

EUROPEAN PATENT APPLICATION

Application number: 84301247.7

Int. Cl.⁴: C 10 J 3/57

Date of filing: 27.02.84

Date of publication of application:
 11.09.85 Bulletin 85/37

Designated Contracting States:
 DE FR GB

Applicant: SUMITOMO METAL INDUSTRIES, LTD.
 15, Kitahama 5-chome Higashi-ku
 Osaka-shi, Osaka, 541(JP)

Inventor: Okane, Koji c/o Kashima Steel Works of
 Sumitomo Metal Industries Ltd. 3 Hikari
 Kashima-cho Kashima-gun Ibaraki-ken(JP)

Inventor: Okamura, Shozo c/o Kashima Steel Works of
 Sumitomo Metal Industries Ltd. 3 Hikari
 Kashima-cho Kashima-gun Ibaraki-ken(JP)

Inventor: Sueyasu, Masanobu c/o Kashima Steel Works
 of
 Sumitomo Metal Industries Ltd. 3 Hikari
 Kashima-cho Kashima-gun Ibaraki-ken(JP)

Inventor: Furujo, Sakae Central Research Laboratories
 of
 Sumitomo Metal Industries, Ltd. 3 Nishinagasu
 Hondori 1-chome Amagasaki-shi Hyogo-ken(JP)

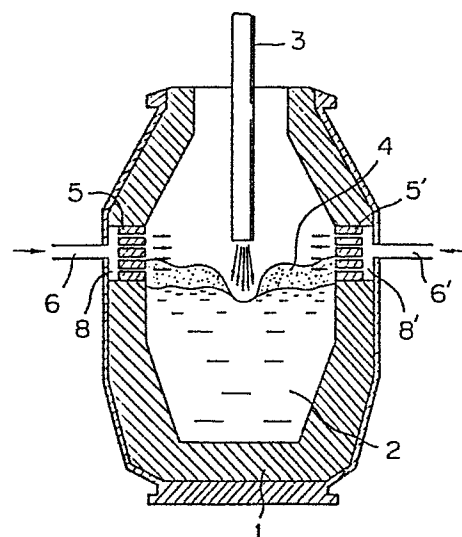
Inventor: Nakajima, Hidemasa c/o Kashima Steel Works
 of
 Sumitomo Metal Industries, Ltd. 3 Hikari
 Kashima-cho Kashima-gun Ibaraki-ken(JP)

Representative: Arthur, Bryan Edward et al,
 Withers & Rogers 4 Dyer's Buildings Holborn
 London EC1N 2JT(GB)

Gasification furnace.

A furnace for gasifying a solid carbonaceous material by
 utilizing a molten metal bath is disclosed. At least part of the
 inner wall of the furnace is composed of a multi-hole
 refractory member (5) through which a cooling fluid is
 supplied to cool the wall portion of the furnace, a plurality of
 finely divided blowing outlets for said cooling fluid being
 provided in said multi-hole refractory member.

Fig. 1



GASIFICATION FURNACE

Background of the Invention

5 This invention relates to a furnace for gasification of solid carbonaceous material, particularly to a gasification furnace utilizing a molten metal bath, in which the heat required for gasifying the solid carbonaceous material is supplied through said molten metal bath, and in which gasification of solid carbonaceous material such as coal,
10 coke, etc. (hereunder sometimes collectively referred to as "coal") is carried out under pressure. More particularly, this invention relates to a gasification furnace in which a cooling means is provided for protecting the lining of the furnace. A gasification furnace utilizing a molten metal
15 bath is hereinafter sometimes called a "molten metal coal gasification furnace" or a "molten iron coal gasification furnace" for convenience.

 As a result of a series of so-called "energy crises", a number of national projects to exploit an energy source
20 other than petroleum has been undertaken in order to ensure a stable supply of energy on a long-term basis using coal, especially low grade coal which has a relatively high content of sulfur and ash.

