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File Number: T 250/90 - 3.3.2

Application No.: 83 304 758.2

Publication No.: 0 103 423

Title of invention: Apparatus for burning pulverulent raw material

Classification: C04B 7/44

D E C I S I O N  
of 24 March 1993

Applicant: F.L. Smidth & Co. A/S

Opponent: Krupp Polysius AG

Headword: Burning apparatus/SMIDTH

EPC Articles 56 and 83

Keyword: "Disclosure - sufficiency - (yes)"  
"Inventive step - non-obvious modification"



Case Number : T 250/90 - 3.3.2

**D E C I S I O N**  
of the Technical Board of Appeal 3.3.2  
of 24 March 1993

**Appellant :**  
(Opponent)

Krupp Polysius AG  
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**Representative :**

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**Respondent :**  
(Proprietor of the patent)

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**Representative :**

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**Decision under appeal :**

Interlocutory decision of the Opposition Division  
of the European Patent Office dated 22 June 1989,  
posted on 8 February 1990 concerning maintenance  
of European patent No. 0 103 423 in amended  
form.

**Composition of the Board :**

**Chairman :** P.A.M. Lançon  
**Members :** I.A. Holliday  
S.C. Perryman

**Summary of Facts and Submissions**

- I. European patent No. 0 103 423 concerning an apparatus for burning pulverulent raw material and based on application No. 83 304 758.2 was granted on the basis of seven claims.
  
- II. The Appellant filed a notice of opposition against the European patent. Six prior art documents were cited of which the following remain relevant in the present appeal:
  - (1) DE-A-2 712 239
  - (6) US-A-4 071 309.
  
- III. The Opposition Division rejected the opposition and maintained the patent in amended form.

In respect of an objection that the embodiment according to Figure 2 of the patent in suit did not fall within the scope of Claim 1, the Opposition Division concluded that at least a considerable part of the pulverulent material from duct 22" was mixed with the up-flowing kiln gas at a point within the retention chamber 29 upstream of the inlet of the calcined suspension.

Furthermore, the Opposition Division took the view that in accordance with the description of the patent in suit, the problem underlying the invention was to reduce bakings in the upstream end of a kiln gas duct and to avoid overheating when very high temperatures were required in a calciner in order to ensure complete burning out of fuel especially low grade types of coal. The most relevant prior art was known from document (1) and document (6). Since none of the cited documents mentioned a very high temperature in the calciner, it was not obvious that the

difficulties caused by very hot material from the calciner could be effectively avoided by the special arrangement of the suspension transfer duct and material inlet of the kiln gas duct according to Claim 1.

IV. The Appellant lodged an appeal against the decision of the Opposition Division. In the Statement of Grounds the Appellant sought to introduce a further document

(7) "Zement-Kalk-Gips, no. 12, 1978, pages 595 to 601.

The arguments of the Appellant, both in the written procedure and at the oral proceedings held on 24 March 1993, may be summarised as follows.

The Appellant could not accept that in view of the high velocity of the kiln gas, a stream of pulverulent raw material from duct 22" slid down the sloping bottom wall of the retention chamber 29. It was clear to those skilled in the art that both the stream of material from duct 22" and the material from the burning chamber 4 which passed along the transfer duct 8, entering the chamber 29 at the same level, would be immediately carried upwards at the same time by the stream of kiln gas. Accordingly, the dashed line 22" in Figure 2 did not conform to the feature "downstream" of present Claim 1.

The particular problem outlined in the description of the patent in suit, namely to provide an apparatus which could easily be constructed by adapting an existing cement production plant, having a multi-stage cyclone suspension preheater connected to a rotary kiln, but no separate calciner, had already been solved by the teaching of document (1).

Moreover, there was no basis in the description of the patent in suit for the problem of reducing bakings in the upstream end of a kiln gas duct and of avoiding overheating when very high temperatures were required in a calciner in order to ensure complete burning out of fuel and low grade coal.

Starting from the disclosure of document (1) and assuming that under exceptional process conditions there would be an excessively high temperature suspension coming from the calciner 10 when using low grade fuel with a high sulfide content and cement raw meal with a high chloride content, it was within the scope of conventional practice followed by persons skilled in the art knowing that said suspension might cause bakings to provide a precooling of the suspension by mixing it with kiln gas upstream of the precipitator 3/IV and not to introduce it directly into said precipitator, as suggested in (1), under normal process conditions. The problem of an alkaline circulation was well-known in the art decades before the use of a separate calciner became common practice in the production of cement.

