(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 128 732**
A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **84303781.3**

(22) Date of filing: **05.06.84**

(51) Int. Cl.³: **B 22 D 11/10**, B 22 D 41/00, B 22 D 41/08

(30) Priority: **07.06.83 GB 8315575**

(43) Date of publication of application: **19.12.84 Bulletin 84/51**

(84) Designated Contracting States: **AT BE CH DE FR LI LU NL SE**

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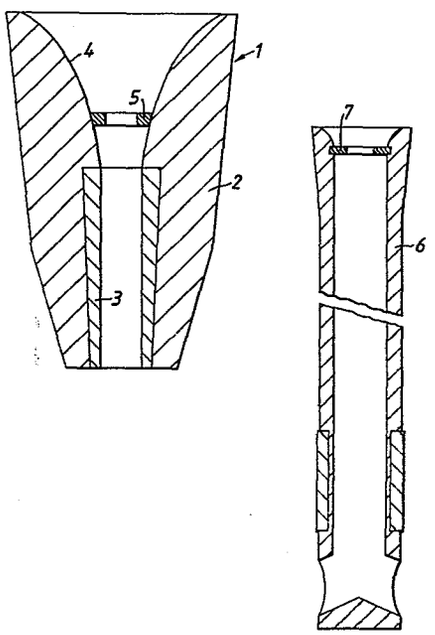
(54) Improvements in or relating to tundish pouring.

(57) The invention provides a tundish pouring arrangement including a tundish having at least one outlet in the base thereof through which molten metal is arranged to flow when poured into a receiving container therebelow, the outlet having associated therewith an annular flow restrictor member through which the outflowing metal is arranged to pass, the flow restrictor being of a material and a magnitude such as to be worn away by molten metal flow therethrough within a time range of between two to ten minutes.



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IMPROVEMENTS IN OR RELATING TO TUNDISH POURING

This invention relates to Tundish Pouring. In particular although not exclusively, this invention relates to apparatus and methods for tundish pouring where the tundish is arranged for pouring molten steel into a continuous casting slab or billet mould.

A problem with such tundish pouring arrangements concerns the initiation of pour into the mould. Thus it is necessary to ensure that the molten steel enters the mould and penetrates therethrough sufficiently to engage satisfactorily with the withdrawal mechanism but that it then freezes sufficiently rapidly so that upon movement of the withdrawal mechanism (typically a claw arrangement) as the mould fills with steel, a solid strand end and an adequately solid side wall to the strand has been formed whereby the risk of "breakout" of liquid metal within the first few minutes of operation is reduced.

It has been proposed previously to introduce scrap steel into the mould adjacent the top of the withdrawal mechanism so as to provide a chilling effect on steel as it flows into the mould. However, such an arrangement can have an effect opposite to that intended in that the scrap can solidfy the steel before the steel has had an opportunity to engage adequately with the withdrawal mechanism.

It has also been proposed that the rate of flow of the steel from the tundish during the initiation of the pour into the mould should be at a reduced rate by means of a variably engagable stopper so that more time is available for the steel at initiation of the pour to enable the steel adequately to freeze upon initiation of the withdrawal mechanism.

However, such stopping arrangements suffer from a severe disadvantage of the possibility of the formation of "skulls" or solid uneven metal coatings, around them and around the outlet from the tundish, rendering accurate control of flow difficult if not impossible. Such problems are particularly severe with high carbon steels which have a wide solidification temperature range.

It is an object to the present to overcome or at least substantially reduce the above mentioned problem.

According to one aspect of the invention there is provided a tundish metal pouring apparatus including a tundish having at least one outlet in the base thereof through which molten metal is arranged to flow when being poured into a receiving container therebelow, the outlet having associated therewith an annular flow restrictor member through which the outflowing metal is arranged to pass, the flow restrictor member being of a meterial and a magnitude such as to be worn away by molten metal flow therethrough within a time range of between two to ten minutes.

In a preferred embodiment the receiving container is a continuous casting mould, which may be for steel.

The flow restrictor member may be located within a flow metering nozzle in the tundish outlet or may be located within a submerged entry nozzle depending therefrom.

The restrictor member may be adapted to lodge within a tapering portion of the nozzle, and may be in the form of an annular disc.

The restrictor member may be formed of any suitable wearing material, and may be a refractory material such as fireclay.

