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Datasheet for the decision of 3 March 2023

Case Number: T 2155/21 - 3.3.05

Application Number: 10780303.3

Publication Number: 2436794

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Language of the proceedings: EN

Title of invention:
HIGH STRENGTH STEEL SHEET HAVING EXCELLENT HYDROGEN EMBRITTLEMENT RESISTANCE

Patent Proprietor:
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Opponent:
ThyssenKrupp Steel Europe AG

Headword:
Steel sheet/KABUSHIKI

Relevant legal provisions:
EPC Art. 56
RPBA 2020 Art. 13(2)

Keyword:
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Amendment to a party's case after summons - cogent reasons (no) - taken into account (no)

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Catchword:

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Beschwerdekammern

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Case Number: T 2155/21 - 3.3.05

D E C I S I O N
of Technical Board of Appeal 3.3.05
of 3 March 2023

Appellant: (Opponent)	ThyssenKrupp Steel Europe AG Kaiser-Wilhelm-Strasse 100 47166 Duisburg (DE)
Representative:	Cohausz & Florack Patent- & Rechtsanwälte Partnerschaftsgesellschaft mbB Bleichstraße 14 40211 Düsseldorf (DE)
Respondent: (Patent Proprietor 1)	Kabushiki Kaisha Kobe Seiko Sho 10-26 Wakinohama-cho 2-chome Chuo-ku Kobe-shi Hyogo 651-8585 (JP)
Respondent: (Patent Proprietor 2)	voestalpine Stahl GmbH voestalpine-Straße 3 4020 Linz (AT)
Representative:	HGF HGF Europe LLP Neumarkter Straße 18 81673 München (DE)
Decision under appeal:	**Interlocutory decision of the Opposition Division of the European Patent Office posted on 18 October 2021 concerning maintenance of the European Patent No. 2436794 in amended form.**

Composition of the Board:

Chairman	E. Bendl
Members:	T. Burkhardt
	R. Winkelhofer

Summary of Facts and Submissions

I. The opponent's (appellant's) appeal is against the opposition division's decision to maintain the European patent No. 2 436 794 B on the basis of an amended main request.

II. The following documents were among those discussed at the opposition stage:

D1 A Clarke, "Carbon partitioning into austenite from martensite in a silicon-containing high strength sheet steel", PhD thesis, 2006, 1-321

D8 JP 2007 197819 A

D8t EP 1 975 266 A1

D8 and D8t are family members.

III. The independent claims as maintained by the opposition division (main and sole claim request in appeal proceedings) read as follows:

"1. A high strength steel sheet having excellent hydrogen embrittlement resistance, the steel sheet having a tensile strength of 1180 MPa or more and satisfying the following condition: with respect to an entire metallographic structure thereof, bainite, bainitic ferrite and tempered martensite account for 85 area% or more in total; retained austenite accounts for 1 area% or more, and fresh marentsite [sic] accounts for 5 area% or less (including 0 area%),

wherein the high strength steel sheet consists of by mass:
C: 0.15 to 0.25 %;
Si: 1 to 2.5 %;
Mn: 1.5 to 2.8 %;
P: 0.015 % or less;
S: 0.01 % or less;
Al: 0.01 to 0.1 %;
N: 0.01 % or less;
Cr: 0,1 % to 1 %;
optionally Mo: 1 % or less;
optionally B: 0.005 % or less;
optionally Cu: 0.5 % or less;
optionally Ni: 0.5 % or less;
optionally Nb: 0.1 % or less;
optionally Ti: 0.1 % or less;
optionally Ca: 0.005 % or less;
optionally Mg: 0.005 % or less;
optionally REM: 0.01 % or less; and
the balance being Fe and inevitable impurities."

"2. A method of producing a high strength steel sheet having excellent hydrogen embrittlement resistance, comprising:

a quenching step of cooling a steel sheet having a composition as defined in claim 1 and a temperature equal to or greater than an Ac_3 point, down to a temperature T1 satisfying the following formula (1), at an average cooling rate of 10°C/sec or more; and

a holding step of holding the steel sheet quenched in the quenching step, at a temperature T2 satisfying the following formula (2), for 300 seconds or more,

(Ms point − 250°C) ≤ T1 ≤ Ms point ---(1)
(Ms point − 120°C) ≤ T2 ≤ (Ms point + 30°C) ---(2)."

