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D E C I S I O N
of 15 July 2003

Case Number: T 1115/00 - 3.2.2

Application Number: 95939832.2

Publication Number: 0791081

IPC: C22C 38/12

Language of the proceedings: EN

Title of invention:
Bake hardenable vanadium containing steel

Applicant:
BETHLEHEM STEEL CORPORATION

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 54, 56

Keyword:
"Novelty and inventive step (yes) after amendment"

Decisions cited:
T 0624/91

Catchword:
-

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Case Number: T 1115/00 - 3.2.2

D E C I S I O N
of the Technical Board of Appeal 3.2.2
of 15 July 2003

Appellant: BETHLEHEM STEEL CORPORATION
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 5 April 2000 refusing European application No. 95939832.2 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: W. D. Weiß
Members: R. Ries
E. J. Dufrasne

Summary of Facts and Submissions

I. This appeal is against the decision of the examining division dated 5 April 2000 to refuse European patent application No. 95 939 832.2.

The ground of refusal was that, having regard to document

D1: JP-A-61 246 327

the subject matter of claim 1 lacked novelty or, alternatively, lacked an inventive step. Moreover, documents

D3: JP-A-4246153 (original document) and

D3a: Patent abstracts of Japan, volume 17, No. 25, C-1017 (abstract in English language of D3)

have been considered.

The examining division argued that, according to the description page 10, line 15, the composition of the exemplifying heats given in the Table had "nominally 0.003% carbon" and thus corresponded to the lower limit of 0.003 % carbon disclosed in the document D1. The division also noted that the claimed range of 0.05 to 0.094% V fell completely within the range of 0.01 to 0.1% V disclosed in document D1. It argued that the criteria for the novelty of a selection were not fulfilled by the claimed composition, because the vanadium contents in the examples disclosed in document D1 (in particular grade A), although falling outside,

were adjacent the claimed range of 0.05 to 0.094% V and since the favourable impact of titanium and vanadium on the bake-hardenability was generally known form document D1. The disclosure of document D1 was, therefore, novelty destroying to the subject matter of claim 1.

In case novelty was acknowledged, the examining division argued that document D1 did not deter a skilled person form using carbon levels lower than 0.003% on condition that lower bake-hardenability values (< 3 kgf/mm^2 = 4.27 ksi) were tolerated. Given that document D1 taught the beneficial effect of vanadium on deep drawability and bake-hardenability of the steel alloy and further discloses recrystallisation annealing temperatures of 800 to 900°C, no surprising effect was connected to choosing the upper half of the vanadium range stipulated in document D1 when regarding bake-hardenability. Hence, no inventive step was seen in restricting the ranges of carbon to 0.0005 to 0.028% and of vanadium to 0.05 to 0.094%.

II. On 8 June 2000, the appellant (applicant) lodged an appeal against the decision and paid the prescribed fee on the same date. On 15 August 2000 a statement of grounds of appeal was filed.

III. Following a communication from the Board inviting the appellant to oral proceedings, the appellant revised his requests and, in support of his arguments, cited the document

D6: The Making, Shaping and Treating of Steel, 9th edition, USS, edited by Harold McGannon, pages 1136, 1137 and 1277.

IV. At the oral proceedings held before the Board on 15 July 2003, the appellant finally requested that

- the decision under appeal be set aside and

- a patent be granted on the basis of claims 1 to 12 and the description, pages 1 to 13 as filed during the oral proceedings and the figure filed on 11 March 1998.

V. Independent claim 1 reads as follows:

"1. Method of making a rolled steel article comprising the steps of casting a low carbon steel containing carbon, manganese, aluminium, nitrogen with the balance iron and incidental impurities and hot rolling said steel, comprising the steps of:

providing said steel with a composition comprising, by weight, 0.0018 to 0.0028% carbon, 0.18 to 0.22% manganese, 0.024 to 0.040% aluminium, 0.0044 to 0.0065% nitrogen, 0.018 to 0.022% titanium as a nitride forming element, between zero and up to 2.5% manganese, 0.049 and 0.094% vanadium, phosphorus in an amount of zero to 0.025% and silicon in an amount of zero to 1.0%, with the balance iron and inevitable impurities, wherein said vanadium contributes to improved bake hardenability of said steel when subjected to paint baking."

