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Datasheet for the decision of 29 July 2008

Case Number: T 1471/06 - 3.2.03

Application Number: 03258049.0

Publication Number: 1433554

IPC: B22F 3/00, B22F 9/20, B22F 9/28, B22F 3/22

Language of the proceedings: EN

Title of invention:
Production of injection-molded metallic articles using chemically reduced nonmetallic precursor compounds

Applicant:
GENERAL ELECTRIC COMPANY

Headword:
-

Relevant legal provisions:
EPC Art. 56

Relevant legal provisions (EPC 1973):
-

Keyword:
"Primary request - inventive step (no)"
"Auxiliary request - remittal to Examining Division"

Decisions cited:
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Catchword:
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Case Number: T 1471/06 - 3.2.03

D E C I S I O N
of the Technical Board of Appeal 3.2.03
of 29 July 2008

Appellant: GENERAL ELECTRIC COMPANY
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 13 April 2006 refusing European application No. 03258049.0 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: U. Krause
Members: G. Ashley
K. Garnett

Summary of Facts and Submissions

I. European patent application EP-A-1 433 554 concerns a method of making an article by injection moulding alloy powders that have been obtained by chemical reduction. The Examining Division was of the view that claim 1 of the main request contained amendments contrary to Article 123(2) EPC and that claim 1 of the auxiliary request lacked inventive step; it therefore decided to refuse the application.

II. In reaching its decision, the Examining Division took the following documents into account:

D1: US-A-6 036 742
D3: JP-A-01 184203
D3': English translation of D3, as provided by the applicant.

The patent application itself refers, amongst other documents, to:

D5: US-A-5 958 106

III. The decision was posted on 13 April 2006; the Appellant (applicant) filed notice of appeal on 8 June 2006, paying the appeal fee at the same time; a statement containing the grounds of appeal was filed on 22 August 2006.

IV. In accordance with Article 15(1) of the Rules of Procedure of the Boards of Appeal, the Board issued a preliminary opinion together with a summons to attend oral proceedings, setting out its view on the issues of

added subject-matter and inventive step. The oral proceedings were duly held on 29 July 2008.

V. During the oral proceedings, the Appellant submitted two sets of claims as its primary and auxiliary requests, and requested that the decision of the Examining Division be set aside and a patent be granted on the basis of the claims submitted as the primary or auxiliary request.

VI. Claim 1 of the primary request reads as follows:

"1. A method of preparing an article (60) comprising a metallic alloy material made of constituent elements, comprising the steps of

furnishing a mixture of nonmetallic precursor compounds (20), wherein all of the nonmetallic precursor compounds collectively include the metallic constituent elements of the metallic alloy material in their respective constituent-element proportions; and thereafter

utilizing the nonmetallic precursor compounds by chemically reducing (22) the nonmetallic precursor compounds to produce a metallic alloy powder comprising a plurality of particles, each particle comprising the metallic alloy material, without melting the nonmetallic precursor compounds (20) and without melting the metallic alloy powder,

wherein the step of utilizing further includes the step of injection molding (26) particles of the metallic alloy to produce a brown article comprising the particles of the metallic alloy powder, without melting the metallic alloy powder, and without melting the brown article."

Dependent claims 2 to 8 define preferred embodiments of the method of claim 1.

Claim 1 of the auxiliary request is as follows:

"1. A method of preparing an article (60) comprising a metallic alloy material made of constituent elements, comprising the steps of

furnishing a mixture of nonmetallic precursor compounds (20), wherein all of the nonmetallic precursor compounds collectively include the metallic constituent elements of the metallic alloy material in their respective constituent-element proportions; and thereafter

utilizing the nonmetallic precursor compounds by chemically reducing (22) the nonmetallic precursor compounds to produce a metallic alloy powder comprising a plurality of particles, each particle comprising the metallic alloy material, without melting the nonmetallic precursor compounds (20) and without melting the metallic alloy powder, further comprising controlling the oxygen content of the metallic alloy by not carrying the chemical reduction process to completion in a molten salt electrolysis solid phase reduction process, or by mixing oxygen with the nonmetallic precursor compounds in a vapour phase reduction process,

wherein the step of utilizing further includes the step of injection molding (26) particles of the metallic alloy to produce a brown article comprising the particles of the metallic alloy powder, without melting the metallic alloy powder, and without melting the brown article."