The drawing of document (6) was merely schematic. In view of the necessity to have a certain time of direct contact of the cement raw meal with the hot kiln gas, the skilled person would in any case have used the complete height of the kiln gas duct to calcine the suspension and would not have fed the material at half the normal height of said duct as appeared from (6). Therefore, especially in the light of a combination of the teachings of (1) and (6), it would have been obvious to modify the known apparatus in such a way that a duct for a second stream of pulverulent raw material entered the riser pipe of the kiln upstream of the suspension transfer duct from the calcinator.

From document (7), although late filed, it was apparent that a solution to the problem of how to operate a calciner assembly at very high temperatures in the suspension burning chamber using low grade coal was within the general knowledge of the skilled person at the priority date of the patent in suit. Accordingly, a person skilled in the art knowing in general that there is a need to operate at very high temperatures to ensure complete burning out of fuel and to avoid bakings by quenching a hot gas stream of suspended material, would have arrived at the apparatus presently claimed without the exercise of inventive skill.

- V. In reply the Respondent argued that even if the inlets 12' and 30 of chamber 29 of Figure 2 were at exactly the same level, the embodiment according to this drawing fell within the ambit of present Claim 1. Since the gas/particle suspension introduced from the suspension transfer duct 8 through inlet 30 had a much lower density than the coherent stream of pulverulent raw material from duct 22" through inlet 12, it was entrained by the gas flow substantially immediately. On the other hand, said coherent stream which was not merely introduced at the bottom of the chamber, but discharged onto the sloping bottom of the chamber, inevitably slid down the sloping bottom wall 43 and was only gradually broken up and entrained.

To supply evidence for this mode of operation, the Respondent submitted a drawing illustrating the particular flow properties of the suspended mass from the calciner and the coherent stream of raw material when entering the retention chamber 29.

None of the cited documents rendered the inventive concept obvious; the specific flow paths of the two streams of

preheated material according to present Claim 1 coming from ducts 22, 22' and 22 " respectively, had the advantage that it allowed the use of low grade fuels with full burning out and the avoidance of unacceptably high temperatures. Operating a suspension calciner assembly comprising a precipitator, for example at a temperature of about 1300°C instead of the 1000°C known from the prior art, without arranging the pipes as presently claimed, would increase by an order of magnitude the costs for the material of the apparatus.

The introduction of document (7) at this late stage of the procedure was not acceptable.

The amended Claims 1 and 7 submitted at the oral proceedings before the Board read as follows:

"1. An apparatus for burning pulverulent raw material, the apparatus comprising:

a preheater with an inlet (14) and an outlet (27) for heating gas, an inlet (26) for pulverulent raw material, and first and second outlet ducts (22,22') for first and second streams of preheated raw material respectively;

a suspension calciner assembly having an inlet (33) for combustion gas, a suspension burning chamber (4) provided with inlets (5,7) for fuel and hot air and with a preheated raw material inlet (6) connected to the first duct (22), a particle precipitator (9) which has a kiln gas suspension inlet (47), an outlet (10) for calciner exhaust gas connected to the heating gas inlet (14) of the preheater and an outlet duct (11) for calcinated material, a kiln gas duct (28) provided with a material inlet (12) connected to the second duct (22') and connecting the combustion gas inlet (33) with the kiln gas suspension inlet (47) of the particle precipitator, and a suspension transfer duct (8) leading from the burning chamber (4) to

the sub-assembly comprising the kiln gas duct (28) and precipitator (9) downstream of the material inlet (12, 12') of the kiln gas duct (28) whereby, in use, the two material streams are reunited in suspension and precipitated together in the precipitator (9),

a kiln having an upper end (13) with a material inlet connected to the calcined material outlet duct (11) of the precipitator (9) and an exhaust gas outlet connected to the combustion gas inlet (33) of the calciner assembly, and a lower end (35) with inlets for fuel and hot air and an outlet (35) for burned material; and

an air cooler having a material inlet (36) connected to the lower kiln end (35), an inlet (37) for cooling air, an outlet (38) for cooled material and two outlets (39, 40) for hot air connected to the hot air inlet (7) of the burning chamber and the lower kiln end (35), respectively;

the suspension transfer duct (8) being connected to the kiln gas duct (28) upstream of the precipitator (9).

