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D E C I S I O N
of 11 December 1996

Case Number: T 0249/95 - 3.4.2

Application Number: 88118744.7

Publication Number: 0318740

IPC: B01D 53/36

Language of the proceedings: EN

Title of invention:
Denitration reactor

Patentee:
BABCOCK-HITACHI KABUSHIKI KAISHA

Opponent:
01: Hüls Aktiengesellschaft
02: EVT Energie und Verfahrenstechnik GmbH
03: L. & C. Steinmüller GmbH

Headword:
-

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

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

Decisions cited:
-

Catchword:
-

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Case Number: T 0249/95 - 3.4.2

D E C I S I O N
of the Technical Board of Appeal 3.4.2
of 11 December 1996

Appellant: (Opponent 01)
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D-45764 Marl (DE)

Appellant: (Opponehnt 03)
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Respondent: (Proprietor of the patent)
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Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted 6 February 1995 rejecting the opposition filed against European patent No. 0 318 740 pursuant to Article 102(2) EPC.**

Composition of the Board:

Chairman: E. Turrini
Members: R. Zottmann
L. C. Mancini

Summary of Facts and Submissions

I. The Appellants 1 and 2 (Opponents 1 and 3) lodged appeals against the decision of the Opposition Division on the rejection of the oppositions against patent No. 0 318 740 with the application No. 88 118 744.7.

Opposition was filed against the patent as a whole and based on the grounds of Article 100(a) EPC that the subject-matter of the patent were not novel (Article 52(1) and 54 EPC) and, respectively, not inventive (Article 52(1) and 56 EPC).

The following documents were cited:

D1: Chem.-Ing.-Tech., 65 (1993) 11, pages 1345 to 1347 (introduced by the Opposition Division),
D4: DE-C-3 612 218,
E1: Chemie-Technik, 15 (1986) 2, pages 17 to 24,
E2: EP-A-0 163 001,
E3: Patent Abstracts of Japan, 56-24030, 7. 3. 1981,
E4: Patent Abstracts of Japan, 56-21627, 28. 2. 1981,
EH1: "Sonderdruck aus Energie Spektrum", June 1987, J. Becker: "Aktiva und Passiva, Betriebserfahrungen mit Sekundärmaßnahmen zur Minderung der NOx-Emission", pages 25 to 48, and
EH2: Leaflet of Hüls AG of October 1986 "Mit Chemie zu einer sauberen Umwelt, DeNOx-Katalysatoren".

II. During the appeal procedure the following further documents were referred to:

L1: London, A. L., Klopfer, G. and Wolf, S.: Technical Report No. 63 "Oblique flow headers for heat exchanger - the ideal geometries and the evaluation of losses", Department of Mechanical Engineering, Stanford University, August 1966,

pages i to x, 1 to 45 and figure sheets with Figures 1 to 19, I-1 to I-3, II-1 and II-2; and

L2: "Heat Transfer and Fluid Flow data Books" from General Electric Company, Section 404.1 pages 1 to 4, Section 404.3, pages 1 to 15, these pages issued between August 1974 and January 1990 (according to the latest issue list of February 1994).

The Respondent (Patentee) put forward that the prior art of Figure 4 of the patent-in-suit is only internal prior art and that the prior art of Figure 5 corresponds to a "denitration reactor built in Mizushima No. 1 unit power plant" (Japan) in 1984, presented a drawing of it (this prior art hereinafter called P1), and put forward that, though the flow deflecting vanes of prior art P1 are drawn as dotted lines, the reactor does have flow deflecting vanes in the bent portion just before the flow controller.

III. Oral proceedings were held at the end of which the Respondent requested that the appeal be dismissed and that the patent be maintained on the basis of the new claims 1 and 2 filed at these oral proceedings and the Appellants requested that the decision under appeal be set aside and that the patent be revoked.

Opponent 2 (other party) filed only one letter where he requested that the case be decided as it stands and did not participate at the oral proceedings.