The arrangement will desirably be such that the restrictor member has a life before it is fully worn away of between three to eight minutes.

We have found that by ensuring a restricted passage through the nozzle for this period of time initiation of continuous casting can be carried out with considerably reduced risk of breakout. With such an arrangement the restricted flow can ensure that the "fill time" for the mould changes in commercial operation from between twenty to twenty-five seconds to about forty-five seconds. Typically, we have found that with a continuous casting mould of 330mm by 254mm plan area, a reduction in nozzle diameter from approximately 21mm to 18 to 16 mm accomplishes the desired effect.

An important feature in the operation of the apparatus and method of the invention is that it is the preferred practice to preheat for perhaps up to an hour's duration, the tundish outlet, including the nozzle and flow restrictor, prior to commencing the initiation of pouring so as to prevent any chilling and solidification of the steel upon initiation as it passes through the various parts of the outlet, which could otherwise risk blocking the outlet. Techniques for such preheating are discussed in our UK Patent No 2091399B. In a preferred embodiment of the invention therefore, the flow restrictor is capable of withstanding such preheating without detrimental effect.

In order that the invention may be more readily understood two embodiments thereof will now be described by way of example with reference to the accompanying drawings in which :-

Figure 1 is a tundish metering nozzle incorporating the invention; and

Figure 2 is a side elevation in section of a submerged entry nozzle for use with a tundish outlet also incorporating the invention.

Referring now to Figure 1, it will be seen that a metering nozzle 1 for a tundish outlet (not shown) comprises a phosphate bonded high alumina material body 2 having a zirconia insert 3.

A rounded tapered inlet 4 to the nozzle is provided within which is located an annular fireclay rapid wearing disc 5 of approximately 3 to 4mm thickness which has an internal diameter of 18 to 16 mms. The minimum internal diameter of the nozzle is of the order of 21.5mm.

We have found with such an arrangement, and depending upon factors such as the head of metal contained within the tundish within which the nozzle is seated, a restricted flow is produced by the presence of the fireclay annular disc for a period of three to eight minutes. This period corresponds, of course, to the time it takes for the disc to be worn away by the flowing metal.

We have found that such an arrangement is particularly suitable for a steel billet continuous casting mould having a plan area of 330 by 254mm. With a minimum workable head of metal in the tundish, metal flow through the full diameter nozzle is of the order of 0.65 to 0.70 metres per minute, whereas with the presence of an 18mm internal diameter annular fireclay disc the flow is restricted to between 0.45 and 0.50 metres per minute whilst with a 16mm internal diameter fireclay disc the flow is restricted to approximately 0.35 to 0.40 metres per minute. Yet again with a normal or optimum working head of metal within the tundish, flow with a full internal diameter nozzle is of the order of 0.80 to 0.85 metres per minute, whereas with an 18mm fireclay disc the flow is reduced to 0.55 to 0.60 metres per minute and with a 16mm fireclay disc it is reduced still further to 0.44 to 0.50 metres per minute.

It will be seen, therefore, that the invention enables a significant reduction in flow rate during the first few minutes of continuous casting enabling adequate freezing of the metal within the mould before withdrawal of metal, after satisfactory solidification, from the bottom of the mould into the continuous casting strand. This is particularly useful when dealing with high carbon steel, such as steel above sixty carbon where the solidification is particularly broad.

Thus seventy-five carbon steel can have a 80° temperature range for solidifying and it is highly desirable to ensure that adequate solidifying of the initial flow of steel into the continuous casting mould occurs.

The arrangement of Figure 2 is similar to that of Figure 1, except that in this case a submerged entry nozzle 6 for use below the outlet from a tundish is adapted to accommodate a fireclay annular disc 7, the submerged entry nozzle being arranged to seat against the lower surface of the tundish and protrude into and below the upper surface of steel in the continuous casting mould.

The invention includes within its scope a method of pouring molten metal from an outlet of a tundish into a container therebelow, the outlet having associated therewith an annular flow restrictor member, wherein the metal is arranged to pass through the flow restrictor member and wear it away within a time range of between two to ten minutes.

CLAIMS:

1 Tundish metal pouring apparatus including a tundish having at least one outlet in the base thereof through which molten metal is arranged to flow when poured into a receiving container therebelow, the outlet having associated therewith an annular flow restrictor member through which the outflowing metal is arranged to pass, the flow restrictor member being of a material and a magnitude such as to be worn away by molten metal flow therethrough within a time range of between two to ten minutes.