7. A method of converting a plant for burning pulverulent raw material to an apparatus according to any one of the preceding claims, the plant being of the kind comprising a multi-stage cyclone preheater in which pulverulent cement raw material is preheated by exhaust gas from a kiln, and from the lowermost cyclone stage of which the material is fed to the kiln for burning and thereafter to an air cooler connected to the kiln for cooling of the burned material, the kiln exhaust gas passing from the kiln to the lowermost cyclone stage via a riser pipe to which the material is fed from the penultimate cyclone stage; and the method comprising providing the plant with a calciner burning chamber having a fuel inlet, and an air inlet connected to the cooler so that waste cooling air is fed to the burning chamber; a suspension transfer duct leading from the burning chamber

to the riser pipe downstream of the material feed to the riser pipe; and means for dividing the material leaving the penultimate cyclone stage and for feeding the two streams of material one into the burning chamber and the other into the riser pipe whereby, in use of the converted plant, the two streams of material are separately calcined in suspension and mixed for precipitation in the lowermost cyclone stage, from which the reunited stream of material is fed to the kiln."

- VI. The Appellant requested that the decision under appeal be set aside and that the European patent be revoked.

The Respondent requested that the appeal be dismissed and that the patent be maintained on the basis of the amended description and claims submitted at the Oral Proceedings.

#### Reasons for the Decision

1. The appeal is admissible.
2. There are no formal objections to the present claims under Article 123(2) and (3) EPC since they are supported by the original disclosure and do not extend the protection conferred. Thus, Claim 1 represents a combination of Claim 1 originally filed and the description on page 12, line 22 up to page 13, line 6 originally filed as well as Claim 1 and column 8, lines 3 to 25 according to the European patent specification; dependent Claims 2 to 6 correspond to dependent Claims 2 to 6 originally filed and Claim 7 represents a combination of Claim 7 originally filed and Claims 1 to 6 originally filed as well as a combination of Claim 7 and Claims 1 to 6 according to the specification. The Board is satisfied that by Claims 1 and 7 no combination of features is created which could not be

derived directly and unambiguously from the whole content of the original disclosure.

3. Where, as in this case, the proprietor has made amendments during the opposition proceedings, Article 102(3) EPC requires the Opposition Division to be satisfied that, taking into consideration the amendments made, the patent and the invention to which it relates meet the requirements of the European Patent Convention. Likewise, on appeal, Article 111 and Rule 66 EPC require the Board to be so satisfied. The Appellant's submission that the embodiments of the patent in suit according to Figure 2 comprising outlet duct 22" did not fall within the scope of Claim 1 in regard to the feature "downstream" raises a question of whether the requirements of Article 83 EPC, that the invention must be disclosed in a manner sufficiently clear and complete to be carried out by a person skilled in the art, and Article 84 EPC that the claims shall be clear and concise and supported by the description, have been complied with.

3.1 For the purposes of Article 83 EPC the description must be considered as a whole. In the specification Figure 2 is described in column 8, lines 26 to 61 (corresponding to page 13, line 7 to page 36, line 3 as originally filed). It is stated there that: "The kiln gas duct 28 is provided with a tubular retention chamber 29 having an upright axis and an annular bottom wall 43 which slopes downwardly and inwardly with a central inlet 31 for kiln gas. The chamber has an inlet 30 for the suspension coming from the suspension burning chamber arranged in the bottom of the retention chamber (as shown it enters above the annular bottom wall 43), the suspension transfer duct 8 being connected to the inlet 30. According to another embodiment the material precipitated in cyclone 18' is discharged as a second stream of pulverulent raw material onto the

sloping bottom of the retention chamber as a coherent stream via a material outlet duct 22', and suspended in kiln gas in the retention chamber 29."

Taking into account the well-known differences of flow behaviour between a coherent stream of pulverulent mass and a fluidised mass, the Board's view that at least a considerable part of the material from duct 22" is mixed with the up-flowing kiln gas at a point within the retention chamber 29 upstream of the inlet of the calcined suspension. It follows that the process sequence is such that the suspension transfer duct leads from the burning chamber to the sub-assembly comprising the retention chamber downstream of the inlet for pulverulent raw material. This is the same as the view taken by the Opposition Division.

- 3.2 The Board therefore concludes that the patent in suit provides sufficient information to enable a person skilled in the art to appreciate the complete concept of the invention and to carry it out in alternative ways as set out in the description, even if a part of a figure according to an alternative embodiment (dashed line 22" in Figure 2) is shown only schematically and does not explicitly show each of the claimed features.
- 3.3 The claims now put forward in themselves appear clear, concise and supported by the description. For the reasons given above the use of the word "downstream" in relation to the alternative embodiment described with reference to Figure 2 appears to the Board to be an appropriate use of this term. The use of the term "downstream" in the claims is thus not rendered unclear because of any special and unusual way of using this term in the description, and no objection under Article 84 EPC arises.

