

Internal distribution code:

- (A) [] Publication in OJ
(B) [] To Chairmen and Members
(C) [X] To Chairmen

D E C I S I O N
of 10 October 1995

Case Number: T 01020/93 - 3.2.3

Application Number: 85905348.0

Publication Number: 0197137

IPC: F27D 1/12

Language of the proceedings: EN

Title of invention:
Furnace cooling system and method

Patentee:
UNION CARBIDE CORPORATION

Opponent:
01: KORTEC AG
02: FUCHS SYSTEMTECHNIK GMBH

Headword:
-

Relevant legal provisions:
EPC Art. 54, 56, 123(2)

Keyword:
"Amendments - added subject-matter (no)"
"Novelty (yes)"
"Inventive step (yes)"

Decisions cited:
-

Catchword:
-



Case Number: T 1020/93 - 3.2.3

D E C I S I O N
of the Technical Board of Appeal 3.2.3
of 10 October 1995

Appellant: UNION CARBIDE CORPORATION
(Proprietor of the patent) 39 Old Ridgebury Road
Danbury
Connecticut 06817 (US)

Representative: Schwan, Gerhard, Dipl.-Ing.
Elfenstrasse 32
D-81739 München (DE)

Respondent: KORTEC AG
(Opponent 01) Baarerstrasse 21
CH-6300 Zug (CH)

Representative: Kramer, R., Dipl.-Ing.
Blumbach Weser Bergen Kramer
Zwirner Hoffmann
Patentanwälte
Radeckestrasse 43
D-81245 München (DE)

Respondent: Fuchs Systemtechnik GmbH
(Opponent 02) Reithallenstrasse 1
D-77731 Willstätt (DE)

Representative: Kramer, R., Dipl.-Ing.
Blumbach Weser Bergen Kramer
Zwirner Hoffmann
Patentanwälte
Radeckestrasse 43
D-81245 München (DE)

Decision under appeal: Decision of the Opposition Division of the
European Patent Office dated 7 June 1993,
dispatched on 6 October 1993, revoking European
patent No. 0 197 137 pursuant to Article 102(1)
EPC.

Composition of the Board:

Chairman: C. T. Wilson
Members: H. Andrae
B. Schachenmann

Summary of Facts and Submissions

I. European patent No. 0 197 137 was granted on 12 December 1990 on the basis of European patent application No. 85 905 348.0 filed on 15 October 1985 as international application PCT/US 85/01 977.

II. The patent was opposed by the Respondents 01 and 02 (Opponents 01 and 02) on the grounds that the subject-matter of the independent claims was not new and did not involve an inventive step with respect to the following prior art documents:

D1: EP-A-0 044 512

D2: US-A-3 429 973

D3: US-A-4 273 949

D4: US-A-4 216 348

D5: US-A-2 006 266.

III. The Patentee requested maintenance of the patent in amended form on the basis of a main request or one of four auxiliary requests.

The patent was revoked by the Opposition Division with a decision dated 7 June 1993, dispatched on 6 October 1993.

According to the decision, the subject-matter of independent Claims 1 and 9 of the main request lacked novelty over document (D5) and the subject-matter according to the auxiliary requests 1 to 4 did not meet the requirement of Article 123(2) EPC.

IV. The Appellant (Patentee) filed an appeal against this decision on 30 November 1993, the appeal fee being paid on the same day.

The Statement of Grounds of Appeal was filed on 7 February 1994 together with three sets of claims and description according to a main request and two auxiliary requests 1 and 2.

- V. Oral proceedings took place on 10 October 1995. Nobody was present on behalf of the Respondent 01 who had informed the Board by letter dated 22 August 1994 that they would not be filing any comments on the grounds of appeal, and withdrew their request for oral proceedings. As they had been duly summoned pursuant to Rule 71(1) EPC, the oral proceedings were conducted without them (Rule 71(2) EPC)

At the outset of the oral proceedings, the Chairman of the Board referred to the further document US-A-205 274 (D6) discussed in the introductory part of the description of the patent in suit which appeared to be relevant to the claimed subject-matter since it describes water spray cooling of components of a blast-furnace.

- VI. The Appellant requests that the decision under appeal be set aside and that the patent be maintained on the basis of the documents according to the main request or the first or second auxiliary request filed with the Statement of Grounds of Appeal.