25 Many types of coal gasification processes and apparatuses using a molten metal bath have been proposed in the past.

 One type noted for its high gasification efficiency and improved desulfurization employs a molten iron bath as a reaction medium for gasification.

30 Coal gasification which utilizes such a molten iron bath comprises preparing a given amount of a molten iron at 1400 - 1600°C in a furnace having a lining of refractory material and introducing coal, a gasification agent such as oxygen, and, if necessary, an auxiliary agent such as steam
35 in addition to a slag-forming agent such as quick lime. The

slag-forming agent is added not only to promote the slag formation but also to adjust the basicity of the slag, i.e. the ratio of CaO to SiO_2 of the slag. The operation of the molten iron bath coal gasification process is in principle quite similar to that of a steel making process utilizing an oxygen-blowing converter.

One system of this type is found in U.S. Patents 4,388,084 and 4,389,246 in which pulverized coal, oxygen, and other auxiliary agents are blown through a top-blowing lance onto the surface of a high temperature molten metal bath prepared in a furnace.

U.S. Patents 3,533,739 and 3,526,478 propose another type of coal gasification system in which pulverized coal is blown into a molten metal bath through a bottom-blowing nozzle provided in the bottom of the furnace.

As mentioned above, the operation of an oxygen-blowing converter for steel making may in principle be applied to the gasification utilizing a molten iron bath. However, what is essentially different from the steel making operation is that it is absolutely necessary to continue gasification for a long period of time in order for the process to be rendered practical. A mere application of an oxygen-blowing converter of the same structure to coal gasification does not achieve continued operation due to an accumulation of slag during operation. The thus built-up slag has to be removed, and the operation has to stop during the removal of slag. In addition, the repair of a furnace lining with a refractory material necessarily results in interruption of operation. Thus, the working efficiency decreases, making the gasification of coal impractical in view of manufacturing costs.

Namely, during operation the inner walls of the gasification furnace are eroded by molten iron and slag, inevitably resulting in mechanical and chemical damage to the refractory lining, i.e. erosion and corrosion of the refractory lining. The erosion and corrosion of the

refractory lining proceeds until the operation of gasification is stopped. The gasification, therefore, cannot be continued for a long period of time.

Therefore, in order to carry out continuous
5 gasification over a long period it is important to prolong the life of the lining. Usually the portion of the furnace wall of a gasification furnace which is most severely damaged is the area above the slag line, i.e. the lowest level of the slag which contacts the furnace wall. The
10 portion of the furnace wall which is in contact with molten iron is also severely damaged after long continuous operation.

In addition, before slag is removed the amount of slag formed during gasification increases and slag builds up on
15 the molten iron bath. When the slag builds up to a certain level, even if it is not necessary to remove it from the furnace, the agitating force of an oxygen jet supplied through a top lance decreases, resulting in less agitation of the molten iron bath. Thus, the dissolution of coal into
20 the molten iron bath is not effectively promoted, decreasing the gasification efficiency of the coal supplied.

In order to eliminate such problems it has been proposed to blow an agitating gas into the molten metal bath through a nozzle provided at the bottom or lower sides of
25 the furnace. This process is similar to a bottom-blowing process for steel making, and it has some inherent disadvantages. That is, it is quite difficult to change the amount of the gas blown through a bottom-blowing nozzle. In particular, it is quite difficult to blow a very small
30 amount of gas into the molten iron bath through a bottom-blowing nozzle.

Thus, the formation or accumulation of slag like this is also one of the causes which prevent achievement of long, continuous gasification with a high gasification efficiency.

Summary of the Invention

One of the objects of this invention is to provide a gasification furnace utilizing a molten iron bath, which can
5 achieve continuous operation for a long peirod of time without the above-mentioned prior art disadvantages.

Another object of this invention is to provide a gasification furnace with a high gasification efficiency.