4. Late-filed document (7) is no more relevant than the prior art already considered; thus its content will hereinafter be disregarded.
5. Neither document (1) nor Document (6) disclose all the features set out in present Claims 1 and 7. In any event, novelty is no longer in dispute.
6. The patent in suit relates to an apparatus for burning pulverulent raw material, e.g. in the production of cement.
  - 6.1 On the basis of an analysis of the process sequence of quenching hot gaseous streams, document (1) appears to be very relevant prior art and in the course of the opposition proceedings Claim 1 had been delimited against this document. However, in the opinion of the Board, having regard to the structural principle of the apparatus, in particular the specific arrangement of the separate calciner chamber in relation to the kiln gas duct, the closest prior art is considered to be document (6) which is also concerned with an apparatus for making cement, in particular Portland cement clinker. Document (6) was indeed initially regarded by the Respondent as a starting point for the subject-matter of the patent in suit and was discussed in detail in the original application documents. It is to be noted that (6) discloses all the structural features of present Claim 1 except that the suspension transfer duct from the separate calciner leads upstream of the inlet of the so-called second stream of pulverulent raw material to the kiln gas duct.
    - 6.1.1 This prior art apparatus furthermore comprises an additional duct leading from the outlet flue which projects upwardly of cyclone 7 to an indirect heat

exchanger 20 fed with pressurised air supplied by a blower in a direction counter to the waste gas flow from said cyclone. The heat exchanger bypasses the final cyclone stage 3 whereby the waste gas flows through a damper 22 and reaches the outlet flue from the first cyclone stage. The preheated air is supplied to the separate calciner furnace 14 or under the control of a damper 24a to the burning end of the kiln 11 whereas the raw materials from the cyclone stage 7 are supplied to the separate calciner chamber and the kiln gas duct through a director damper 17 downstream of the inlet for gases and solids from the separate calciner into said kiln gas duct.

- 6.1.2 In operation, the heat exchanger unit extracts heat from the kiln exit gases which is excess heat of the preheater stage. In other words, the additional heat exchanger recovers surplus sensible heat of waste gas not needed to preheat raw material and thus makes it possible that the separate calciner unit can be operated at a high efficiency.
  
- 6.2 According to the description of the patent in suit as originally filed and the Respondents submissions in course of the proceedings, when burning out low grade coal in the separate calciner furnace of (6), there is a risk of overheating of downstream parts of the plant and bakings in the upstream end of the kiln gas duct (see page 3, line 36 up to page 4, line 10; page 5, lines 12 to 27 and page 6, lines 23 to 30).
  
- 6.2.1 Such bakings may be caused by partially burnt-unburnt fuel components, but it is also generally known to those skilled in the art that a further risk of bakings may occur from e.g. a chloride content of the raw cement material well-known as alkaline circulation.

6.3 In the light of the said prior art, the technical problem underlying the patent in suit can be seen as reducing bakings in the upstream end of the kiln gas duct and avoiding overheating.

Although the Appellant contested the particular disclosure of such a problem in the patent in suit, he did not contest that such bakings and overheating would occur in an apparatus according to (6).

6.4 The problem is solved by the apparatus and method defined in present Claims 1 and 7. The Respondent has argued in a plausible manner that the burning chamber of a calciner, connected in the way presently claimed to the kiln gas duct of a cement plant, may be operated at temperatures which are 100°C to 300°C higher than according to normal calcining conditions, thereby enabling the use and full burning out of low grade fuels, without either producing bakings of unburnt fuel components in the downstream parts of the plant or causing the precipitator to be raised to unacceptably high temperatures (cf. also column 4, lines 28 to 32 of the patent in suit). This was also not contested by the Appellant. Therefore, the Board is satisfied that the problem has been solved.

7. It remains to consider whether or not the said solution satisfies the requirements of Article 56 EPC in respect of inventive step.