VI. The appellant argued as follows:

Based on the technical teaching of the criticality of the carbon content and the other variables such as titanium, vanadium and nitrogen given in document D1, a person skilled in the art would refrain from reducing the carbon content to below 0.003% since the skilled person always aims at increasing rather than lowering the bake-hardenability. Moreover, there is no teaching in this document that even with levels of carbon lower than 0.003%, an increase in bake-hardenability of the steel sheet could be achieved by adding increased amounts of vanadium to the alloy. This finding was quite surprising and could not be expected from what is taught in document D1, all the more so since the examples given in D1 comprise at most 0.046% V. Thus by adhering essentially to the narrow ranges for carbon, aluminium, nitrogen, titanium and vanadium and other components including manganese, silicon and phosphorus, a "producer-friendly" bake-hardenable, ageing-resistant steel sheet can be produced since the alloy chemistry can be easily controlled and lower annealing temperatures are permitted to achieve the final properties. Moreover, according to the invention the steel sheet may be air cooled after annealing whereas the method disclosed in document D1 requires water quenching.

The teaching of document D2 is even more remote since the steel alloy comprises only trace amounts of vanadium. Although the carbon content of various examples is below 0.003%, i.e. in the claimed range, none of them satisfies the compositional requirements stipulated in claim 1 of the application. Hence, the

claimed subject matter is clearly distinguished from the teaching given in any of documents D1 and D3 and not obvious thereof.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments (Article 123(2) EPC)*

Present claim 1 results from a combination of claims 1, 6, 21 and 22 as originally filed. Dependent claims 2 to 8 correspond to original claims 2, 3, 5 and 7 to 10, respectively.

Independent claim 9 is based on claims 17, 21 and 22 as filed and the dependent claims 10 to 13 correspond to the original claims 15, 16 and 18, respectively.

The description has been suitably adapted to the revised wording of the claims and comprises, like the single Figure, the conversion of non-SI units and temperatures.

Hence, there are no formal objections to the claims, the description and the Figure.

3. *Novelty*

3.1 According to the independent claims 1 and 9, the carbon content in the steel composition is restricted to 0.0018 to 0.0028%. In this respect, the claimed composition is clearly distinguished from that given in

document D1 which stipulates higher carbon contents in the range of 0.003 to 0.02%. It is noted that a "distance" or "gap" exists between the lower limit for carbon in D1 and the upper limit for carbon in the claimed composition. Given this situation, any overlap of the carbon ranges is excluded.

3.2 The examining division referred in this context to decision T 624/91 saying that "point-like disclosures for alloy compositions in the state of the art must be interpreted as average or nominal values within a small range in view of known fluctuations in reproducibility and in analytical results, unless there is evidence available to the contrary".

It should, however, be borne in mind that the carbon content in steel alloy compositions can be controlled and reproduced by the skilled steel-producer very precisely so that carbon levels are obtained within narrow ranges in parts-per-million (ppm). This high degree of accuracy is corroborated by the ultra-low carbon contents in the examples of document D3, ranging from 0.0021 to 0.0053% C. Having in mind this evidence, the lower limit of 0.003% carbon in document D1, therefore, cannot be interpreted to include 0.0028%, this finding being fully in line with the spirit of decision T 624/91.

The steel composition according to claims 1 and 9 differs from that given in document D3 in that the claimed vanadium range lies far outside the trace amounts admitted for the ULC alloy disclosed in this prior art.

3.3 Hence, the novelty of the subject matter of claims 1 and 9 cannot be disputed.

4. *Inventive step*

4.1 The automotive industry demands higher strength steel sheet and strip with excellent cold forming properties (ductility, press formability) together with a certain dent resistance. For improving the dent resistance in steel sheet, a measurable increase in strength during paint-baking, i.e. a bake-hardenability (BH) without noticeable ageing at ambient temperature, is a suitable and desirable quality. Paint bake-hardenability is defined as the strain ageing increment found after forming and ageing for 20 or 30 minutes at 180°C. It is commonly assumed in the steel industry that the carbon and nitrogen in solid solution during the bake-hardening step is responsible for the bake-hardening strength increment observed.

Given that ductility and strength are two conflicting parameters resulting from the steel composition and the thermal history, the present application aims at providing a suitable low carbon steel sheet having an alloy chemistry which provides an excellent match in both properties, can be more easily controlled than prior art chemistries, is less energy intensive when heat-treated and has less demanding processing requirements.

These objects are achieved by the technical features, in particular the steel composition, given in independent claims 1 and 9 of the present application. As is apparent from the single Figure and the examples

in the Table on page 11, a considerable bake-hardening increment in the steel sheet is obtained by the addition of vanadium in amounts of 0.05 to 0.10% while concurrently the carbon content is reduced to the range of 18 to 28 ppm promoting a high formability and nitrogen is kept to be 44 to 65 ppm. Due to the relatively broad range for vanadium, the claimed ultra-low carbon (ULC) steel chemistry can be more easily controlled during casting, is less prone to variations in the final properties and results in a satisfactory bake-hardenability of the sheet at rather low annealing temperatures of 815°C (1500°F) which makes it more "producer-friendly" than the steel composition suggested by the prior art (cf. the application page 6, second paragraph).