IV. Claim 1 reads as follows:

"1. A denitration reactor comprising:

an entrance duct portion (1) into which exhaust gas (G) from a combustion apparatus flows;

an intermediate duct portion (10) incorporating therein a catalyst layer (4) for denitration, said intermediate duct portion (10) being so disposed that the axis thereof is perpendicular to the axis of said entrance duct portion (1);

an exit duct portion (5) connected to said intermediate duct portion (10);

a bent portion (2) for connecting said entrance duct portion (1) to said intermediate duct portion (10), the top wall (2a) of said bent portion (2) extending with an inclination angle θ relative to the axis of said entrance duct portion (1) from a section (hereinafter called X) on which the wall (10a) of said intermediate duct portion (1), crosses the plane including a surface of the floor (1a) of said entrance duct portion (1) to a section (hereinafter called Y) on which the plane including the wall (10b) of said intermediate duct portion (10), which is near the entrance duct portion, crosses the plane including the roof (1b) of said entrance duct portion (1); and

a flow controller (3) disposed in said intermediate duct portion (10) so that the exhaust gas introduction surface of said controller (3) coexists with the plane including said floor (1a) of said entrance duct portion (1), wherein the flow controller is of single vane type

or of grid vane type, the vanes being spaced equidistant from each other by 30 to 200 mm, and the height of the vanes being at least three times the spacing (P) between the vanes."

Claim 2 is dependent on claim 1.

V. The arguments presented by Appellant 1 are summarized as follows:

Though the subject-matter of claim 1 seems to be novel, it is obvious in view of the cited prior art.

Prior art P1, when compared e.g. with E1, shows that the particular form of the flow channel can be varied.

The position of the flow controller and its dimensions as in the attacked claim 1 are disclosed in D4 column 3 lines 8 to 11 suggesting the skilled person to replace the U-shaped lamellas of the invention D4. Moreover, not only said lamellas but also the vanes of the attacked claim 1 create vortices due to their thickness.

It is true that the heat exchangers of L1 and L2 belong to a different technical field. However, the fact that these documents are referred to in D1 shows that the skilled person would take into account said documents. Moreover, the skilled person would take into account L1 and L2 since the heat exchangers have to be impinged by a uniform flow, too.

VI. The arguments presented by Appellant 2 in addition to the arguments presented by Appellant 1 are summarized as follows:

The U-shaped lamellas of EH1 ("Bild 29" right-hand figure) are of the grid type. The flow controller is in the same position as according to the attacked patent. Though the form of the bent portion of D4 is different from that of the attacked claim 1, the skilled person would, when starting from the prior art of Figure 7 of EP-B-0 318 740, choose a position of the flow controller as in D4 to avoid vortices at the left-hand edge of the bent portion. The passage in D4 column 5 from line 28 on shows that the lamellas do not create a non-uniform flow such that a flow controller downstream of the lamellas creating a uniform flow ("Gleichrichter") is unnecessary.

VII. The Respondent's arguments are summarized as follows:

It was not shown that EH2 had been published.

E1 does not show a hood construction as shown in the drawing prepared by the Opposition Division and filed as annex "Anlage 1" to the grounds of appeal of Appellant 2.

D4 and EH1 are regarded as the same prior art. It is the only prior art where catalysts are combined with flow controllers. However, the type of the flow controller of D4/EH1 is quite different from that of claim 1 of the patent-in-suit above all as far as the creation of vortices by the flow controller is concerned. The vortices after the lamellas of D4/EH1 cannot be characterized as microeffects ("Mikroeffekte"). The width of the U-shaped lamella elements 8 perpendicular to the axis of the intermediate duct is much greater than the thickness of the material forming said elements and also the vanes of the attacked claim 1.

L1 and L2 relate to flow headers for heat exchangers the latter creating a turbulent gas flow. Therefore, these documents would not be considered by the skilled person to solve the problem underlying the patent-in-suit.

None of the prior art documents deals with the problem of the edge vortices created at the left-hand upper part of the intermediate duct.

Aerodynamics is a field where results of constructional modifications are hard to predict. This point of view is supported by the teachings of D1.