This invention resides in a furnace for gasifying solid
10 carbonaceous material utilizing a molten metal bath, which comprises a furnace body maintaining said molten metal bath, the inner wall of said furnace being provided with a refractory lining, characterized in that at least part of the inner wall of the furnace is composed of a multi-hole
15 refractory member, and a plurality of fine blowing pipes being provided in said refractory member, through which a cooling fluid is supplied to cool the inner wall portion of the furnace.

According to one embodiment of this invention, this
20 invention resides in a furnace for gasifying solid carbonaceous material utilizing a molten metal bath, said multi-hole refractory member for blowing a cooling fluid for the furnace inner wall being provided in an inner wall of the furnace above the slag line, i.e. the lowest level of
25 molten slag which contacts the inner wall of the furnace.

According to another embodiment of this invention, this invention resides in a furnace for gasifying a solid carbonaceous material utilizing a molten metal bath, said multi-hole refractory member for blowing a cooling fluid for
30 the furnace inner wall being provided in an inner wall where molten metal contacts the inner wall of the furnace.

The cooling fluid for cooling the furnace wall may be steam, carbon dioxide gas, or mixtures thereof. As the cooling fluid, part of the endothermic product gas of this
35 invention may be used and an inert gas such as nitrogen, argon, etc. and a hydrocarbon gas such as propane, methane,

etc. which decomposes when blown into the furnace may also be employed. In place of the above-mentioned cooling gas, a fluid like a heavy fuel oil which decomposes when blown into the furnace, and a fluid like a suspension containing a pulverized solid such as pulverized coal may also be used in this invention.

The provision of the multi-hole refractory member which is provided on or above the slag line is effective not only for cooling the furnace wall but also for protecting the furnace wall from the spitting of slag. The provision of the multi-hole refractory member in an area where the molten metal contacts the furnace wall is effective not only for cooling the furnace wall but also for promoting agitation of the molten metal bath to increase the gasification efficiency of the coal supplied.

According to a preferred embodiment of this invention, this invention resides in a gasification furnace in which a multi-hole refractory member for blowing a cooling fluid into the furnace is provided in at least one place in both the inner wall of the furnace on or above the slag line and in the inner wall of the furnace where molten metal contacts the inner wall.

It is to be noted that this invention may be applied not only to a coal gasification furnace in which pulverized coal is blown onto the surface of a molten metal bath through a top-blowing lance, but also to a coal gasification furnace in which pulverized coal is blown into a molten metal bath through a bottom-blowing nozzle.

Brief Description of the Drawings

Fig. 1 is a cross-sectional view showing an embodiment of a molten iron coal gasification furnace of this invention;

Fig. 2 is a cross-sectional view of another embodiment of this invention;

Fig. 3 is a cross-sectional view of still another embodiment of this invention;

Fig. 4 is a front view of a multi-hole refractory member which is employed in this invention; and

5 Fig. 5 is a longitudinal, sectional view of the multi-hole refractory member shown in Fig. 4.

Detailed Description of the Preferred Embodiments

10 This invention will be described in conjunction with the attached drawings.

Fig. 1 is a diagrammatical, sectional view of an embodiment of a molten iron bath gasification furnace of this invention. As is apparent from the drawing, a furnace wall 1 is comprised of a refractory lining within which a molten iron bath 2 is maintained. Slag 4 is formed on the molten iron bath 2 and is surrounded by the furnace wall 1. Since the area on or above the slag line, the lowest level where the furnace wall 1 contacts slag 4, is most severely damaged, multi-hole refractory members 5, 5' are provided in the area on or above the slag line. The structure of the multi-hole refractory member is shown in detail in Figs. 4 and 5. Preferably, they are provided in the furnace wall so as to extend from the slag line to above the slag surface. 20 The multi-hole refractory member has a plurality of finely divided outlets for a cooling fluid for cooling the inner wall of the furnace. Each of these outlets is composed of an iron pipe having a fine pore, i.e. a small inner diameter. Alternatively, it may be composed of a porous refractory with fine pores.

