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# D E C I S I O N
# of 9 August 2000

**Case Number:** T 0498/97 - 3.2.2

**Application Number:** 90907247.2

**Publication Number:** 0424502

**IPC:** C21C 7/072

**Language of the proceedings:** EN

**Title of invention:**
GAS INJECTOR

**Patentee:**
INJECTALL LIMITED

**Opponent:**
Didier-Werke AG

**Headword:**
-

**Relevant legal provisions:**
EPC Art. 54, 56

**Keyword:**
"Inventive step (yes) after amendment"

**Decisions cited:**
-

**Catchword:**
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Beschwerdekammern | Boards of Appeal | Chambres de recours

**Case Number:** T 0498/97 - 3.2.2

**D E C I S I O N**
**of the Technical Board of Appeal 3.2.2**
**of 9 August 2000**

**Appellant:** (Proprietor of the patent)
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**Representative:**
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**Respondent:** (Opponent)
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**Decision under appeal:** **Decision of the Opposition Division of the European Patent Office posted 20 March 1997 revoking European patent No. 0 424 502 pursuant to Article 102(1) EPC.**

**Composition of the Board:**

**Chairman:** W. D. Weiß
**Members:** R. Ries
M. B. Günzel

## Summary of Facts and Submissions

I. European patent No. 0 424 502 was granted on 23. November 1994 on the basis of European patent application No. 90 907 247.2.

II. The grant of the patent was opposed on the grounds that its subject-matter lacked novelty and did not involve an inventive step with respect to the state of the art (Article 100(a) EPC).

III. With its decision posted on 20 March 1997 the Opposition Division held that the claimed subject-matter did not involve an inventive step and revoked the patent.

IV. On 2 May 1997 the appellant (patentee) lodged an appeal against the decision of the Opposition Division. The notice of appeal was followed by the statement of grounds submitted with letter of 16 July 1997.

V. In a letter received on 2 July 1997, the opponent, which did not submit any arguments in the appeal proceedings, withdrew its opposition.

VI. In the appeal proceedings, the following documents were considered:

A1 WO-A-88/08041 & EP-A-0 286 435
D1 DE-C-3 810 098 & GB-A-2 217 438
D2 AT-B-0 387 404
D3 JP-A-61096022
D4 EP-A-0 297 067
D5 GB-A-1 152 330
D6 DE-U-8 622 452.2

VII. Oral proceeding were held before the Board on 9 August 2000.

The appellant requested that

- the decision under appeal be set aside and

- the patent be maintained with the claims and the description of the main request filed at the oral proceedings.

VIII. Independent claims 1, 6 and 7 read as follows:

"1. A gas injector for a molten metal vessel, comprising a gas inlet chamber in the form of a metal enclosure having an inlet port and at least one outlet port; and an extruded rod which extends to a gas discharge end of the injector, the extruded rod being formed of a substantially gas-impermeable refractory material and having a plurality of axially-extending gas passages therealong in the form of capillary bores or slots, the passages communicating with the gas inlet chamber, and being of such small dimensions that in use, melt is substantially unable to intrude into the passages, the capillary bores or slots having a diameter or width up to 0.6 mm; the extruded rod being secured gas-tightly to the outlet port of the gas inlet chamber and being embedded in a refractory body of the injector save for the discharge end of the rod."

"6. A gas injector for a molten metal vessel, comprising: a gas inlet chamber having an inlet port and an outlet port, said outlet port having

secured gas-tightly thereto by means of a compression gland connector, an extruded rod which extends to a gas discharge end of the injector, the extruded rod being formed of a substantially gas-impermeable refractory material and having a plurality of axially-extending gas passages therealong in the form of capillary bores or slots, the passages communicating with the gas inlet chamber, and being of such small dimensions that in use, melt is substantially unable to intrude into the passages, the capillary bores or slots having a diameter or width up to 0.6 mm; the rod and compression gland connector being embedded in a refractory body of the injector save for the discharge end of the rod."