Reasons for the Decision

1. The appeals are admissible.

2. *Amendments*

The Board of Appeal is satisfied that the amended claims comply with Article 123(2) and (3) EPC. Since the allowability of the claims in this respect was not disputed by the Appellants, it is unnecessary to give detailed reasons.

3. *Prior Art and Novelty*

3.1 D1 is a post-published document and has, therefore, to be disregarded.

EH2 has to be disregarded as well since it has not been shown that it was published.

The same applies to the prior art corresponding to Figure 4 of the patent-in-suit since the allegation of the Respondent that it is only internal prior art has not been contested by the Appellants.

3.2 From the reactors shown in the figures of E1 only the reactor of Figure 6 ("Abb. 6") employs an structure similar to that of the patent-in-suit. The flow controller called grid ("Gitterrost") and flow rectifier ("Strömungsgleichrichter") is not shown in said figure. The expression "at the boundary" ("an der Grenze") used in the description does not exactly define the position of the flow controller with respect to the plane defined by the floor of the inlet duct. However, it can be taken from Figure 6 that section X (definition in claim 1, see point IV. above) is a certain distance (hereinafter called VA, as in "Anlage 1", see point VII. above) above the plane defined by said floor (which follows unambiguously from an extension of the line characterizing the floor of the inlet duct to the wall of the intermediate duct portion, which is opposite to the entrance duct portion). The remaining features of the attacked claim 1 - concerning top wall of the bent portion, position of section Y, angle of axes of the entrance duct portion and intermediate duct portion, position of the catalyst, provision of an exit duct portion after the intermediate duct portion - except for the dimensions of the vanes can be taken from said reactor of E1.

3.3 D4 and EH1 (see Figure 1 and, respectively, Figure 29 right-hand part) show quite similar reactors.

The intermediate duct of the reactor of D4/EH1 has a flow controller upstream of the catalyst layer consisting of U-shaped lamella elements with a round middle portion arranged upstream and with two adjacent

leg portions extending downstream and parallel to the axis of the intermediate duct. The distance of the leg portions of each element is considerably greater than the thickness of the sheet material forming the elements (see Figures 2 to 5 of D4). The flow controller has the purpose to obtain a uniform gas impingement of the catalyst but also to create turbulences (see column 4 lines 38 to 54). The vortices created by the lamellas 8 are considerably greater than those created by the vanes of the attacked claim.

Section Y lies between the plane including the wall of the intermediate duct portion, which is near the entrance duct portion; and the axis of the intermediate duct portion; the distance from said axis is smaller than from said plane. Moreover, VA is not zero, that is, section X lies a certain distance above the plane including the floor of the entrance duct. Thus, the structure of the intermediate duct portion of D4/EH1 differs considerably from that of the attacked patent.

In the passage in column 2 line 44 to column 3 line 11, a device is described which is the prior art with respect to D4. The invention of D4 starts with said prior art; particularly the features concerning the dimensions of the flow controller of said invention are totally different from what is disclosed in column 3 lines 8 to 11.

3.4 The reactors of E2 to E4 have a catalyst but do not include a flow controller. The reactors of E3 and E4 correspond to the prior art of Figure 7 of the contested patent. The structure of the bent portion, entrance duct portion and intermediate duct portion of E3 and E4 are the same as in claim 1 of the

patent-in-suit, whereas the sections X and Y of E2 are not in the plane including the roof of the entrance duct portion and, respectively, the plane including the bottom of the entrance duct portion (see Figure 3 of E2).

3.5 L1 and L2 relate to oblique flow headers and ducts for heat exchangers. Such exchangers usually comprise a lot of tubes but not vanes in the sense of the patent-in-suit (see e.g. the Figures of L2). Said tubes create vortices to a large extent. Moreover, L1 and L2 disclose apparatuses where only one element - the matrix - is disposed in the gas flow duct. The embodiments having a structure of the intermediate duct portion - in L1 called a triangular inlet header or header shape and in L2 a triangular manifold - like that of the patent-in-suit have a free discharge (L1, Figure I-3 lower portion; L2, Figure 3-3) or an infinite box exit header (L1, Figure I-3 upper portion) or a box exit with a non-uniform flow distribution (L1, Table 4 Test No. 31 to 33; Figure 19 "ACTUAL TRIANGULAR"), particularly with respect to a modified top wall profile (L1, Table 4 Test No. 22 to 24; Figure 19 "MODIFIED ACTUAL").