30 The multi-hole refractory members 5, 5' are connected through conduits 6, 6' to a source of a cooling fluid (not shown) for cooling the furnace wall. Preferably, the multi-hole refractory member is provided in a wall portion of the furnace which is in contact with the slag in the furnace. It may be provided around only a portion of the 35

periphery of the furnace wall with the rest of the periphery comprising usual refractory brick. Preferably, 30 - 70 % of the total peripheral area where the inner wall of the furnace contacts the molten slag is provided with said
5 porous member.

The multi-hole refractory members 5,5', as shown in Figs. 4 and 5, are prepared by embedding a plurality of fine iron pipes 7 in a brick 9. Alternatively, the multi-hole refractory member may be formed of a porous brick
10 containing no pipes 7.

Thus, the multi-hole refractory member employed in this invention may be either a member which comprises a plurality of fine pores formed of a plurality of fine iron pipes embedded in brick, or a member which is a porous brick with
15 a plurality of fine pores. If the multi-hole refractory member comprises a plurality of iron pipes, the interval between the pipes and pore diameter thereof are preferably 20 - 50 mm and 0.5 - 1.5 mm, respectively. When the interval is small and the pore is large in diameter, an
20 excess amount of a cooling fluid is blown into the furnace to render the gasification operation unstable.

On the other hand, when the interval is large and the diameter is small, the cooling performance of the furnace wall is deteriorated, resulting in much spitting of slag
25 onto the furnace wall, and a cooling fluid at a higher pressure is also required. The total area of the blowing inlets is preferably about 20 - 80% of the whole area of the inner end surface of the multi-hole refractory member. The multi-hole refractory member is preferably in the shape of a
30 wedge in section and is detachably fitted into the furnace wall. On the outer ends of the multi-hole refractory members, fluid-distributing chambers 8,8" connected to conduits 6,6' are provided.

A cooling fluid supplied from an external source (not
35 shown) is passed through conduits 6,6' to multi-hole refractory members 5,5' provided surrounding the slag 4

formed on the molten metal bath 2. The cooling fluid is blown into the furnace from fluid-distributing chambers 8,8' through a plurality of gas outlets, as shown by arrows.

Fig. 2 is a diagrammatical, sectional view showing another embodiment of this invention, in which part of the furnace wall 1 where the molten iron bath 2 contacts the lining is comprised of multi-hole refractory members 5,5'. The multi-hole refractory members 5,5' are connected through conduits 6,6' to an external source of a cooling fluid (not shown) for cooling the furnace wall. The multi-hole refractory member 5 may be placed around the entire periphery of the inner wall of the furnace or along a part thereof. Preferably, it is placed near the bottom of the furnace where erosion and corrosion of the refractory lining 1 are severe. The multi-hole refractory members 5,5' employed in this case are the same as those shown in Figs. 4 and 5. When a bottom-blowing furnace (not shown) is employed, the multi-hole refractory members 5,5' are preferably comprised of a brick with fine pores, e.g. a porous brick. Such porous brick may be arranged as shown in Fig. 2.

Outside the multi-hole refractory members 5,5', there are provided fluid-distributing chambers 8,8', which are connected with conduits 6,6', respectively.

Fig. 3 shows still another embodiment of this invention, in which the multi-hole refractory members 5,5' are provided in both the furnace wall above the slag line and in the furnace wall in an area where the molten iron bath 2 contacts the furnace wall 1. The basic structure of the furnace in Fig.3 is the same as in Figs. 1 and 2, and the same members are indicated by the same reference numerals.

It is herein to be noted that damage to the refractory lining is effectively prevented and gasification efficiency of the coal supplied is markedly improved by employing the arrangement shown in Fig. 3.

This invention will be further described with reference to some working examples, which are presented merely for illustrative purposes.