Claim 1 of the main request reads as follows:

"Method for liquid water cooling the roof and/or side walls and/or components of electric-arc, plasma-arc and ladle furnaces and of basic oxygen and iron mixer vessels, having an outer plate (20, 96) and an inner

working plate (22, 76, 94), which define an enclosed space therebetween, said inner working plate being exposed to the heat of the interior of the furnace, vessel or component thereof, said method comprising the steps of:

passing a liquid water coolant through a plurality of spray nozzles (40, 72, 92) within said enclosed space under sufficient pressure only to effect sprays of liquid coolant in the form of droplets, and directing said coolant sprays, exclusively consisting of water in the form of droplets, against the inner working plate (22, 76, 94) in a quantity such that the spray water droplets absorb heat from the inner working plate due to surface area contact and remain in liquid form until after removal from the inner working plate and the enclosed space; and

removing from the inner working plate surface and positively evacuating from said enclosed space by pump means (56) the coolant water, while still substantially in its liquid form, thereby preventing build-up of liquid coolant water on the inner working plate and in said enclosed space."

Claim 6 of the main request reads as follows:

"Liquid water cooling apparatus for the liquid water cooling of the roof and/or side walls and/or components of electric-arc, plasma-arc and ladle furnaces and of basic oxygen and iron mixer vessels, having an outer plate (20, 96) and an inner working plate (22, 76, 94) which define an enclosed space therebetween, said inner working plate being exposed to the heat of the interior of the furnace, vessel or component thereof, said apparatus comprising:

a spray system under sufficient pressure only to effect sprays of liquid coolant in the form of droplets, said spray system defining a framework (12, 14, 16, 18, 68, 74, 82, 84, 86, 88) for supporting said inner and outer plates (20, 22, 76, 94, 96) and having liquid cooling water droplet spray means (14, 16, 16', 16", 18, 18', 34, 40, 68, 70, 72, 82, 86, 88, 90, 92) extending into the enclosed space and including header pipe means (14, 16, 16', 16", 68, 82, 86, 88) connected with a supply of coolant, a plurality of spray pipes (18, 18', 70, 90) connected with the header pipe means to receive coolant therefrom, and a plurality of spray nozzles (40, 72, 92) carried by the spray pipes for directing said coolant sprays exclusively consisting of liquid water in the form of droplets against the inner working plate (22, 76, 94), in a quantity such that the spray water droplets absorb heat from the inner working plate due to surface area contact, and remain in liquid form until after removal from the inner working plate and the enclosed space; and

positive water evacuation means (50, 52, 54, 56, 74, 84, 98, 102, 104, 106) connected with the enclosed space and comprising pump means (56) for removing from the inner working plate surface and positively evacuating from said enclosed space the coolant water while still substantially in its liquid form thereby preventing build-up of liquid coolant water in said space."

The Appellant's arguments can be summarised as follows:

- The entire subject-matter of the claims including the feature that the spray water droplets absorb heat from the inner working plate and remain in liquid form until after removal from the inner working plate and the enclosed space has been originally disclosed so that no objections as to extended subject-matter are justified.

- The subject-matter of Claim 1 and Claim 6, respectively, of the main request is novel and involves an inventive step.

Document (D1) as the closest prior art deals with an evaporative cooling system in which the enthalpy of evaporation is relevant. In contrast to this known system, the invention avoids the evaporation of the cooling water under the normal operating conditions achieving thereby an improved operational safety and a reduction of deposits formed on the surfaces to be cooled.

- The documents (D3) and (D4) concern a basically different type of cooling system, namely a flood cooling system which cannot give any lead to improve a spray cooling system as claimed.

Document (D5) relates to a duplex-type fluid cooling system in a blast-furnace in which additionally to a liquid coolant, air is used to atomize the coolant and contributes to absorbing heat.

Document (D6) does not deal with an electric-arc furnace but with blast-furnaces which the skilled person when trying to improve electric-arc

furnaces, would not take into consideration. Moreover, this known furnace could not solve the safety-issue as the water being collected in the cooling boxes would be hazardous in view of the risk of explosion.

No combination whatsoever of the documents discussed would lead in an obvious manner to the subject-matter of Claims 1 and 6, respectively.

VII. The Respondent 01 announced by the letter dated 22 August 1994 that he would not make any observations in respect of the Statement of Grounds of Appeal.

The Respondent 02 requests that the appeal be dismissed.

He argues essentially as follows:

- The feature according to Claims 1 and 6, respectively, of the main request that the spray water droplets remain in liquid form until after removal from the inner working plate and the enclosed space has not been originally disclosed and constitutes therefore added subject-matter in the sense of Article 123(2) EPC. Besides, the originally filed description indicates on page 15, lines 1ff, that the droplets of cooling water flash to steam. Moreover, evaporation is a phenomenon that normally takes place below a temperature of the wall to be cooled of 100°C.

