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**Datasheet for the decision
of 2 February 2018**

Case Number: T 2102/14 - 3.2.03

Application Number: 09784522.6

Publication Number: 2382062

IPC: B22D41/58, B22D11/10

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Title of invention:
SUBMERGED ENTRY NOZZLE

Applicant:
Refractory Intellectual Property GmbH & Co. KG

Headword:

Relevant legal provisions:
EPC Art. 56

Keyword:
Inventive step - (yes)

Decisions cited:

Catchword:



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Case Number: T 2102/14 - 3.2.03

D E C I S I O N
of Technical Board of Appeal 3.2.03
of 2 February 2018

Appellant: Refractory Intellectual Property GmbH & Co. KG
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Decision under appeal: **Decision of the Examining Division of the
European Patent Office posted on 16 April 2014
refusing European patent application No.
09784522.6 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman G. Ashley
Members: C. Donnelly
E. Kossonakou

Summary of Facts and Submissions

- I. The appeal lies from the decision of the examining division refusing European application No. 09 784 522.6.

In its decision the examining division held that the subject-matter of claim 1 according to the main request and auxiliary request 1 then on file lacked an inventive step in view of GB 201 853 (D3) in combination with WO 02/081123 A2 (D2).

In the examining division's view D3 disclosed all the features of claim 1 except for that of the fluid supply means introducing a fluid via a bore into the annular channel.

It argued that this feature is, however, known from D2 and that it would be obvious for the skilled person to combine D3 and D2 in order to obtain the subject-matter of claim 1 without exercising an inventive step.

- II. The applicant (hereinafter: the "appellant") filed an appeal against this decision.
- III. The board set out its provisional opinion in a communication pursuant to Article 15(1) of the Rules of Procedure of the Boards of Appeal (RPBA). Oral proceedings were held at the appellant's request on 2 February 2018.

At the end of the debate the appellant confirmed its request that the decision under appeal be set aside and that a patent be granted on the basis of the main request filed during the oral proceedings before the board.

IV. Claim 1 according to the main request reads:

"A nozzle (410) for guiding molten metal comprising: an inlet (106) at an upstream first end; at least one outlet (210) towards a downstream second end; an inner surface (117) between said inlet (106) and said at least one outlet (210) defining a bore (118) through the nozzle (410); the bore (118) having a throat region (200) adjacent the inlet (106); an annular channel (420) being provided in the inner surface (117) of the nozzle (410); and a fluid supply means (900) being arranged to introduce fluid into the bore (118) via the annular channel (420); wherein the throat region (200) has a convexly curved surface and the annular channel (420) is located within or adjacent the convexly curved surface of the throat region (200) such that the inner surface of the nozzle immediately upstream of the annular channel is curved; and wherein the curved surface of the throat region provides a tangential lift off surface which encourages the molten metal to detach from the inner surface of the nozzle prior to the introduction of the fluid through the annular channel, the molten metal remaining substantially in laminar flow and continuing in a generally curved downwardly direction when detached from the inner surface."

Reasons for the Decision

1. *Main request, Basis for the amendments, Article 123(2) EPC*

Claim 1 of the main request is based on claim 1 as originally filed. The basis for the additional functional feature reading:

"wherein the curved surface of the throat region provides a tangential lift off surface which encourages the molten metal to detach from the inner surface of the nozzle prior to the introduction of the fluid through the annular channel, the molten metal remaining substantially in laminar flow and continuing in a generally curved downwardly direction when detached from the inner surface"

is to be found on page 3, lines 3 to 10 of the originally filed description.

The basis for the feature:

"such that the inner surface of the nozzle immediately upstream of the annular channel is curved"

is to be found at page 5, lines 30 to 33.

The requirements of Article 123(2) EPC are therefore met.

2. *Main request, Inventive step, Article 56 EPC*

2.1 Starting out from D3 as the nearest prior art

In its decision the examination division chose to take D3 as the starting point.

2.1.1 D3 discloses:

a nozzle (c) for guiding molten metal comprising: an inlet at an upstream first end; at least one outlet towards a downstream second end (see figure 2); an inner surface between said inlet and said at least one outlet defining a bore (f) through the nozzle (c); the bore (f) having a throat region adjacent the inlet ; an annular channel (e) being provided in the inner surface of the nozzle (c); wherein the throat region has a convexly curved surface and the annular channel ((e) is located within or adjacent the convexly curved surface of the throat region such that the inner surface of the nozzle immediately upstream of the annular channel(e) is curved (see figure 2).

2.1.2 The subject-matter of claim 1 differs therefrom in that:

- (i) - a fluid supply means is arranged to introduce fluid into the bore via the annular channel or downstream thereof; and wherein
- (ii) - the curved surface of the throat region provides a tangential lift-off surface which encourages the molten metal to detach from the inner surface of the nozzle prior to the introduction of the fluid through the annular channel, the molten metal remaining substantially in laminar flow and continuing in a

generally curved downwardly direction when detached from the inner surface."

2.1.3 The technical effect of distinguishing feature (i) is to form a protective curtain of fluid between the inner surface of the nozzle and the molten metal flowing through the nozzle. Distinguishing feature (ii) limits the shape of the curved surface of the throat region to one which facilitates the introduction of the fluid introduced into the bore via the annular channel and enhances its effect.

2.1.4 The objective technical problem to be solved can be seen as one of how to optimise the nozzle of D3 to minimise oxidation and precipitation.

