shows the insulating slab 2 of Figure 2 with a reactive flux layer 6 attached to its underside.

In Figure 5, a tundish 7 has upwardly and outwardly sloping sidewalls 8 and 9 and a base 10. A slab 11 of the invention is placed in the tundish when empty and rests with its depending thickened edges 13 and 14 contacting the side walls 8 and 9 near to base 10.

Molten steel is then introduced into the tundish. It enters underneath slab 11, which then rises floating on the molten metal surface. The filled tundish is shown in Figure 6. The hot metal causes expansion and powdering of the slab. The edges 13 and 14 have powdered to cover the gaps 15 and 16 that would otherwise have been left uncovered between the sidewalls and the slab. The underside layer 17 of the slab has also started to react with the metal and, as shown, has to a degree insulated the upper layer 18 of the slab from the metal so that the slab has still retained some of its integrity.

In Figure 7, tundish 19 has an outlet 20, closable by a stopper rod 21. A slab 22 of the invention has a thickened edge 23 and an aperture 24 to accommodate the stopper rod. The aperture 24 is also surrounded by a depending thickened portion 25 of the slab.

Claims

1. An insulating slab for use as a covering layer for the molten metal in a molten metal handling vessel, e.g. a tundish, the slab comprising at least a layer of heat-insulating material, characterised in that the slab (2, 4) is shaped to have a thickened portion (3, 5) extending along at least two opposite edges of the slab.

2. An insulating slab according to Claim 1, in which the slab is for use in a tundish (7) of frusto-conical section with opposite walls (8, 9) sloping outwardly as they rise from the base (10) of the tundish, characterised in that the thickened edge portions (13, 14) of the slab (11) correspond to and so can be positioned to extend substantially parallel to the sloping walls (8, 9) of the tundish (10).

3. An insulating slab according to Claim 1 or 2, characterised in that the insulating layer (2) of the slab is formulated to expand and turn to powder under the action of the heat of molten metal.

4. An insulating slab according to Claim 3, characterised in that the insulating layer is formed from refractory fibres, refractory filler and a binder.

5. An insulating slab according to Claim 4, characterised in that the refractory fibre is of calcium silicate or aluminosilicate.

6. An insulating slab according to Claim 5, characterised in that the refractory filler is of silica, alumina, magnesia or refractory silicate.

7. An insulating slab according to Claim 4, 5 or 6, characterised in that the binder is colloidal silica sol, sodium silicate, starch, phenol-formaldehyde resin or urea-formaldehyde resin.

8. An insulating slab according to any one of Claims 3 to 7, characterised in that the insulating layer contains as heat-expandable material, expandable graphite, perlite or vermiculite.

9. An insulating slab according to any one of the preceding claims, characterised in that the underside of the insulating layer (2) of the slab has attached to it a reactive flux layer (6) of lesser insulating properties than the insulating layer (2).

10. An insulating slab according to Claim 9, characterised in that the reactive flux layer is formed of one or more metallic oxides with carbon or calcium fluoride.

11. An insulating slab according to any one of the preceding claims, characterised in that the thickened edge portion (3, 5) is of frusto-conical or parallelo-piped shape.

12. An insulating slab according to any one of the preceding claims characterised in that the thickened edge portions (3, 5) extend downwardly from the plane of the slab when it is positioned horizontally in the molten metal

handling vessel.

13. An insulating slab according to any one of the preceding claims, characterised in that there is an aperture (24) through the slab (22) to accommodate, e.g. a stopper rod (21).

14. An insulating slab according to Claim 13, characterised in that the aperture (24) is surrounded by a depending thickened portion (25) of the slab (22).

15. A method of insulating the surface of molten metal in a handling vessel, e.g. a tundish, which comprises placing a covering layer in the form of a slab of heat-insulating material on the surface of the molten metal, characterised in that the slab (2, 4) is shaped to have thickened portions (3, 5) extending along at least two opposite edges of the slab.

16. A method according to Claim 15, in which the vessel is a tundish (7) of frusto-conical section with the opposite walls (8, 9) sloping outwardly as they rise from the floor (10), characterised in that the slab (11) is placed in the tundish (7) with its thickened edges (13, 14) adjacent sloping walls (8, 9), molten metal is poured into the tundish, slab (11) rises on the surface of the metal and the slab turns to powder under the action of the heat of the metal, the powder formed from thickened edges (13, 14) covering the gaps (16, 17) forming between the rising slab (11) and the sloping walls (8, 9).

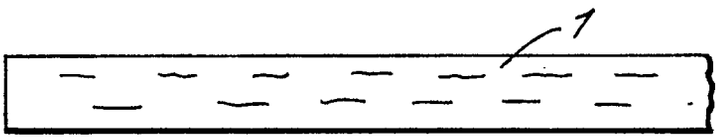


FIG.1.

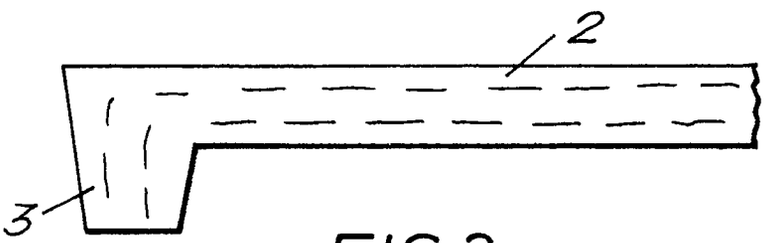


FIG.2.