5 Example 1

Gasification was carried out using the molten iron coal gasification furnace shown in Fig. 1, which contained 10 tons of molten iron at 1450°C . Pulverized coal, 70% or more of which was -200 mesh, was blown onto the surface of the molten iron bath maintained in the furnace at a rate of 2.5
10 tons/hr together with oxygen gas, i.e. a gasification agent at a rate of $1600 \text{ Nm}^3/\text{hr}$ and steam at a rate of 200 kgs/hr through a non-immersing top-blowing lance. As a slag-forming agent, quick lime was added at a rate of 80 kgs
15 per ton of the coal supplied.

A portion of the product gas, after being dust-removed and cooled, was recycled to the multi-hole refractory members and was blown into the furnace at a rate of 150 - 200 Nm^3 per ton of the coal supplied. The proportion of the
20 gas blown through the multi-hole refractory members was about 1/10 to 1/15 of the total volume of the product gas.

The multi-hole refractory members employed in this example were prepared by embedding iron pipes with an inner diameter of 1.0 mm in a refractory material at intervals of
25 30 mm at a distance of 2 meters above the slag line. A series of multi-hole refractory members were placed at intervals along the circumferential inner wall portion and half of the circumference was occupied by the porous brick portions. For the purpose of comparison, usual bricks were
30 left between the multi-hole refractory members.

After 200-hour running, it was determined how much damage has occurred to the multi-hole refractory member and the usual brick portion. The damage to the usual brick was 200 mm thick, but damage to the multi-hole brick of this
35 invention was about one-tenth of this value, i.e. 19 mm. It is therefore to be noted that without providing multi-hole

refractory members, the operation would have to be stopped after running for 100 hours because of excessive damage to the refractory lining.

Thus, according to this invention in which the
5 multi-hole refractory members were employed, it was possible to markedly prolong the life of the furnace lining, making the gasification of this invention practical.

Example 2

10 This example was identical to Example 1 except that the gasification furnace shown in Fig. 2 was employed and a product gas was recycled to the multi-hole refractory members at a rate of 75 - 100 Nm³ per ton of input coal. The proportion of the product gas blown into the furnace was
15 about 1/20 - 1/30 of the total volume of the product gas.

The multi-hole refractory members were placed at a depth of 1 meter below the slag line with a width of 1 meter wide in contact with the molten iron bath. In this example, the multi-hole refractory members were placed at constant
20 intervals around the furnace such that half of the circumference of the inner furnace wall was covered by the multi-hole refractory members. For comparative purposes, usual brick portions were left between the multi-hole refractory members.

25 Compared with the case in which a conventional furnace was employed without using the multi-hole refractory members, it was noted that according to this invention the gasification efficiency was improved by about 2%.

In addition, according to this invention, there was no
30 substantial damage to the multi-hole refractory members even after 100 hours of running.

Example 3

In this example, Examples 1 and 2 were repeated using
35 the gasification furnace shown in Fig. 3.

The product gas blown into the furnace through the

-11-

upper multi-hole members was 150 - 200 Nm³ per ton of the input coal. The product gas blown into the molten iron bath through the lower multi-hole members was 75 - 100 Nm³ per ton of the input coal.

5 It can be said that according to this example, Example 1 and Example 2 were simultaneously carried out.

10 After about 200 hours of running, the damage to the refractory lining was determined. There was substantially no damage to the multi-hole refractory members contacting the molten iron bath, and the damage to the multi-hole refractory members contacting the slag was about 20 mm thick. Thus, it can be said that the multi-hole refractory members were practically free from damage.

15 In addition, the gasification efficiency was improved by about 2% in comparison with the case in which a conventional gasification furnace was employed.

20 Although the invention has been described with respect to preferred embodiments, it is to be understood that variations and modification may be employed without departing from the concept of the invention as defined in the following claims.