- The document (D1) describes a liquid water cooling system which is identical with the system according to Claim 1. It is clear from page 4, paragraph 2 of the document (D1) that the known system operates under atmospheric pressure or a pressure slightly above 1 bar so that no danger of explosion can be

recognised. Moreover, no cooling water remains in the enclosed space since a pump (8; Figure 1) provides for evacuation of the water therefrom. In accordance with the embodiments of Figures 2 and 3 of the known system, a duct (22) is arranged for guiding saturated vapour to a condensate container.

Thus, besides its inadmissibility in view of Article 123(2) EPC, Claim 1 contains no novel subject-matter.

- The additional feature of Claim 6 in respect of Claim 1 that the spray system defines a framework for supporting the inner and outer plates is suggested by document (D4).

A combination of the teachings of documents (D1) and (D4), to which there are no obstacles, would therefore lead in an obvious way to the subject-matter of Claim 6 so that this claim is lacking in an inventive step.

Reasons for the Decision

1. The appeal is admissible.

Main request

2. *Amendments*

- 2.1 Claims 1 to 16

Claim 1 is supported essentially by the original Claims 17, 18 and 9 (last paragraph). The following additional features of Claim 1 derive as indicated below:

"Cooling of the roof and/or side walls and/or components of electric-arc, plasma-arc and ladle furnaces, of basic oxygen vessels and of iron mixer vessels" derives from page 1, lines 4 to 11 and page 3, line 30 to page 4, line 5 of the original description;

"Cooling of a working plate" derives from page 3, lines 9 to 14 of the original description;

"Passing a liquid water coolant through a plurality of spray nozzles within the enclosed space under sufficient pressure only to effect sprays of liquid coolant" derives from original Claim 9 and from page 3, lines 15 to 22 and page 6, lines 11 to 14 of the original description;

"The coolant adsorbs heat from the inner working plate" derives from page 11, lines 15 and 16 of the original description;

"The spray water droplets remain in liquid form until after removal from the inner working plate and the enclosed space" derives from page 4, line 33 to page 5, line 2 of the original description, see in particular the wording "...the spray droplets absorb heat due to surface area contact and "dance" or move across the plate and are positively exhausted or evacuated as droplets."

The argument of the Respondent 02 that this passage has to be interpreted such that the droplets on contacting the surface area are vaporised and that then, subsequently, the vapour is re-condensed by contact of the vapour with sprayed water is not convincing. On page 5, lines 8 to 14 of the original description, it is indicated that flashing of the sprayed water may take place due to the occurrence of a temporary hot spot. It

is, however, also emphasised in this passage that the temperature of the coolant fluid (water) normally does not reach 212°F (100°C) at which temperature vaporisation of the coolant to a substantial extent would occur.

In the view of the Board, it is therefore clearly disclosed that evaporation of a substantial amount of the sprayed cooling water has to be avoided in the normal operating range.

The feature "Positively evacuating coolant water from the enclosed space by pump means" derives from page 4, lines 24 to 30 of the original description in combination with the original Claim 9.

The coolant has been disclosed to be a cooling fluid, preferably water or a water base fluid, cf. page 3, lines 15 to 29, and the passage bridging pages 4 and 5 of the original description. There is no disclosure of the coolant consisting of a different heat carrier as e.g. a gas or a gas-fluid mixture. The restriction of the independent claims to the coolant spray consisting **exclusively** of water in the form of droplets is, therefore, supported by the original disclosure.

Independent Claim 6 is supported essentially by the original Claims 1 and 2. It includes in substance also the additional features indicated above relating to Claim 1 and reference is made in respect of the disclosure of these features to the above comments.

Claims 2 and 11, respectively, derive from page 5, lines 31 to 36 and page 13, paragraph 2, respectively, of the original description.

Claims 3 to 5, 7 to 10 and 12 to 16 are supported by the original Claims 20, 21, 19, 2, 14, 16, 7, 3 to 6 and 10 in the indicated order.

The independent Claims 1 and 6 contain all the features of the corresponding Claims 1 and 9 as granted. The additional features of the Claims 1 and 6 as listed above limit the scope of the corresponding claims as granted.

Claims 1 to 16 comply, therefore, with the requirements of Article 123(2) and (3) EPC.

2.2 Description

The description has been amended by way of indication of the background art and has been brought into conformity with the valid claims. Hence, also the description does not contravene Article 123 EPC.

