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Bezeichnung der Erfindung:
Title of invention:
Titre de l'invention : Method and apparatus for continuous production of silicon carbide

Klassifikation / Classification / Classement : C01B 31/36

ENTSCHEIDUNG / DECISION
vom / of / du 26 July 1990

Anmelder / Applicant / Demandeur :

Patentinhaber / Proprietor of the patent /
Titulaire du brevet : Superior Graphite Co.

Einsprechender / Opponent / Opposant : Lonza AG

Stichwort / Headword / Référence : Silicon carbide/SUPERIOR GRAPHITE

EPÜ / EPC / CBE Article 56

Schlagwort / Keyword / Mot clé : "Inventive step (confirmed) - after amendment"

Leitsatz / Headnote / Sommaire

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Case Number : T 449/88 - 3.3.2

D E C I S I O N
of the Technical Board of Appeal 3.3.2
of 26 July 1990

Appellant : (Proprietor of the patent)
Superior Graphite Co.
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Representative :
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Respondent : (Opponent)
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Representative :

Decision under appeal : **Decision of the Opposition Division of the European Patent Office of 28 April 1988, posted on 14 July 1988 revoking European patent No. 0 044 867 pursuant to Article 102(1) EPC.**

Composition of the Board :

Chairman : A. Nuss
Members : R.W. Andrews
W. Moser

Summary of Facts and Submissions

I. European patent No. 0 044 867 was granted with fourteen claims on 22 May 1985 in respect of European patent application No. 81 900 608.1 filed on 4 February 1981.

II. A notice of opposition, filed on 31 January 1986, requested the revocation of the patent on the grounds that its subject-matter lacked novelty and did not involve an inventive step. During the opposition proceedings the Opponent cited, **inter alia**, the following documents

(1) DE-C-1 184 739 and
(2) US-A-3 368 871.

III. By a decision delivered orally on 28 April 1988, with written reasons posted on 14 July 1988, the Opposition Division revoked the patent. The Opposition Division held that the subject-matter of the claims filed during the oral proceedings did not involve an inventive step in view of the combined teaching of documents (1) and (2). The Opposition Division considered that the skilled person aware of the process of document (1) for producing silicon carbide from gaseous reactants using an electrothermal fluidised bed and wishing to employ cheaper sources of silicon and carbon would use solid particulate sources of carbon and silicon as disclosed in document (2).

IV. An appeal was lodged against this decision on 8 September 1988 and the prescribed fee duly paid. A statement of grounds was filed on 11 November 1988 and oral proceedings, at which the duly summoned Respondent was not represented, were held on 26 July 1990.

In his written submissions and during the oral proceedings, the Appellant argued that the subject-matter of an amended Claim 1 based on a combination of granted Claims 1 and 8 involved an inventive step, since neither of the cited references suggested a fluidised bed for the preparation of silicon carbide in which two materials having different average particle sizes are supplied in order to form two distinct zones in the fluidised bed.

V. The Respondent maintained very generally that none of the submitted arguments would speak for the inventiveness of the process.

VI. The Appellant requested that the decision under appeal be set aside and that a patent be maintained on the basis of Claims 1 to 6 submitted during oral proceedings. The only independent claim of this set of claims reads as follows:

"A method of making a silicon carbide-bearing material, which comprises:
continuously introducing silicon-bearing and carbon-bearing materials into a fluidised bed of electrically conductive particulate material contained within a furnace,
maintaining the bed in a fluidised condition by controlling the flow rate of gases entering beneath the fluidised bed,
applying an electric potential between electrodes in direct contact with the particles of the fluidised bed to cause a sufficient flow of electrical current through the fluidised bed to heat the bed to a temperature at which the silicon-bearing material and the carbon-bearing material react to form a silicon carbide-bearing material, and

continuously removing the silicon carbide-bearing solids from the fluidised bed furnace, characterised in that a relatively coarse particulate carbon-bearing material and a finer particulate carbon-bearing material are supplied to the furnace, the relative size difference between the two particulate materials being chosen and the velocity of the fluidising gas being controlled so as to create a fluidised bed comprising an upper zone which principally contains the finer particulate carbon-bearing material and a lower zone which principally contains the coarser particulate carbon-bearing material, the flow of electric current is sufficient to heat the lower zone of the fluidised bed to a temperature above the decomposition temperature of silicon carbide, heat is removed from the upper zone of the fluidised bed so that the temperature of the upper zone is below the decomposition temperature of silicon carbide, but above the temperature required to form silicon carbide by the reaction of silicon vapour with solid carbon, and the silicon-bearing material is introduced into the lower zone of the fluidised bed whereby silicon vapour is formed which passes upwardly into the upper zone of the fluidised bed to react with the finer particulate carbon-bearing material to form silicon carbide-bearing material."

