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**Datasheet for the decision
of 30 April 2020**

Case Number: T 0704/16 - 3.2.03

Application Number: 11757707.2

Publication Number: 2608911

IPC: B22F1/00, C22C38/54

Language of the proceedings: EN

Title of invention:

PROCESSABLE HIGH THERMAL NEUTRON ABSORBING FE-BASE ALLOYS

Applicant:

CRS Holdings, Inc.

Headword:

Relevant legal provisions:

EPC Art. 56

Keyword:

Inventive step - (yes)

Decisions cited:

Catchword:



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Case Number: T 0704/16 - 3.2.03

D E C I S I O N
of Technical Board of Appeal 3.2.03
of 30 April 2020

Appellant: CRS Holdings, Inc.
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Representative: Mewburn Ellis LLP
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Decision under appeal: **Decision of the Examining Division of the
European Patent Office posted on 22 October 2015
refusing European patent application No.
11757707.2 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman G. Ashley
Members: B. Miller
E. Kossonakou

Summary of Facts and Submissions

I. The present appeal lies from the decision of the examining division to refuse European patent application No. 11757707.2 (hereinafter: the application) on the ground of lack of inventive step (Articles 52(1) and 56 EPC).

II. This decision was appealed by the applicant (hereinafter: the appellant). The appellant requested that the contested decision be set aside and a patent be granted on the basis of the set of claims of the main request or, alternatively, on the basis of the auxiliary request, both filed with the statement setting out the grounds of appeal.

III. Independent claim 1 of the main request reads as follows:

"An alloy powder formed of a corrosion resistant, thermal neutron absorbing austenitic alloy comprising in weight percent:

Carbon	0.08 max.
Manganese	up to 3
Silicon	up to 2
Chromium	17-27
Nickel	11-20
Mo+(W/1.92)	up to 5.2
B _{Eq}	0.78-13.0
Nitrogen	up to 0.2
Oxygen	0.01-0.1

wherein $B_{Eq} = \%boron + (4.35 \times \%gadolinium)$, the alloy powder contains at least 0.25% boron and at least 0.05% gadolinium, and the balance is iron and usual impurities, wherein the impurities include 0.05% max. phosphorus, 0.03% max. sulfur, less than 0.005% yttrium, and less than 0.01% aluminum."

Dependent claims 2 to 10 concern preferred embodiments of the alloy of claim 1.

Claim 11 of the main request is directed to

"An article of manufacture that provides good processability in combination with good mechanical and corrosion resistance properties, said article being formed from consolidated austenitic alloy powder as set forth in any one of the preceding claims and the article comprises a matrix and a plurality of boride and gadolinide particles dispersed within the matrix, said boride and gadolinide particles are predominantly M_2B , M_3B_2 , M_5X , and M_3X in form, where X is gadolinium or a combination of gadolinium and boron and M is one or more of the elements silicon, chromium, nickel, molybdenum, iron."

Dependent claim 12 concerns a preferred embodiment of the article of claim 11.

IV. The following documents were cited in the contested decision:

D1: US 4 891 080
D2: US 5 820 818
D3: JPH 09 111 414

V. The reasons for the decision under appeal may be summarised as follows:

D1 disclosed an alloy powder from which claim 1 only differed by the presence of gadolinium (Gd).

D2 and D3 taught that a combination of gadolinium and boron was beneficial for finding the perfect balance between neutron absorbability, corrosion resistance and mechanical properties such as workability and weldability.

Therefore it was obvious to partly replace boron in the alloy described in D1 by gadolinium.

VI. The appellant's respective arguments may be summarised as follows.

In the examples of D1 the expectation of the skilled person was confirmed that the oxygen level of an iron alloy was higher for a powder than for cast metal.

D2 and D3 taught that it was very important to thoroughly deoxidise the alloy with aluminium before adding gadolinium in order to avoid the formation of gadolinium oxide.

This teaching in D2 and D3 established a prejudice to use gadolinium in an iron alloy powder.

Reasons for the Decision

Main request - Article 56 EPC

1. D1 discloses in column 1, lines 59 to 63 a boron (B) containing austenitic stainless steel alloy that has a unique combination of neutron absorption, workability, strength, ductility, toughness and corrosion resistance. According to the table in in column 2, lines 10 to 20 the preferred alloy has the following composition in weight percent:

Carbon	0.05 max.
Manganese	1 to 3
Silicon	0.2 to 0.75
Chromium	18-20
Nickel	12-15
Molybdenum	0.5 max.
Boron	0.7 to 1.6
Nitrogen	0.015 max.
Phosphorus	0.025 max.
Sulphur	0.002 max.
Iron	balance.

Therefore the components of the alloy disclosed in D1 are present within the ranges defined in claim 1 of the main request.

According to column 4, lines 51 to 63 and examples 1 to 7 the alloy is atomized to form a powder.

2. The subject-matter of claim 1 differs from the alloy disclosed in D1 in that the alloy comprises at least

0.05 weight percent of gadolinium (Gd) and the boron equivalent (B_{Eq}) lies between 0.78 and 13.0.