3. *Novelty*

3.1 The closest state of the art is that described in document (D1).

This document discloses a method and an apparatus for liquid water cooling of the roof or side wall or other component of a metallurgical furnace, in particular an electric-arc furnace. The liquid coolant, in particular water, is sprayed within an enclosed space through a plurality of spray nozzles against a heat exchange surface which defines an outer wall such as a side wall or the roof of the furnace. In accordance with the inherent problem, satisfactory cooling across the entire heat exchange area is to be achieved in spite of thermal loads strongly varying in terms of location and time while making use of the enthalpy of evaporation. As a

function of measured temperature values on the heat exchange surface, cooling liquid is sprayed to the heat exchange surface as long as the measured temperature is above the boiling point of the cooling liquid whereby the quantity of the sprayed liquid is limited so as to cause a spontaneous evaporation of the cooling liquid and to avoid a coherent film of liquid on the heat exchange surface (see Claims 1 and 8 and page 4, paragraph 3 of the description).

According to all the embodiments described, there is provided a duct (22) through which the saturated vapour originating from the evaporation of the sprayed water is drawn off.

According to the embodiment of Figure 1, a duct (9) for withdrawing condensate is provided, the function of which is explained as follows (page 5, lines 29 to 31, in English translation):

"Parts of the coolant which condensate without any control are led to the container 7 by means of a condensate duct 9."

Hence, it is clear that the substantial portion of the sprayed coolant is withdrawn in the form of saturated vapour through the duct (22) by means of vapour pump (5) and that only a part of the coolant which condensates in an uncontrolled manner leaves the enclosed space through the condensate duct (9).

There is also no hint of the arrangement of a pump withdrawing the condensate through the duct (9). The argument of the Respondent 02 that the pump (8) provided in the embodiment of Figure 1 between the condensate container (7) and the pressure container (18) would create a pressure difference in the condensate duct (9)

sufficient for pumping the condensate into condensate container (7) is not supported by the factual disclosure of document (D1) and therefore based on speculative considerations.

Thus, the subject-matter of Claim 1 and that of Claim 6, respectively, differs from the disclosure of document (D1) by the features that the spray system, (a) operates according to a method in which and (b) is designed so that, respectively, the water is sprayed in the form of droplets against the inner working plate in a quantity such that the spray water droplets absorb heat from the inner working plate due to surface area contact and remain in liquid form until after removal from the inner working plate and the enclosed space and that the cooling water is removed from the inner working plate surface and positively evacuated from the enclosed space by pump means while still substantially in its liquid form, thereby preventing build-up of liquid coolant water on the inner working plate and in the enclosed space.

3.2 The documents (D3) and (D4), although concerning water cooling of electric-arc furnaces, relate to flood cooling systems in which streams of pressurised cooling liquid, in particular water, are guided through flow channels exposed to the furnace heat. These cooling systems do not dispose of a water spraying system comprising spray nozzles.

3.3 Document (D5) relates to a blast furnace in which individual cooling chambers are cooled by using two different fluids, namely water and compressed air, the air being used for atomising the water within the cooling chamber and spraying it in a fine spray against

the cooling chamber walls. Surplus cooling water is collected in the lower part of the cooling chamber, its level reaching the height determined by an overflow whereby a permanent pool of water is established in the cooling chamber.

Document (D5) does not disclose

- the use of a single cooling fluid, namely exclusively water
- removing the water from the inner working plate surface and positively evacuating the water from the enclosed space by pump means, thereby preventing build-up of coolant water on the inner working plate and in the enclosed space.

3.4 Document (D6) relates to a blast furnace comprising open cooling boxes which are cooled by water being sprayed against the inner walls of the cooling boxes. The water after being sprayed runs down from the walls and is collected and held at the bottom of a respective cooling box, the depth of the water standing in the box being regulated by the position and size of waste pipes provided at the bottom of the boxes.

Document (D6) does not describe a method of and an apparatus, respectively, for cooling the roof and/or side walls and/or components of electric-arc, plasma-arc and ladle furnaces, and basic oxygen and iron mixer vessels having an enclosed space between an outer and an inner working plate. Furthermore, it does not disclose removing the coolant water from the working plate surface and evacuating it from an enclosed space by pump means.

3.5 It follows from the above considerations that the subject-matter of Claim 1 and Claim 6, respectively, of the patent in suit is novel in the sense of Article 54 EPC.

4. *Inventive step*

4.1 In comparison with the closest prior art according to document (D1) the invention aims to reduce the formation of scale on the heat exchange surfaces and to avoid a dangerous pressure build-up which may occur in an evaporation cooling system with relatively high temperatures of the heat exchange surfaces.