In his letter filed on 17 October 1989, the Respondent requested a decision on the file as it stands.

VII. At the conclusion of the oral proceedings, the Board's decision to maintain the patent in amended form was announced.

Reasons for the Decision

1. The appeal complies with Articles 106 to 108 and Rule 64 EPC and is, therefore, admissible.

2. There are no formal objections under Article 123 EPC to the present claims since they are adequately supported by the original disclosure and do not extend the protection conferred. Thus, present Claim 1 represents a combination of Claims 1 and 8 as granted (cf. also Claims 1 and 18 as originally filed). Claims 2 to 6 correspond to granted Claims 3 to 5, 7 and 9 respectively (cf. also page 4, lines 13 to 22, 33 to 34, page 9, lines 30 to 34, page 11, lines 3 to 8 of the published patent application and original Claim 22).

3. The disputed patent relates to a continuous process for the preparation of silicon carbide using an electrothermal fluidised bed. A process of this type is disclosed in document (1). This document, which is considered to represent the closest prior art, discloses, in particular, the continuous preparation of silicon carbide by reacting, in the presence of a diluent, gaseous silane and gaseous hydrocarbons or halohydrocarbons in a fluidised bed (cf. Claim 1 in combination with column 1, lines 42 to 44). The necessary reaction temperature in the fluidised bed may be obtained by means of ohmic electrical heating (cf. column 1, lines 47 to 49).

   In the light of this closest prior art the technical problem underlying the patent in suit may be seen in providing an alternative process for the continuous production of silicon carbide using an electrothermal fluidised bed.

According to the disputed patent this technical problem is essentially solved by introducing the silicon-bearing material into the lower zone of an electrothermal fluidised bed having two distinct zones. The lower zone, which is formed from relatively coarse particulate carbon-bearing material, is at a temperature above the decomposition temperature of silicon carbide. The upper zone, which is formed from relatively fine particulate carbon-bearing material, is below the decomposition temperature of silicon carbide, but above the temperature to form silicon carbide.

4. After examination of the prior art, the Board has reached the conclusion that the claimed subject-matter is novel. Since novelty is not disputed it is not necessary to consider this matter in detail.

5. It still remains to be examined whether the requirement of inventive step is met by the claimed subject-matter.

5.1 Although it may be true that the particulate material in the fluidised bed used in the process of document (1) will contain particles having a range of particle sizes and that when such particulate material is fluidised, there would tend to be a higher concentration of the finer particles in the upper part of the bed, nevertheless the concentration of the finer particles would increase progressively and continuously from the bottom to the top of the bed. Therefore, the teaching of this document would not provide the skilled person with any incentive to supply two materials having different average particle sizes so as to form two distinct zones in the fluidised bed, or to take measures to ensure that the temperature of the upper zone is lower than that of the lower zone in order that the silicon carbide results from the reaction

between silicon vapour formed in the lower zone and the finely divided carbon-bearing material present in the upper zone.

5.2 Document (2) discloses a process for the preparation of silicon carbide particles in a fluidised bed by reacting particles of carbon and a silicon compound. The heat necessary for maintaining the reaction occurring in the fluidised bed is obtained primarily from heat radiated from an upper combustion zone where exothermic combustible materials are reacted in the presence of oxygen (cf. Claim 1).

Although the Examples of this document illustrate the batch-wise operation of the claimed process, in the Board's opinion it is clear from the drawing that the process may also be operated continuously. Therefore, this document teaches the continuous preparation of silicon carbide from solid reactants in a fluidised bed. However, this document does not provide any indications which would lead the skilled person to the proposed solution to the technical problem underlying the disputed patent.

Therefore, in the Board's judgment, the claimed solution to the problem of providing an alternative process for the continuous process for the preparation of silicon carbide is inventive in the light of the cited prior art. Claim 1 is therefore allowable. Claims 2 to 6, which relate to preferred embodiments of the process according to Claim 1, are also acceptable.

Order

For these reasons, it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the Opposition Division with the order to maintain the patent on the basis of Claims 1 to 6 submitted during oral proceedings and description and drawings brought into conformity with these claims.

The Registrar: The Chairman:

M. Beer A. Nuss