"7. A gas injector for a molten metal vessel, comprising a gas inlet chamber having an inlet port, an outlet port and a pipe with a gas-impermeable wall gas-tightly connected with the latter and extending to a gas-discharge end of the injector, the pipe encasing an extruded refractory rod formed of a substantially gas-impermeable material and terminating at a discharge end of the pipe and the rod having a plurality of axially-extending gas passages therealong in the form of capillary bores or slots of such small dimensions that, in use, melt is substantially unable to intrude into the passages, the capillary bores or slots having a diameter or width up to 0.6 mm, the pipe being embedded in a refractory body of the injector save for its discharge end."

IX. The appellant argued as follows:

The metallurgical industry requires an injector which delivers well defined gas streams or directed jets into the molten bath and which eliminates the problem of lateral gas dissipation into the surrounding refractory body of the vessel. Moreover, the gas injector should be reusable and economical to produce. These objects are achieved by the claimed gas injector which comprises one or more gas-impermeable extruded ceramic rods having a plurality of gas passages (capillaries) with dimensions which prevent intrusion of the melt into the bores or slots even when the gas supply to the injector is stopped. To this end, the diameter of the capillaries is restricted to at most 0.6 mm. Given that the ceramic rods are gas-tightly connected with the outlet ports of the gas distributing chamber, lateral gas dissipation is completely avoided. None of the cited documents discloses or makes it obvious to use such extruded gas impermeable ceramic rods in the manner described in claims 1, 6 and 7 of the patent. Hence the claimed subject-matter is novel and involves an inventive step vis-à-vis the cited state of the art.

## Reasons for the Decision

1. The appeal complies with Rule 65 EPC and is admissible.

2. *Amendments*

The amendments to claims 1, 6 and 7 "**a plurality of** axially extending gas passages" and "**in form of capillary bores and slots**" derive from claim 8 as granted. Support for the amendment "**the capillary bores or slots having a diameter or width up to 0.6 mm**" is found in column 5, lines 19 to 21 which specify a range

from 0.2 to 0.6 mm. Since, however, the "capillary effect" of the bores or slots breaks down when exceeding a certain inner diameter, the essential limitation for the diameter of the capillary passages lies in the upper limit of 0.6 mm, whereas the lower limit of 0.2 mm is not bound to the capillary function but simply represents the minimum bore diameter that is preferred in view of the manufacture of the extruded rod. The amendment "**up to 0.6 mm**" is, therefore, admissible in the present case.

For reasons of consistency with claims 1, 6 and the description, claim 7 has been supplemented by the wording "**formed of a substantially gas-impermeable material**". Furthermore, the description has been suitably adapted to the wording of the revised claims.

The amendments, therefore, satisfy the requirements of Article 123(2) EPC.

3. *Novelty*

Given that none of the cited prior art documents discloses a gas injector comprising an extruded rod which is formed of a gas-impermeable refractory material, which exhibits a plurality of bores or slots and which is embedded in a refractory body, the Board concurs with the position of the opposition division that the claimed gas injector is novel.

4. *Inventive step*

Among the cited prior art, only document D3 discloses a gas injector comprising rod-shaped elements 6 which exhibit fine holes 7 pierced in the axial direction of

the elements 6 and extending from the inlet to the discharge ends. Therefore, document D3 represents the closest prior art. The stainless steel rod-shaped elements are embedded in a non-porous refractory material which is surrounded by a metal jacket 2. The cross sectional area of the fine holes 5 is specified to be in the range of 0.7 to 20 $mm^2$ (cf. D3, page 128, left hand column, line 20) which corresponds to an inner diameter of between 0.94 to 5 mm, for example 2.5 mm (cf. translation of parts of document D3 enclosed by the appellant with the grounds of appeal). By selecting this inner diameter of the fine holes and by providing in operation a sufficient gas pressure to the holes (by blowing a small amount of gas), metal ingress is prevented. However, the stainless steel rods may alloy with or dissolve in the surrounding melt, in particular when liquid steel is treated, and repetitive gas blowing can be obstructed or even blocked when the gas supply is cut off. Moreover, stainless steel is an expensive material and drilling long fine holes into the rods or bars is costly. Nothing is disclosed in D3 regarding whether the stainless steel rod shaped elements are tightly connected with the gas plenum to provide a gas tight seal. Moreover, even if - as in the case of D3 - a metal jacket is used, differential thermal expansion of the metal jacket and the ceramic body can cause the jacket to break away from the refractory thereby causing the gas to be dissipated.