IV. The patent proprietors' (respondents') arguments at the appeal stage, where relevant to the present decision, can be summarised as follows.

The requirements of Article 56 EPC were met in view of a combination of D1 with D8/D8t.

D1 was the closest prior art, but the skilled person would not have started from the specific example labelled "900-240-400" with a holding time of 1000 s since page 192 of D1 taught that the formation of bainite was to be avoided.

A combination of D1 with D8/D8t did not result in the claimed subject-matter. More particularly,

- D1 did not mention anything regarding hydrogen embrittlement. Therefore, the skilled person had no incentive to look for other documents to improve this property.

- D8/D8t was directed to microstructures that were different from those in claim 1. It also did not mention anything regarding the role of fresh martensite with regard to hydrogen embrittlement resistance.

- D8/D8t taught that the dispersion and the dimensions of the residual austenite grains were to be chosen to improve hydrogen embrittlement resistance. It also taught that carbon was to be added in this regard.

V. Following the board's communication under Article 15(1) RPBA 2020, the respondents submitted a number of new lines of argument:

(a) The Koistinen-Marburger equation used by the appellant was not suitable for calculating the martensite content of the steel in D1, let alone the entire microstructure.

(b) Ductility of the steel sheet had to be accounted for as well when formulating the technical problem to be solved, starting from D1.

(c) D8/D8t disclosed two embodiments, namely a first embodiment with a lower carbon content and a second embodiment with a higher carbon content.

The holding times in the examples relating to the first embodiment were, however, below the range in claim 2 of the main request and, unlike claim 1 of the main request, a dual phase texture was obtained.

In addition, in the second embodiment, a microstructure that was different from that in claim 1 was obtained, which additionally contained ferrite and perlite.

(d) D8, in particular paragraph [0008], provided teaching that led away from the addition of Cr since this resulted in cracks.

(e) D1 did not mention anything regarding a cooling rate, in particular since the term "equilibrated" in the last paragraph on page 24 was to be construed as a holding step subsequent to quenching.

(f) Example 48 of the patent in suit had a short holding time and resulted in a high amount of fresh martensite, and hence in low hydrogen embrittlement resistance (Table 6 of the patent in suit). This

demonstrated that the process parameters also had an important influence.

VI. The appellant's arguments at the appeal stage are reflected in the reasons below.

VII. The appellant requests that the decision under appeal be set aside and that the patent be revoked.

The respondents request that the appeal be dismissed.

Reasons for the Decision

1. Consideration of new arguments

1.1 It has not been disputed that the new lines of argument (a) to (f) (see point VI. above) were presented for the first time at the appeal stage, following the board's communication indicating its preliminary opinion.

Regarding point (a) above, in their reply to the appeal the respondents had not commented on the fact that the appellant had applied the Koistinen-Marburger equation to the steel in D1 in their statement of grounds of appeal.

Regarding point (b), the respondents had stated in their reply to the appeal that the technical problem to be solved was to provide a steel sheet with high strength and hydrogen embrittlement resistance (e.g. first paragraph on page 4 and the last full paragraph on page 8). At that stage, ductility had not been mentioned as part of the problem.

Regarding point (c), the respondents had not mentioned the presence of two distinct embodiments in D8/D8t in their reply to the appeal.

Regarding point (d), the respondents similarly had not mentioned the alleged teaching of D1 according to which the addition of Cr caused cracks in the steel.

Regarding point (e), in their reply to the appeal the respondents had not contested that the average cooling rate of the example labelled "900-240-400" with a holding time of 1000 s of D1 was 10°C/s or more.

Regarding point (f), the respondents had not mentioned Example 48 in their reply either.

Therefore, these lines of argument represent amendments to the respondents' case.