Dependent claims 2 to 8 are as those of the primary request.

VII. Submissions of the Appellant

The Appellant's submissions concerning inventive step starting from D5 are relevant for this decision.

Concerning the method of claim 1 of the primary request, the Appellant argued essentially that when the chemical reduction of non-metallic precursor elements is performed in the absence of any melting, the resulting alloy powder has advantages that cannot be derived from the cited prior art. In particular, the alloy particles have an improved morphology that facilitates debinding of the green article, the sintering kinetics are improved, there is greater control over the alloy composition, and it is possible to make alloys that are normally difficult to achieve, such as those involving immiscible components.

D5 does not unambiguously disclose that the powders are not melted during production; the prevention of melting is a measure deliberately chosen by the inventors. In particular, one of the metals expressly mentioned in D5 is gallium, which has a melting point of 27.76°C; according to D5, gallium can be reduced by means of an alkali earth metal. Should francium, which has a melting point of 27°C, be selected as the alkali earth metal for the reduction, then it would be practically impossible to avoid melting, especially as the reaction is highly exothermic.

Although D5 mentions that the reactants should be maintained below the sintering temperature, there is no indication that the temperature should be kept below the melting point during subsequent processing steps.

Further, it is not clearly stated in D5 that each of the particles comprises the metallic alloy, so they could merely comprise the elemental components.

The particles produced in accordance with the process of D5 have a low density and are in "snow-flake" form; such particles would not normally be considered as suitable for injection moulding.

All of the above teaches away from the invention, and hence the claimed method has an inventive step.

Reasons for the Decision

1. The appeal is admissible.

2. Article 123(2) EPC

The Examining Division considered that the feature of chemical reduction occurring without melting was consistently presented in the application as being essential to the invention, hence its deletion in claim 1 of the main request before the Examining Division was contrary to Article 123(2) EPC. However, the feature in question has been reinstated in the claims of both of the present requests, and hence there is no ground for objection under Article 123(2) EPC.

3. Primary Request

3.1 Claim 1 has been amended to require that each particle comprises the metallic alloy material. The basis for this amendment can be found in paragraphs [0020] and [0026] of the published application, and hence the requirements of Article 123(2) EPC are met.

3.2 Since none of the cited documents discloses all the features of claim 1, the claimed method is novel.

3.3 Inventive Step

Documents D1 and D3

3.3.1 The Examining Division found that the claimed method lacked an inventive step in light of either D1 or D3, and the common knowledge of the skilled person.

3.3.2 D1 discloses a method for preparing phosphorus-containing iron powder by vapour phase reduction of a non-metallic precursor compound (iron pentacarbonyl). Since the powder of D1 contains no metals other than iron, it does not relate to metallic alloy material made of metallic constituent elements, ie a plurality of metallic elements; a preferred application for the powder of D1 is injection moulding, but no details of the process are given. Given the disclosures of D3 and D5 (described below), D1 does not provide an appropriate starting point for the assessment of inventive step.

3.3.3 D3 is concerned with a method for making articles from alloy material made of metallic constituent elements,

in which non-metallic precursor compounds are reduced to form a powder that is then used for injection moulding. The powder produced in accordance with D3 is called "alloy powder", but it is not clear if each powder particle is an alloy, as is required by claim 1. The method of D3 seeks to improve dispersion and reduce segregation during the sintering process (page 3 of the translation) which takes place at 1230°C or 1250°C (page 7); this would indicate that alloying occurs during sintering rather than during the formation of the metal powder particles. Alloying during sintering is contrary to the essential feature of claim 1 that the non-metallic precursor compounds should be reduced to form a powder with each particle comprising the metallic alloy material. Consequently, the claimed method has an inventive step in light of D3.

Document D5

3.3.4 Document D5 describes the making of metals by vapour-phase reduction process, and is cited in the description of the present application as a preferred method of making the metal alloy powder. It therefore presents an appropriate starting point for the assessment of inventive step.