3. High amounts of boron adversely affect the toughness, ductility and processability of the alloy, see paragraph [0047] of the application. According to paragraph [0049] gadolinium is 4.35 times more potent as a neutron absorber than boron. The application therefore proposes to use gadolinium in order to reduce the overall amount of boron and consequently to improve the alloy's mechanical properties.
4. The objective technical problem to be solved can therefore be regarded as providing a powdered alloy having an improved thermal neutron absorption capability or an improved workability and corrosion resistance.
5. D2 concerns both austenitic and ferritic stainless steel alloys having excellent thermal neutron absorbing capacity, workability and corrosion resistance. D2 therefore relates to the same technical field as D1 and would be consulted by the skilled person.

D2 discloses in column 2, lines 25 to 32 that gadolinium has a thermal neutron absorbing capacity of 4.4 times that of boron, can provide equal neutron absorption when added in smaller amounts than boron and thus can reduce the negative effects on workability and corrosion resistance that boron causes.

The alloy according to D2 therefore preferably contains 0.05 to 0.75 wt.% boron and 0.11 to 1.5 wt.% gadolinium, see column 3, lines 51 to 64.

6. However, D2 further teaches in column 9, lines 37 to 45 with respect to aluminium (Al) that the alloy has to be "thoroughly deoxidised" by adding enough aluminium before adding gadolinium in order to avoid the formation of gadolinium based oxides which negatively affect workability and corrosion resistance.

The term "thoroughly deoxidised" implies that the oxygen content should be particularly low. This means that the oxygen content should be lower than for a cast iron which has been deoxidised in a conventional manner and should be by far lower than for the corresponding powdered alloy, which as a consequence of the manufacturing process has a higher oxygen content than cast iron.

7. The fact that powdered alloys have a higher oxygen content than cast alloys is confirmed by the examples of D1. The cast alloys of examples A to G contain oxygen in an amount of 10 to 30 ppm whereas similar alloys in the form of a powder according to examples 1 to 7 comprise oxygen in higher amounts of 145 to 239 ppm.
8. Considering the higher oxygen content in powder alloys and further considering the teaching of D2 in column 9, lines 37 to 45 concerning thorough deoxidation, the skilled person would expect that gadolinium is possibly oxidised when added to the powdered alloy described in D1. Since gadolinium oxides have detrimental effects on the workability and corrosion resistance, the skilled person would not be motivated to add gadolinium to powdered iron alloys.
9. It could be argued that in view of the teaching of D2 the skilled person could get the idea that gadolinium

can still be used when manufacturing a powdered alloy having a lower oxygen content, i.e. an oxygen content as low as for a cast alloy.

However, if the skilled person motivated by the statement in D2 further lowers the oxygen content of the powder alloy to the oxygen content of the cast alloy of D1 before adding gadolinium, the resulting oxygen content is lower than required by claim 1.

10. Therefore starting from D1 the subject-matter of claim 1 is not obvious, since the teaching of D2 either leads to the expectation that gadolinium is oxidised in powdered alloys due to its relatively high content of oxygen or provides an incentive to manufacture a powdered alloy which does not fall within the definitions of claim 1, since claim 1 requires that the oxygen content is above 100 ppm (0.01 %) which is clearly above the oxygen level of a thoroughly deoxidised iron alloy.
11. The subject-matter of claims 1 to 12 of the main request therefore fulfils the requirements of Article 56 EPC when starting from D1 and combining it with D2.
12. The teaching in D3 is similar to the teaching in D2.

D3 concerns an austenitic stainless steel having excellent thermal neutron absorption capability, workability, corrosion resistance and weldability, see paragraph [0009]. In order to achieve these properties it teaches in paragraph [0014] to add both gadolinium and boron in amounts that satisfy the equation for calculating the boron equivalent:

$$[(1-0.0015 \times \%B) \times \%B] + (4.4 \times \text{Gd}\%) \geq 2.$$

The alloy contains 0.9-1.8 wt.% boron, see paragraph [0023], and 0.05-1.5 wt.% gadolinium, see paragraph [0026].

In paragraph [0027] it is further disclosed that the alloy should contain enough aluminium to achieve the necessary deoxidation to avoid oxidation of gadolinium.

13. Therefore starting from D1 the same arguments apply when considering D3 instead of D2.

Order

For these reasons it is decided that:

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the examining division with the order to grant a patent on the basis of the following documents:

- description:

pages 1, 2, 6 to 8 and 11 to 29 as published,
pages 5 and 30 as filed with letter of 11 October 2013,
pages 9 and 10 as filed with letter of
24 September 2014

and

page 3 as filed with letter of 29 July 2015;

- claims:

1 to 12 of the main request filed with the letter dated 29 July 2015, resubmitted with the grounds of appeal dated 26 February 2016;

- drawing sheets: 1/13 to 13/13 as published.

The Registrar:

The Chairman:



C. Spira

G. Ashley

Decision electronically authenticated