Starting from document D3, the problem underlying the present invention, therefore, is seen in designing a gas injector which

- is reusable and not dependent upon the gas pressure,

- can be economically produced,

- does not react with the contacting metallic melt, and

- prevents the gas to be dissipated into the adjacent

refractory wall of the melt containing vessel.

The solution to this problem consists in embedding one or more extruded gas-impermeable refractory rods which exhibit capillary slots or bores up to 0.6 mm in a refractory body and joining the ceramic rods gas-tightly to the gas distributing chamber. The sealing is achieved e.g. by a compression gland connector or, in the alternative, by welding a metal pipe encasing the rods to the plenum. Given that the ceramic rods and capillary passages are produced by extrusion, expensive drilling operations into metal are avoided. Moreover, the refractory rods do not react with the liquid metal to be treated, and since they are impermeable to gas, a metal jacket used in conventional ceramic flushing plugs to prevent lateral gas dissipation into the refractory lining of the ladle can be dispensed with.

Although the remaining documents are all concerned with refractory injector bodies having a plurality of straight capillary size passages to provide a "directional porosity", none of them discloses the use of ceramic rod-shaped elements pierced with slots or bores.

In the case of document A1, in particular the embodiments depicted in Figures 11 and 12, these disclose a tapered refractory plug which is pierced by capillary bores. Since the capillary passages may

become blocked when the gas injection is interrupted, the passages are provided in tapered removable plugs rather than an integral closure of the nozzle (cf. A1, column 8, lines 44 to 53). This passage of A1 reflects the fact that, in the absence of any contrary information, the width of the capillary passages in said document appears to be larger than claimed since it does not prevent substantially the intrusion of liquid metal as does the invention.

Also the tapered flushing block disclosed in document D1 provides a plurality of fine channels 12 which have a diameter of approximately 1 mm and which are longitudinally aligned in a sealed refractory matrix. A similar flushing block exhibiting such a "directional porosity" is described in documents D2, D4 and D6, whereby the directional gas flow is provided by either small metal tubes (cf. D6, page 1, 3. paragraph) or alternatively by ceramic tubes having an inner diameter in the range of 1 to 4 mm (cf. D2, Figure 1; page 3, lines 33 to 53). However, nothing is said in document D2 regarding how the ceramic tubes are joined gas-tightly to the gas distributing chamber 3. Also the refractory plug disclosed in document D4 cannot make the claimed combination of technical features obvious since it also does not teach either the use of an extruded refractory rod which is embedded in a surrounding refractory plug body, although the cross dimension of the capillary passages is preferably selected to fall within 0.2 to 0.5 mm.

Consequently, even if specific technical features were picked from any of documents A1, D1, D2, D4 or D6 to associate with the teaching of document D3, the subject-matter of claim 1 would not be reached. The

same statement applies to independent claims 6 and 7.

Document D5 is more remote in that it relates to an underbath tuyere for metal processing vessels. The blowpipe made of a steel tube is surrounded by a refractory packing. Hence this document also fails to give any suggestion towards the problem solved by the present invention.

5. Consequently, the subject-matter given in claims 1, 6 and 7 is novel and involves an inventive step within the meaning of Article 56 EPC.

## Order

## For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the first instance with the order to maintain the patent with

- the claims 1 to 11 and
- the description pages 2 to 7 as submitted at the oral proceedings and
- the figures as granted.

The Registrar: The Chairman:

S. Fabiani W. D. Weiß