4.2 Like the invention, also document D1 aims at improving the bake-hardenability and press-formability (expressed by the r-value). The problem to be solved is, therefore, the same as in the present invention. As disclosed on page 4, 4th paragraph, lines 6 to 10 of D1, in particular steel no. 4 showed excellent BH and r-values due to the combined addition of titanium and vanadium. An explanation for this phenomenon is given in document D1, 5th paragraph on page 4.

However, document D1 also teaches that the carbon content in the steel alloy should be higher than 0.003% to achieve a BH of more than 3 kgf/mm^2 (cf. D1, page 4, last paragraph), and that the nitrogen content is to be held down as much as possible (cf. D1, page 5, 7th paragraph). To this end, carbon is reduced in the exemplifying steel grades given in Table 1 of document D1 to not lower than 0.005% and vanadium is kept below

a maximum of 0.040% (grade A). There is no teaching in D1 that an acceptable BH performance at carbon levels lower than 0.003% could be achieved by simultaneously adding increased amounts of vanadium in the range of 0.049 to 0.094% as taught by the present invention. On the contrary, a skilled person - following the second formula on page 3, last line - would have reduced the concentration of titanium, nitrogen and also vanadium since some carbon (>0.001%) in solid solution is needed to ensure the hardening effect during baking (see also page 3, 3rd paragraph, first line). The sheet and strip of the ULC steel grades (0.005% C; grade A), according to document D1, are generally annealed at 850°C and require water quenching to develop a satisfactory BH. It is, therefore, concluded that document D1 dissuades from decreasing the carbon level below 0.003% and from adding increasing amounts of vanadium to improve the BH of such a steel sheet.

4.3 The examining division extrapolated the BH below the lower limit of 0.003% C stipulated in document D1 and argued that carbon contents of <0.003% could be used provided that lower BH values were acceptable.

4.4 Such a speculative extrapolation is, however, not permissible because there is evidence from document D3 that the precise effect and interaction of the various components, in particular of C, N, Ti and V on the properties of the resulting alloy cannot be exactly forecast. Document D3 which was published in 1991, i.e. six years after the publication date of document D1 (1985), discloses on page 9, last paragraph, at least four formulae which are to be carefully adhered to in order to bring about a satisfactory BH and aging index

(AI) of the ULC steel sheet. Hence, the alloy chemistry is not easy to control during casting. Although in the examples D, J, N and T, which come closest to the invention, at least the amounts of carbon and titanium are within or very close to the corresponding range stipulated in the present application, the amounts of vanadium are much lower. The reason why vanadium there is added only in trace amounts is evident from Figures 2, 3 and 4. These figures show that with increasing amounts of vanadium the BH is impaired rather than improved for steel sheet comprising less than 30 ppm carbon. In particular Figure 4 teaches that an acceptable compromise between a BH $\geq$ 4 kgf/mm^2 and an AI < 3 kgf/mm^2 could be achieved by adding only trace amounts of vanadium (cf. D3a) in the range of 0.003 to 0.020 %, i.e. in much lower amounts than required in the steel composition according to the present invention (0.049 to 0.094% V). The basic technical teaching given in document D3 is, therefore, to restrict the vanadium content to max. 0.020% rather than to increase it and thus is in contradiction to what the skilled reader is taught in document D1.

A further difference resides in that the claimed steel composition comprises 0.0044 to 0.0065 % N, whereas nitrogen in the steel alloy according to document D3 should be kept below 0.0025% (cf. D3, column 1, line 37 and column 8, point 0014). Moreover, sophisticated annealing (830°C, 850°C; see D3, point 0031 column 15) and cooling conditions (see D3a) have to be adhered to in the known process.

Based on these considerations it is concluded that also document D3 does not provide any technical information

prompting a skilled person to design the producer-friendly, less energy intensive steel composition featuring in independent claims 1 and 9 and to achieve the objects mentioned above. The subject matter of claims 1 and 9 is, therefore, novel and involves an inventive step.

The dependent claims 2 to 8 and 10 to 12 relate to preferred embodiments of the method according to claim 1 or the rolled steel article according to claim 9, respectively. These claims are therefore also allowable.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the first instance with the order to grant a patent based on the description pages 1 to 13, claims 1 to 12 both as filed during the oral proceedings and the figure filed on 11 March 1998.

The Registrar: The Chairman:

V. Commare W. D. Weiß

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