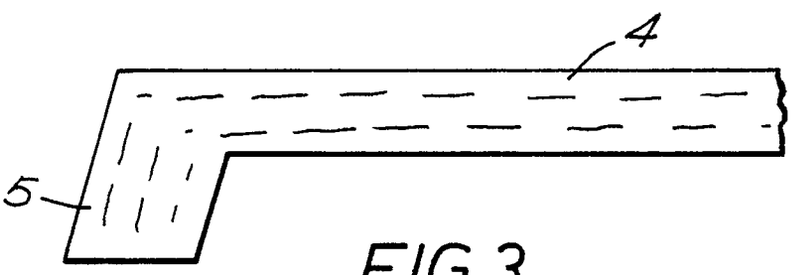


FIG.3.

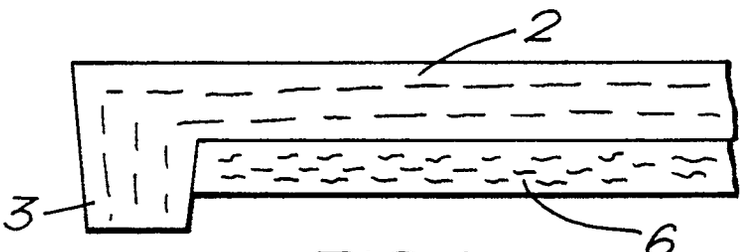


FIG.4.

FIG.5.

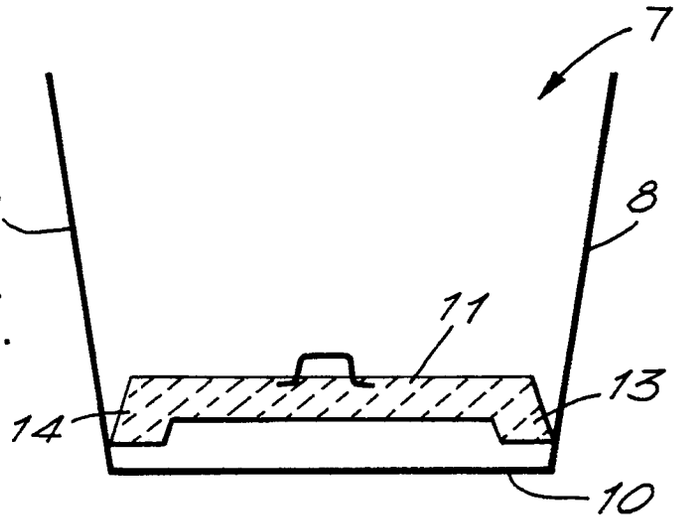


FIG.6.

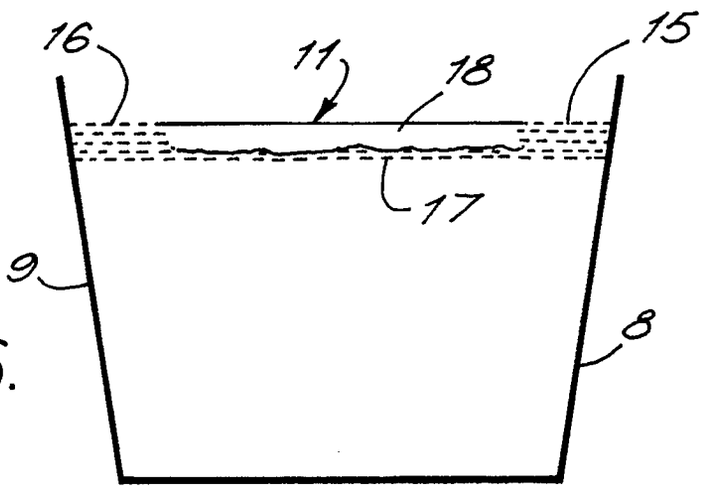
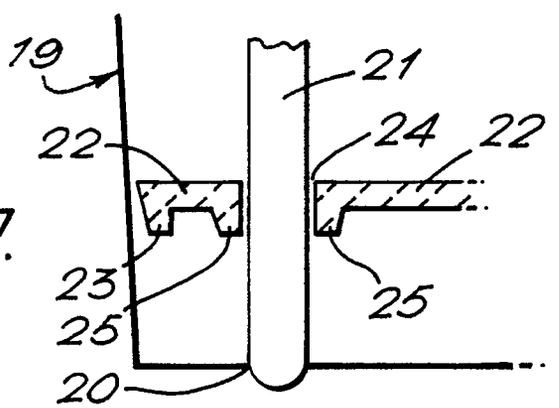


FIG.7.



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EUROPEAN SEARCH REPORT

Application Number

EP 91301774.5

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	WO - A1 - 84/03 460 (INTERNATIONAL FERROX COMP.) * Totality *	1,4,7, 8,15, 16	B 22 D 11/10 B 22 D 41/00 B 22 D 45/00
A	DE - A1 - 2 852 011 (CONTHERM) * Fig.; claim 8 *	1,2,4, 15	
D,A	GB - A - 1 571 333 (FOSECO) * Claims 1-6,14,15; fig. 1-3 *	1,4,5, 8,15	
A	GB - A - 1 586 683 (FOSECO)		
A	EP - A1 - 0 239 257 (FOSECO)		
A	DD - A - 139 220 (VEB MAX HÜTTE)		

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

B 22 D 1/00
B 22 D 11/00
B 22 D 35/00
B 22 D 41/00
B 22 D 45/00
C 04 B 5/00
C 21 C 7/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	13-06-1991	RIEDER

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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