The replacement of the evaporation cooling system according to document (D1) by a cooling system in which substantially no evaporation occurs decreases the formation of scale or deposits on the heat exchange surfaces leading thus to an increased efficiency of heat exchange. The use of pump means for evacuating the coolant water from the working plates and the cooling chamber provides for quick and effective removal of the coolant water after it has been sprayed against the working plates and for a reduction of the danger of pressure build-up and explosion in case of a system failure as for example a rupture of the furnace wall.

Contrary to the opinion of the Respondent 02, that the system known from document (D1) is not susceptible to the danger of pressure build-up and explosion as it operates under a pressure being at a maximum slightly above 1 bar, the Board considers that cooling systems having higher temperatures of the heat exchange surfaces run a higher risk of explosion in the case of a failure

of the system which leads to contact between the coolant and the contents of the furnace or vessel and this in particular when no provisions are made for an effective withdrawal of the coolant after its use.

The distinguishing features of Claims 1 and 6, respectively, as illustrated in section 3.1 above, manifestly solve the underlying problem.

4.2 As the Appellant pointed out in his letter dated 7 September 1995 the cooling system according to document (D1) represents a single fluid system operating with two fluid phases. That is a system using coolant both in the liquid phase for spraying onto the wall to be cooled and in the gaseous phase as a heat carrier after evaporation. Thus, making intentional use of the enthalpy of evaporation of the coolant is an indispensable part of the teaching of this document which the skilled person would not omit in any combination with further pieces of the prior art.

4.3 In the duplex fluid cooling system known from document (D5) the second fluid, that is compressed air, is utilised both for atomising the first fluid, that is water, and for increasing the cooling effect in consequence of the expansion of the compressed air. As the problem underlying the cooling system known from document (D5), is to ensure reliable cooling at all times and to reduce the consumption of water, the utilisation of both water and compressed air is crucial to the operation of this system. Thus, in any combination of this known system with additional prior art the skilled person would not suppress the combined utilisation of water and pressurised air so that he would not arrive thereby at the subject-matter of Claims 1 and 6, respectively.

4.4 As shown in section 3.2 above, the water-cooling systems known from documents (D3) and (D4) represent flood cooling systems. These systems do not operate pursuant to the concept of distributing the cooling water by spraying over the heat exchange surface as according to the patent in suit but provide for conducting the cooling water within closed passages the walls of which constitute the heat exchange surfaces. These two concepts are basically different so that it is not recognisable in which way they might be combined in order to arrive at the claimed subject-matter.

4.5 Finally according to document (D6) as outlined in section 3.4 above, water is sprayed against the inner walls of open cooling boxes provided in the brick work of a blast-furnace. The document teaches to collect and hold the water running down the cooling box walls in the bottom of the boxes, the depth of the water being regulated by the position and size of waste pipes provided in the cooling boxes.

Since this known method and apparatus, respectively, for liquid water cooling does not provide for removing the water by pump means quickly and effectively from the coolant space after being sprayed, the inherent problem of the invention to avoid any possibly detrimental collection and movement of the coolant fluid, in particular in case the furnace is tilted (see also the passage bridging pages 4 and 5 of the amended description of the patent in suit, based upon page 4, paragraph 3 of the original description), cannot be solved with this known system. Moreover, as this system relates to a blast furnace in which, as opposed to metallurgical furnaces or vessels, tilting of the furnace is not normally envisaged the skilled person would also not be induced to take a closer look at this document.

4.6 Summing up, the Board comes to the conclusion that the subject-matter of Claim 1 and Claim 6, respectively, of the main request cannot be derived in an obvious manner from the cited prior art and accordingly involves an inventive step (Article 56 EPC).

5. For the above reasons, the subject-matter of Claim 1 and Claim 6, respectively, is patentable (Article 52(1) EPC) and the patent may be maintained on the basis of these claims and dependent Claims 2 to 5 and 7 to 16 which relate to preferred features of the method and apparatus according to Claim 1 and Claim 6, respectively.

Auxiliary requests 1 and 2:

Since Claims 1 to 16 according to the main request are found to be maintainable, consideration of the auxiliary requests is not necessary.

Order

For these reasons it is decided that:

1. The contested decision is set aside.
2. The case is remitted to the first instance with the order to maintain the patent in the following version:
 - Claims 1 to 16 filed as main request on 7 February 1994.
 - Description pages 1 to 9 filed as main request on 7 February 1994.
 - Drawings Figures 1 to 15 as granted.

The Registrar:



N. Maslin

The Chairman:



C. T. Wilson