2.1.5 The description of D2 at the passage from page 10, line 18 to page 11, line 9, gives the reader the following information concerning the purpose of inert gas injection:

"Inert gas is frequently used to protect the stream of molten steel from contact with oxygen and the resultant oxidation and precipitation. Ideally, inert gas diffuses into the bore and covers the inner surface, thereby enshrouding the stream. In prior art, the inert gas is frequently injected at higher than desired pressure to overcome the resistance from pressure in the boundary layer. High pressure, injected gas can escape from the surface and dissolve in the molten steel stream. This limits the amount of inert gas actually enshrouding the stream and causes defects in the final product because of dissolved gas bubbles."

2.1.6 In the device of D2, since a perturbation induces non-laminar flow in the boundary layer and therefore lowers

pressure in the layer and also at the inner surface, the gas can be injected at a low enough pressure that it remains on the surface and does not easily diffuse away into the molten steel thereby ensuring a more effective shrouding of the steel from oxygen.

2.1.7 It is apparent from this, that in D2 there is no disturbance of the molten steel flowing vertically down through the central part of the nozzle passageway and the introduction of an inert gas would provide an effective protective shroud.

2.1.8 However, this is not the case with the nozzle disclosed in D3 where there is considerable mixing and disturbance of the initially central and vertical flow. According to the description of D3 at page 2, lines 37 to 60, when the nozzle is operated, a portion of the metal, which has met at point h, will vertically flow down along the centre-line of the nozzle passage with reduced velocity. The remaining portion of the molten steel will cross itself at the point h, and will rush forward and strike the annular groove e, whereby it is reflected in an opposite direction. The molten steel thus reflected will meet again itself and with said other portion of the molten steel which is vertically flowing down through the central part of the nozzle passageway. The reflected molten steel may have enough energy to strike the opposite surface of the nozzle passage and to be reflected again and combine with the column of molten steel

2.1.9 Therefore, the examining division's assessment that the flow patterns in the nozzles of D2 and D3 are similar is not accurate since the central portion of the flow in the nozzle of D3 only remains less turbulent until it is disturbed by the flow reflected from the annular

groove. The nozzle design of D3 is intended to slow flow by causing direction changes and mixing to absorb kinetic energy (see page 2, lines 61 to 68).

2.1.10 In view of this, the board agrees with the appellant that the examining division's assertion, that the skilled person faced with the above problem would, by way of trial, adapt the nozzle known from D3 by incorporating a fluid supply means arranged to introduce fluid into the bore via the annular channel, is based on hindsight. On the basis of the teachings of D2 and D3 without knowledge of the invention, the skilled person would dismiss such a measure as futile in view of the high degree of mixing ("repeated battering", see D3, page 2, line 61) deliberately induced by the nozzle design of D3 which affects the whole of the molten stream and would completely nullify any intended protective shrouding effect of the inert gas.

2.2 *Starting out from D2 as the nearest prior art*

2.2.1 As the appellant has suggested, the closest prior art is in fact D2, since this document discloses a nozzle designed for the same purpose as the claimed invention.

2.2.2 The appellant accepts that the embodiment shown in figure 2 of D2 discloses all the features of claim 1 with the exception of:

(i) a convexly curved surface in the throat region such that the inner surface of the nozzle immediately upstream of the annular channel is curved;

(ii) the curved surface of the throat region provides a tangential lift-off surface which encourages the molten

metal to detach from the inner surface of the nozzle prior to the introduction of the fluid through the annular channel, the molten metal remaining substantially in laminar flow and continuing in a generally curved downwardly direction when detached from the inner surface.

2.2.3 The technical effect of these features is to allow the introduction of a fluid into the bore of the nozzle with minimal disruption to molten metal flowing through the nozzle (see the originally filed application page 3, lines 1 to 3).

2.2.4 The board agrees with the appellant that the objective technical problem can be seen as one of how to reduce the rate of inclusion accumulation.

2.2.5 D2 is quite specific that laminar flow is disrupted; e.g. at page 4, lines 14 to 17, it states:

"the article includesat least one perturbation at a surface sufficient to interrupt laminar flow of the molten metal in a boundary layer at the surface"

and at page 5, lines 22 to 24:

"The method of the present invention includes disrupting laminar flow in a boundary layer adjacent to the surface without significantly affecting flow in a remainder of the stream".

2.2.6 By causing non-laminar flow, pressure in the boundary layer and also at the inner surface is lowered, such that the gas can be injected at a low enough pressure that it remains on the surface and does not easily

diffuse away into the molten steel thereby ensuring a more effective shrouding of the steel from oxygen.

2.2.7 In contrast, the device of claim 1 works in a different manner by providing a tangential lift-off surface such that the metal can detach before the point where the gas is introduced without any disruption to the laminar flow. The lack of any turbulent flow is considered to render the formation of the gas curtain more effective.

2.2.8 Therefore, faced with the above technical problem, the skilled person would not consider modifying the throat region immediately upstream of the annular channel of the device according to D2 into a convexly curved surface providing a tangential lift-off surface since this would go against the teaching of D2, since it would promote, rather than interrupt, laminar flow of the molten metal.

2.2.9 Therefore, taking either D2 or D3 as the starting point, the subject-matter of claim 1 according to the main request meets the requirements of Article 56 EPC since it involves an inventive step.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the examining division with the order to grant the patent on the basis of the following documents:
 - claims 1 to 13 of the main request filed during the oral proceedings before the board,
 - description pages 1, 2, 2a and 3 to 18 filed during the oral proceedings before the board and
 - the figures of the published application.

The Registrar:

The Chairman:



C. Spira

G. Ashley

Decision electronically authenticated