3.3.5 According to D5, non-metallic precursor compounds in the form of gaseous metal halides are reduced to metallic form by a liquid alkali metal or alkaline earth metal. In the particular example of D5, titanium tetrachloride vapour is contacted with molten sodium to form reaction products of titanium metal and sodium chloride. D5 also teaches that it is possible to make alloys of a predetermined composition by providing

mixed metal halides in the required molecular ratio at the beginning of the process (see column 3, lines 32 to 34, and column 7, lines 47 to 51). It is an important feature of D5 that the temperature of the reactants is maintained at a temperature lower than the sintering temperature of the alloy to be produced, and thus below the melting point of the material being produced (see the abstract, column 2, lines 43 to 47, column 4, lines 6 to 17).

3.3.6 The vapour-phase reduction process of D5 is mentioned in the present application as being one of the preferred techniques for achieving the chemical reduction required by the claimed invention; an outline of the technique is given in paragraph [0021] of the application, which also refers the reader to D5 as providing a more detailed description. It is therefore intended that the method of D5 will result in a metallic alloy powder whose particles comprise alloy material without the melting of either the non-metallic precursor or the resultant alloy powder.

According to the detailed description of the process of D5 (column 4, lines 6 to 16), titanium tetrachloride vapour is mixed with liquid sodium. The temperature is controlled by the quantity of flowing sodium so that it is kept below the sintering temperature; the temperature of the sodium away from the immediate reaction zone is maintained in the range 200 to 400°C, which acts to quench the particles leaving the reaction zone. Any melting that may occur initially, as a result of the exothermic reaction between titanium tetrachloride and sodium, falls within the meaning given in the application for the expression "without

melting" (see column 6, lines 49 to 52), which is said to include very brief melting in the order of 10 seconds or less.

The Appellant argues that D5 discloses an embodiment for which melting during production of the powder would be inevitable. The example quoted is that of gallium, which has a melting point of 27.9°C. Should gallium tetrachloride (melting point 201°C) be reacted with francium (melting point 27°C) then melting would be inevitable. Gallium is one element in a list of 15 mentioned in column 1, lines 19 to 20 of D5, and francium, although an alkali metal, is the least stable of all naturally occurring elements, having a half-life of 22 minutes. This example seems to be a fairly obscure example and contrary to the tenor of D5, namely that the temperature should remain below the sintering temperature, and hence the melting point, of the alloy to be produced.

As set out above, it is clear from D5 that all attempts should be made during production of the alloy powder to maintain the temperature below the melting point. The skilled person would immediately recognise that the example cited by the Appellant is not realistic and is contrary to the overall teaching of D5.

3.3.7 The Appellant submits that it is not apparent from D5 that the powder particles comprise the alloy. Although D5 teaches that alloys can be produced, it does not explicitly state that each of the resulting powder particles is itself an alloy. However, the present application itself puts forward the technique of D5 as a preferred means of producing the powder of claim 1.

Following the instructions given in the application (paragraph [0021]), the skilled person would expect to achieve the alloy powder of the invention without the need to take any further essential measures.

3.3.8 In light of the above reasoning, the method of claim 1 differs from that of D5 only in that the powders are subjected to injection moulding to produce a brown article without melting the brown article. D5 itself indicates that the powders are suitable powder for metallurgical applications (column 1, lines 46 to 48). Injection moulding is a common-place technique for processing alloy powders and presents an obvious choice for the skilled person faced with the problem of choosing an appropriate means for further processing the powders of D5.

3.3.9 Powders for injection moulding are mixed with a binder and formed into granules or pellets, thus the fact that they are could be in snow-flake form would not deter the skilled person from using them.

It is a general feature of injection moulding that the temperature is not raised above the melting point.

3.3.10 Consequently, the method of claim 1 of the primary request lacks an inventive step.

4. Auxiliary Request

4.1 The method of claim 1 of the auxiliary request has the additional requirement that the oxygen content of the metallic alloy is controlled in a molten salt electrolysis solid phase reduction process by not

carrying the chemical reduction process to completion, or in a vapour phase reduction process by mixing oxygen with the non-metallic precursor compounds.

4.2 The basis for this amendment is to be found in paragraph [0023] and at column 6, lines 40 to 42 respectively of the published application; the requirements of Article 123(2) EPC are thus met.

4.3 The invention is now directed to the control of the oxygen content, a topic that has neither been searched nor subjected to substantive examination by the department of first instance. The case must therefore be remitted to the Examining Division for further prosecution.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the Examining Division for further examination on the basis of the auxiliary request filed during the oral proceedings.

The Registrar: The Chairman:

A. Counillon U. Krause