3.6 The structure of the reactor of P1 is quite similar to the structure of Figure 5 of the patent-in-suit, which latter structure is, except for the fact that the flow controller is positioned below the plane including the floor of the entrance duct portion and provision of flow deflecting vanes, the same as according to attacked claim 1. However, section Y is shifted a bit in the direction of the gas flow through the entrance duct portion and the edges at sections X and Y are rounded off.

3.7 From the above analysis of prior art follows that the claimed subject-matter is novel in the sense of Article 54 EPC (which was not disputed by the Appellants) and that the nearest prior art with respect to the subject-matter of claim 1 of the patent-in-suit is disclosed in E1.

4. *Inventive Step*

4.1 The subject-matter of claim 1 differs from the nearest prior art disclosed in Figure 6 of E1 (see 3.2 above) in that

(A) the upper surface of the flow coexists with the plane including the floor of the entrance duct portion,

(B) section X lies in said plane, and

(C) the dimensions of the flow controller vanes are indicated in detail.

Apparently, these differences have the effect that the gas flow rate distribution across the exit surface of the flow controller and at the inlet surface of the catalyst is more uniform and that the stream lines upstream of the catalyst deviate less from parallelism. As a consequence, solid particles such as fly ash can pass through the catalyst with less collisions and wear it and accumulate on it in a smaller manner, and the catalyst parts are exposed more uniformly to the gas.

The problem underlying the solution according to claim 1 is therefore to further develop the reactor of Figure 6 ("Abb. 6") of E1 in such a manner that collision of solid particles with the catalyst and thus accumulation of them on the catalyst and non-uniform exposure of different catalyst parts are minimized.

4.2 Generally, the skilled person is, in the Board's view, well aware that even small changes of parameters (e.g. provision, place and dimensioning of flow deflecting vanes, provision, geometry and position of the flow controller, means for removal of the dust before the catalyst, relative angles of the flow channel sections and geometry of the sections) of the flow channel can have considerable effects on the flow properties of the exhaust gas which effects cannot be easily predicted, and there is a great number of parameters which have to be determined.

Since there is no hint in E1 to position the flow controller according to feature (A) and to shift section X to said floor plane according to feature (B), let alone to realize features (C), the skilled person would not arrive at a reactor according claim 1 when taking into account the teachings of E1 alone.

4.3 Documents E2 to E4, L1 and L2 relate to devices where the catalyst and or, respectively, a heat exchanger alone is disposed in the flow channel. Moreover, there are still more differences between these documents and the attacked claim 1 (see e.g. 3.4 and 3.5 above). The person skilled in the art would, therefore, not take into account their teachings to solve the above problem.

4.4 If he considered prior art D4/EH1 or P1 to solve the above problem, the transfer of the shape of the bent portion of D4/EH1 or P1 (see sections 3.3 and 3.6 above) would not lead to a bent portion as defined in claim 1 of the patent-in-suit. Moreover, the skilled person would, when considering P1, provide flow deflecting vanes in the plane including the floor of the entrance duct portion and mount the flow controller downstream said plane.

4.5 Therefore, having regard to the foregoing, the subject-matter of claim 1 involves an inventive step in the sense of Article 56 EPC.

Claim 1 and also the dependent claim 2, which refers to a particular embodiment of the invention as defined in claim 1, are thus allowable.

Order

for these reasons it is decided that:

1. The appealed decision is set aside.

2. The case is remitted to the Opposition Division with the order to maintain the patent in amended form with claims 1 and 2 filed at the oral proceedings held on 11 December 1996 with description and possibly drawings to be adapted.

The Registrar: The Chairman:

P. Martorana E. Turrini