1.2 Moreover, the respondents have failed to justify why they submitted these lines of argument only after the board's communication, let alone failed to assert or even prove exceptional circumstances justified by cogent reasons.

1.3 These lines of argument therefore cannot be considered under Article 13(2) RPBA 2020.

2. Inventive step

For the reasons set out below, the main and sole request does not meet the requirements of Article 56 EPC, in contrast to the opposition division's conclusion.

2.1 The invention relates to a high strength steel sheet and to a method for the production of a steel sheet.

2.2 In the appellant's view, PhD thesis **D1** is the closest prior art. The respondents share this view.

D1 relates to high strength TRIP steel sheets (see e.g. the title and the last paragraph on page 19).

More precisely, the appellant considers the example labelled "900-240-400" with a holding time of 1000 s (Table 3.2 on page 25) as a starting point. This example is based on a steel with the composition set out in Table 3.1 (page 20).

In this example, "900" designates the austenitising temperature in °C, "240" the temperature at the end of the quenching step and "400" the temperature of the holding step (pages 24 and 25).

As regards the composition in claim 1, it has not been contested that only Cr is missing (page 20, Table 3.1).

This example has a tensile strength of 1351 MPa, which is within the claimed range (page 291, continuation of Table B.1, line 17).

It has not been contested that 900°C is above the Ac_3 temperature of the example labelled "900-240-400", which is 870°C according to the formula in paragraph [0068] of the patent in suit.

Uncontestedly, the quenching end temperature T1 = 240°C and the holding temperature T2 = 400°C satisfy criteria (1) and (2) in claim 2, given that the martensite start

temperature Ms for this example is 418°C according to the formula in paragraph [0068] of the patent in suit.

Prior to the board's communication, it had also not been contested that
- the cooling rate during the quenching step in this example in D1 is 10°C/s or more; in fact, during quenching the temperature decreases from 900°C to 240°C in 10 s (pages 24/25), or that
- the time of the holding step is 300 s or more; in fact, it is 1000 s (pages 24/25).

The respondents argue that the skilled person would not start from the specific example in D1 labelled "900-240-400" with a holding time of 1000 s since page 192 of D1 taught that the formation of bainite is to be avoided; however, claim 1 does not stipulate a minimum amount of bainite alone, but a minimum amount of bainite, bainitic ferrite and tempered martensite *in total*. Contrary to the respondents' position, there is thus no "teaching away" in this regard.

D1 is a PhD thesis relating to the same technical field and considered by both parties to be the closest prior art. In particular, the example labelled "900-240-400" with a holding time of 1000 s is part of the teaching of this prior-art document and has numerous features in common with the subject-matter of claims 1 and 2 of the main request. Therefore, this example is a suitable starting point for assessing inventive step.

2.3 According to the patent in suit, the problem to be solved is to provide a steel sheet with both high strength and high hydrogen embrittlement resistance (e.g. paragraph [0013]).

However, since the steel sheet in the example labelled "900-240-400" with a holding time of 1000 s already has a tensile strength in the claimed range, the problem has to be reformulated as that of providing a steel sheet having improved hydrogen embrittlement resistance, without compromising strength.

2.4 It is suggested that this problem be solved by means of a Cr content of 0.1 wt.% to 1 wt.% and a metallographic structure with:
- bainite, bainite ferrite and tempered martensite accounting for 85 area% or more in total,
- retained austenite accounting for 1 area% or more, and
- fresh martensite accounting for 5 area% or less.

2.5 It has not been contested that the problem has been successfully solved.

2.6 However, for the following reasons, the subject-matter of claims 1 and 2 is obvious.

D8/D8t also relates to high strength TRIP steel sheets and is directed to improving hydrogen embrittlement resistance (e.g. paragraph [0010]).

According to paragraph [0144], the addition of 0.003 wt.% to 2.0 wt.% Cr to the steel improves, *inter alia*, the hydrogen embrittlement resistance while "secur[ing] the mechanical strength".