7.1 As indicated above, document (6) relates to the problem of recovering excess heat from waste gases in a method of producing Portland cement clinker and thus to improve the overall energy balance of the cement plant. There is not the slightest hint in this document that the inlet points of the ducts from the separate calciner unit and from the penultimate cyclone stage into the flue duct from the kiln

might be inverted having regard to baking problems, the formation of hot spots or for any other reason. Even taking into account the Appellant's argumentation that with a view to optimising the heat transfer between the pulverulent raw material and the kiln gas, the skilled person would in any case use the complete height of the kiln gas duct to calcine the suspension, there is no need and it would in no way be obvious to invert the sequence of said inlets into the kiln gas duct resulting in a completely new process sequence. It is in fact the geometry of the kiln duct and the contact time with the hot kiln gas which determines the desired degree of calcination. In this respect, it can be accepted that the figure in (6) is shown schematically, but not in respect of the flow diagram in itself. Moreover, the alleged inversion of the process sequence in the kiln gas duct without taking further measures would alter the heat balance exemplified in (6). This is a further obstacle which would deter those skilled in the art from attempting to modify this prior art apparatus.

7.2 It now remains to consider whether a combination of the teachings of documents (6) and (1) would have suggested the solution to the above mentioned problem.

7.2.1 Document (1) is concerned with the production of low alkali cement clinker starting from raw materials showing either a very high absolute alkali content or a wide fluctuation of alkali content. Starting from a prior art which proposes, depending on the alkali content of the raw material, to let off a certain amount of the kiln gas and not to use it in the preheating stage of the process, it appears to be the aim of the authors of this document to design such a process in a more economical way, in particular to minimise heat loss and to avoid the risk of

an unwanted alkali circulation (cf. page 4, line 5 to page 5, line 15). Bakings in the apparatus resulting from a high content of alkali metal chloride in the starting material are mentioned expressly in (1) (cf. page 2, line 5 ff).

7.2.2 The Appellant did not contest the Respondent's analysis of the essential features of the kiln plant described in (1), namely that two streams of preheated raw material are separately calcined in suspension, one in a calciner and the other in a kiln riser pipe. The amount of material in each stream is controlled so that both suspensions are substantially at the same temperature before they separately enter a precipitator, in which they are reunited and precipitated and then serve as a heating medium for the raw material (cf. paragraph bridging pages 13 and 14; Claims 1 and 2 as well as the only figure). Taking into account this disclosure, the Appellant argued that a skilled person knowing from (6) the possibility of reuniting the materials and gas streams before the precipitator and faced with the problem of burning out low grade fuel at a high temperature in the calciner of such an apparatus would in any case quench the hot suspension with kiln gas before the precipitator and thus, since the sequence of introducing the materials in the kiln riser pipe system is the same as described in the patent in suit, would arrive at the subject-matter presently claimed.

7.2.3 The Board, however, is not convinced that without hindsight based on knowledge of the invention the skilled person would reach such a conclusion. As already discussed above in the context of the disclosure of (6), the overall heat balance of the process for the production of cement clinker is strongly affected by the individual temperature level in each of the process stages. It is furthermore

common general knowledge and clear from the disclosure of (1) that a change of the temperature conditions in the pipe system of such a plant also would strongly affect the volatilisation and agglomeration of the unwanted alkali metal chloride components. Having regard to the bypass system on top of the kiln and the construction of the apparatus as a whole, the plant according to (1), appears to be especially designed for the treatment of raw material having a high alkali content. Since both the heat balance and the possibility to use raw material with a high alkali content are optimised in (1), there is clearly no incentive for those skilled in the art to operate at very high temperatures with low grade fuels and to reconstruct parts of the apparatus including a new pipe system upstream of the precipitator which involves a high risk of undesired bakings and energy loss in the kiln plant. The Board therefore fails to see any reason which would induce the skilled person to combine the teachings of (6) and (1) for a different purpose.

7.2.4 Accordingly, the subject-matter of present Claim 1 would not have been obvious in the light of the prior art and the requirements of Article 56 EPC are satisfied.

7.3 Dependent Claims 2 to 6 derive their patentability from Claim 1 and are likewise allowable. Method Claim 7 insofar as it relates to a method of constructing an apparatus according to Claim 1 is also allowable under Article 56 EPC.

**Order**

**For those reasons, it is decided that:**

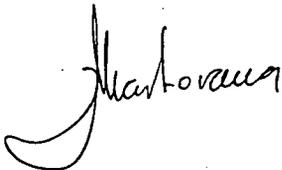
1. The contested decision is set aside.

2. The appeal is dismissed.
  
3. The case is remitted to the first instance with the order that the European patent be maintained on the basis of the amended description and claims submitted at the oral proceedings.

The Registrar:

The Chairman:

P. Martorana



P.A.M. Lançon



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