25

30

35

- 1 -

Claims:

1. A furnace for gasifying solid carbonaceous material by utilizing a molten metal bath, which comprises a furnace
5 body maintaining said molten metal bath, the inner wall of said furnace being provided with a refractory lining, characterized in that at least part of the inner wall of the furnace is composed of a multi-hole refractory member, and a plurality of finely divided blowing outlets is provided in
10 said refractory member, through which a cooling fluid is supplied to cool the wall portion of the furnace.
2. A gasification furnace as defined in Claim 1, in which said multi-hole refractory member is composed of a porous
15 refractory brick or a refractory material in which a plurality of longitudinally-extending pipes having fine pores are embedded.
3. A gasification furnace as defined in Claim 1, in which
20 said solid carbonaceous material is coal.
4. A gasification furnace as defined in Claim 1, in which said molten metal bath is a molten iron bath.
- 25 5. A gasification furnace as defined in Claim 1, in which said cooling fluid is the product gas recovered from the gasification furnace.
6. A gasification furnace as defined in any one of Claims
30 1 - 5, in which said multi-hole refractory member is provided in an inner wall of the furnace on and above the slag line.
7. A gasification furnace as defined in any one of Claims
35 1 - 5, in which said multi-hole refractory member is provided in an inner wall where molten metal contacts the

- 2 -

inner wall of the furnace.

8. A gasification furnace as defined in any one of Claims
1 - 5, in which said multi-hole refractory member is
5 provided at least one place each of an inner wall of the
furnace on and above the slag line and of an inner wall of
the furnace where a molten metal contacts the inner wall.