More specifically, paragraph [0145] suggests a more preferable Cr range of between 0.3 % and 1.0 %, which falls within the range of claim 1. Almost all the examples set out in Table 1 have a Cr content of between 0.2 and 0.7%. In particular, Example 10 in

Table 2 of D8/D8t, which is based on alloy J with a Cr content of 0.5 % (see Table 1), exhibits the highest hydrogen embrittlement resistance (penultimate column of Table 2).

The skilled person would therefore apply the teaching of D8/D8t to the example in D1 labelled "900-240-400" with a holding time of 1000 s by adding Cr in the more preferable range of between 0.3 % and 1.0 %, or even 0.5 % according to Example 10.

All the elements on file indicate that the metallographic structure in this case is inherently as claimed. Therefore, according to the patent in suit, the desired metallographic structure is obtained if
- the concentrations fall within the ranges in claim 1 (paragraphs [0035] to [0053] and [0056]), and
- the process parameters are those in claim 2 (paragraph [0055] to [0059]), notably
    - the holding temperature (paragraph [0027]) and
    - the holding time (paragraph [0055]).

In other words, the claimed microstructure is an inevitable consequence of
- the composition in claim 1, and
- the method steps in claim 2.

If the skilled person adds 0.5 wt.% Cr to the steel in the example in D1 labelled "900-240-400" with a holding time of 1000 s, the composition and the method steps in claims 1 and 2 of the main request will be respected. Therefore, the metallographic structure will inevitably be within the ranges in claim 1.

Consequently, the subject-matter of claims 1 and 2 is obvious (Article 56 EPC).

2.7 In addition, prior to the board's communication, it had not been disputed that the Koistinen-Marburger equation and the relations in paragraph [0068] of the patent in suit confirmed that the claimed metallographic structure would be obtained if Cr was added, in the claimed range, to the example in D1 labelled "900-240-400" with a holding time of 1000 s.

2.8 The opposition division held that the skilled person was not prompted to add Cr to the example in D1 labelled "900-240-400" with a holding time of 1000 s since, according to paragraph [0069] of D8/D8t, Cr improved hardness, which was different from improving strength (last paragraph on page 7 of the decision under appeal).

This is not convincing since, as demonstrated above under point 2.3, an *improvement* in strength is not necessary for solving the (reformulated) technical problem, and paragraph [0069] of D8/D8t does indicate that strength is "secure[d]" when Cr is added.

2.9 D8/D8t indeed does not mention anything regarding the negative impact of fresh martensite on hydrogen embrittlement resistance.

This at most amounts, however, to the *discovery* of an underlying phenomenon and cannot justify an inventive step.

As explained above (see the end of point 2.6), the claimed microstructure is an inherent consequence of the obvious addition of Cr to the example in D1.

2.10 The respondents allege that a combination of D1 with D8/D8t did not result in the subject-matter of claims 1 and 2.

For instance, the respondents argue that D8/D8t was directed to microstructures that were different from those in claim 1 of the patent in suit.

However, the claimed microstructure is not part of the problem to be solved as explained under point 2.3 (this would instead be an unallowable pointer to the solution). Hence, the disclosure of different microstructures in D8/D8t is not a reason why the skilled person would not consider D8/D8t for solving the problem posed when starting from D1.

Moreover, while the respondents hint at the teaching of D8/D8t according to which the dispersion and the dimensions of the residual austenite grains improve hydrogen embrittlement resistance (e.g. claim 1), there is no reason to conclude that this would lead to subject-matter falling outside the scope of claims 1 and 2 of the main request.

The respondents also noted the fact that D8/D8t taught that, besides Cr, carbon also contributed to increased hydrogen embrittlement resistance.

However, following the teaching of D8/D8t, there is again no reason to conclude that the C content would be outside the range in claim 1.

Therefore, the respondents failed to give convincing reasons for their allegations according to which
- the teaching of D1 and D8/D8t was incompatible,

- the skilled person would not add Cr to the example in D1 in the amount required by claim 1 of the patent in suit, and
- a combination of D1 with D8/D8t resulted in subject-matter falling outside the scope of claims 1 and 2 of the main request.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The patent is revoked.

The Registrar: The Chairman:

C. Vodz E. Bendl

Decision electronically authenticated