2 Apparatus as claimed in Claim 1 wherein the receiving container is a continuous casting mould and the apparatus is for the casting of steel.

3 Apparatus as claimed in Claim 1 or 2 wherein the flow restrictor is located within a flow metering nozzle in the tundish outlet.

4 Apparatus as claimed in Claim 1 or 2 wherein the flow restrictor member is located within a submerged entry nozzle depending from the tundish outlet.

5 Apparatus as claimed in claim 4 wherein the restrictor member is adapted to lodge within a tapering portion of the nozzle.

6 Apparatus as claimed in any one of the preceding claims wherein the restrictor member is such as to be worn away within a time range of between three and ten minutes.

7 Apparatus as claimed in any one of the preceding claims wherein the restrictor member is in the form of an annular disc.

8 Apparatus as claimed in Claim 7 wherein the restrictor member has an internal diameter of 16 to 18mm and is of approximately 3 to 4mm thickness.

9 Apparatus as claimed in any one of the preceding claims wherein the restrictor member is formed of a refractory material.

10 Apparatus as claimed in any one of the preceding claims wherein the restrictor member is formed of fireclay.

11 A method of pouring molten metal from an outlet of a tundish into a container therebelow, the outlet having associated therewith an annular flow restrictor member, wherein the metal is arranged to pass through the flow restrictor member and wear it away within a time range of between two to ten minutes.

12 A method as claimed in Claim 11 wherein the metal is arranged to wear away the restrictor member within a time range of between three to ten minutes

13 A method as claimed in Claim 11 or 12 for the casting of steel wherein the container is a continuous casting mould.

14 A method as claimed in any one of Claims 11 to 13 including the step of preheating the tundish nozzle, including the restrictor member, before commencing pouring metal therethrough.

FIG. 1.

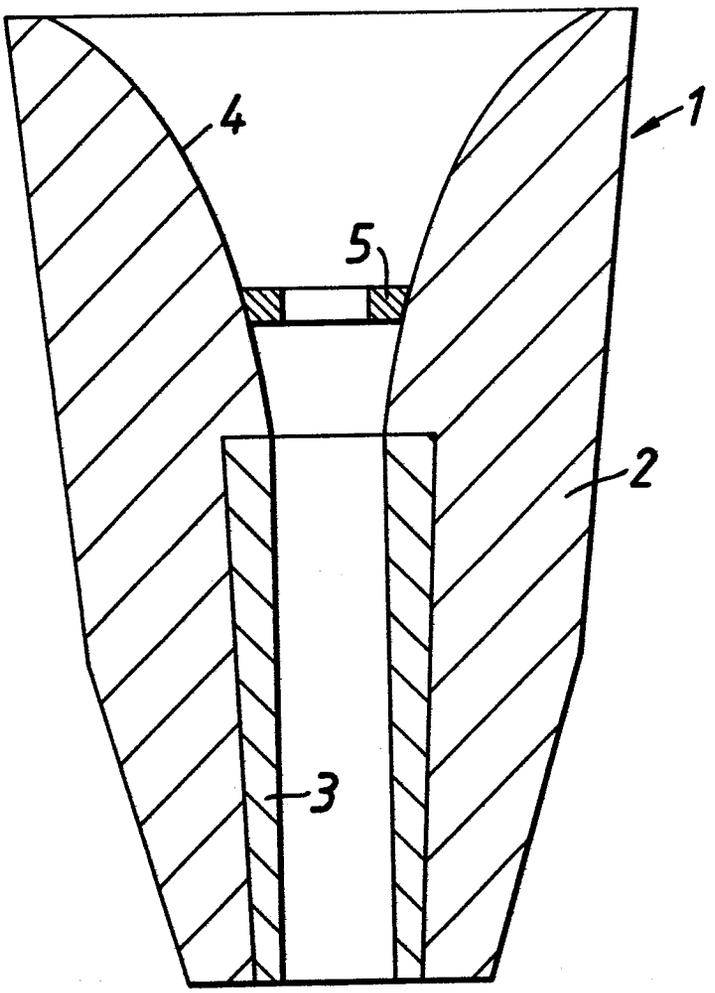

FIG. 2.