10

15

20

25

30

35

1/4

Fig. 1

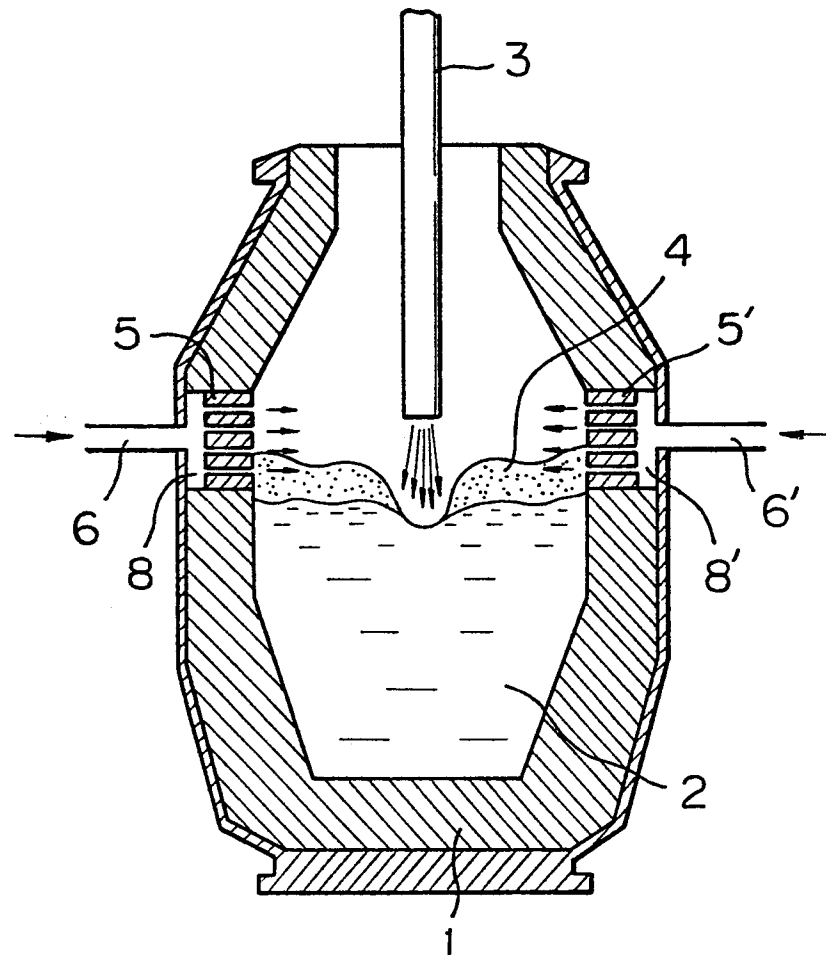


Fig. 2

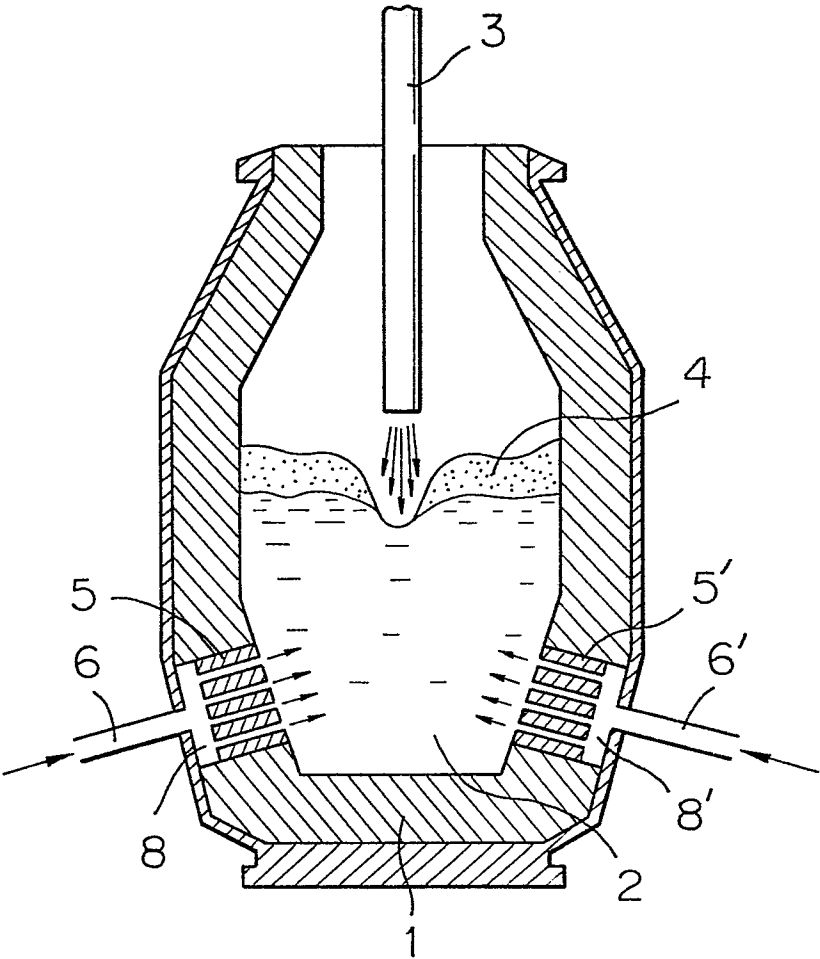
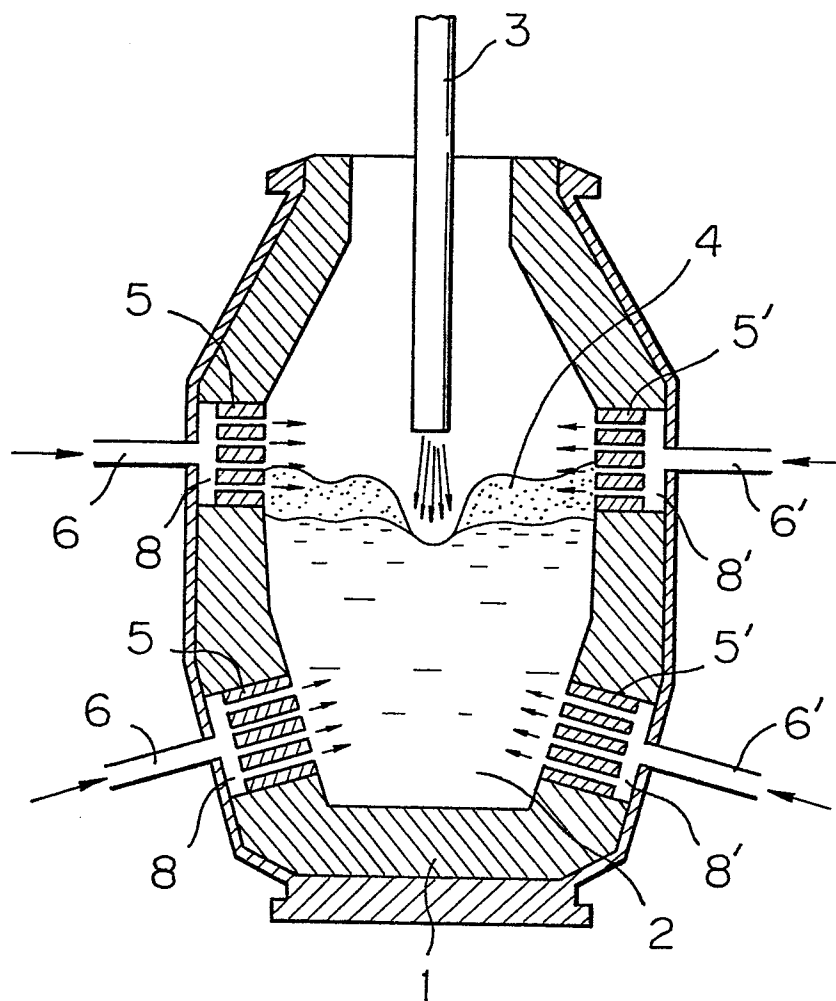
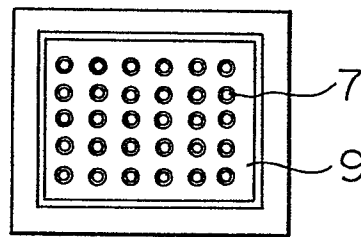
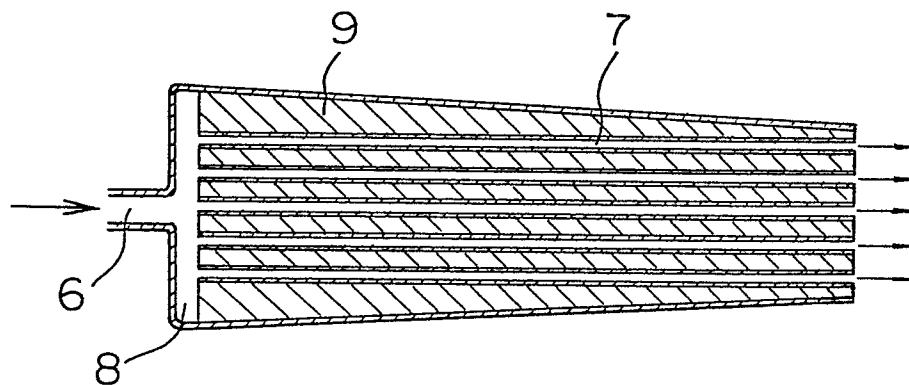


Fig. 3

4/4

Fig. 4*Fig. 5*



European Patent
Office

EUROPEAN SEARCH REPORT

0154056

Application number

EP 84 30 1247

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. ³)
A	GB-A-2 103 648 (BRITISH STEEL CORP.) * page 2, claims 1-21 *	1,3,4	C 10 J 3/57
A	FR-A-2 507 208 (NIPPON KOKAN) * page 12, lines 1-20 *	2,7	
A	EP-A-0 070 197 (NIPPON STEEL CORP.) -----		
			TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
			C 10 J C 21 C
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 22-10-1984	Examiner WENDLING J.P.
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			