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Datasheet for the decision of 14 January 2025

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Language of the proceedings: EN

Title of invention:
HIGH-STRENGTH COLD-ROLLED STEEL SHEET HAVING EXCELLENT WORKABILITY AND COLLISION CHARACTERISTICS AND HAVING TENSILE STRENGTH OF 980 MPa OR MORE, AND METHOD FOR PRODUCING SAME

Patent Proprietor:
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(Kobe Steel, Ltd.)

Opponent:
ArcelorMittal

Headword:
Steel sheet/KABUSHIKI

Relevant legal provisions:
EPC Art. 56, 123(2)

Keyword:
Inventive step - main request (yes) - credibly solved
Amendments - extension beyond the content of the application as filed (no)

Decisions cited:
T 1437/07, T 0629/22

Catchword:

Beschwerdekammern

Boards of Appeal

Chambres de recours

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Case Number: T 0969/23 - 3.3.05

D E C I S I O N
of Technical Board of Appeal 3.3.05
of 14 January 2025

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Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted on 6 March 2023 rejecting the opposition filed against European patent No. 3279363 pursuant to Article 101(2) EPC.**

Composition of the Board:

Chairman E. Bendl
Members: T. Burkhardt
P. Guntz

Summary of Facts and Submissions

I. The opponent's (appellant's) appeal lies from the opposition division's decision to reject the opposition to European patent No. 3279363 B1.

II. Of the documents discussed at the opposition stage, the following are relevant to the present decision.

D2	US 2012/0312433 A1
D4	US 2014/0182748 A1
D5	JP 2014/95155 A
D5a	English translation of D5

III. With its grounds of appeal, the opponent (appellant) additionally submitted the following documents *inter alia.*

D7	EP 3 279 362 A1
D8	WO 2013/146087 A1
D8a	US 2015/0101712 A1
D9	US 2015/0034218 A1
D10	JP 5400484 B2
D10a	Machine translation of JP 2010285636 A
D11	EP 2 692 893 A1
D12	JPH 11-152544 A
D12a	machine translation of D12

IV. The opposition division concluded that the granted version of the patent met the requirements of Articles 123(2) and 56 EPC.

V. The independent claims of the main request (granted version) read as follows:

"1. A high-strength cold-rolled steel sheet having a tensile strength of 980 MPa or more and being excellent in formability and crashworthiness, the high-strength cold-rolled steel sheet containing, in mass%:

C: 0.10% or more to 0.5% or less,
Si: 1.0% or more to 3% or less,
Mn: 1.5% or more to 7% or less,
P: more than 0% to 0.1% or less,
S: more than 0% to 0.05% or less,
Al: 0.005% or more to 1% or less,
N: more than 0% to 0.01% or less, and
O: more than 0% to 0.01% or less, and

optionally, as other elements, one or more of any of (a) to (e) below, in mass%:

(a) at least one selected from the group consisting of Cr: more than 0% to 1% or less and Mo: more than 0% to 1% or less,
(b) at least one selected from the group consisting of Ti: more than 0% to 0.15% or less, Nb: more than 0% to 0.15% or less, and V: more than 0% to 0.15% or less,
(c) at least one selected from the group consisting of Cu: more than 0% to 1% or less and Ni: more than 0% to 1% or less,
(d) B: more than 0% to 0.005% or less, and
(e) at least one selected from the group consisting of Ca: more than 0% to 0.01% or less, Mg: more than 0% to 0.01% or less, and REM: more than 0% to 0.01% or less,

with a balance being iron and inevitable impurities, wherein
a metal structure at a position of 1/4 of a sheet thickness satisfies (1) to (4) below:

(1) when the metal structure is observed with a scanning electron microscope, an area ratio of ferrite relative to a whole of the metal structure is more than 10% to 65% or less, with a balance being a hard phase including quenched martensite and retained austenite and including at least one selected from the group consisting of bainitic ferrite, bainite, and tempered martensite, wherein the metal structure may, in addition to ferrite and the hard phase, contain at least one selected from the group consisting of pearlite and cementite,
(2) when the metal structure is measured by X-ray diffractometry, a volume ratio V_{γ} of retained austenite relative to the whole of the metal structure is 5% or more to 30% or less,
(3) when the metal structure is observed with an optical microscope, an area ratio V_{MA} of an MA structure, in which quenched martensite and retained austenite are combined, relative to the whole of the metal structure is 3% or more to 25% or less, and an average circle-equivalent diameter of the MA structure is 2.0 µm or less, and
(4) a ratio V_{MA}/V_{γ} of the area ratio V_{MA} of the MA structure to the volume ratio V_{γ} of the retained austenite satisfies a formula (i) below:

$$0.50 \leq V_{MA}/V_{\gamma} \leq 1.50 \quad ...(i),$$

and wherein

the value of tensile strength TS x elongation EL is 17000 MPa·% or more, the value of TS x expansion ratio λ is 20000 MPa·% or more, and the value of TS x VDA bending angle is 90000 MPa·°or more, wherein the sample for the TS was taken according to JIS Z2201 and the VDA value was determined according to standard VDA238-100."

"5. A method for producing a high-strength cold-rolled steel sheet having a tensile strength of 980 MPa or more and being excellent in formability and crashworthiness, the method comprising:

using a steel satisfying a component composition as set forth in claim 1,
hot rolling the steel with a rolling rate at a final stand of finish rolling being 5 to 20% and with a finish rolling end temperature being an Ar_3 point or higher to 900°C or lower, coiling the steel with a coiling temperature being 600°C or lower, and cooling the steel to room temperature,
cold rolling the steel,
heating the steel, at an average heating rate of 10°C/second or more, to a temperature region of 800°C or higher and lower than an Ac_3 point, and soaking the steel while holding the steel in the temperature region for 50 seconds or more,
cooling the steel at an average cooling rate of 10°C/second or more, to an arbitrary cooling stop temperature T°C that lies in a temperature range of 70°C or higher and an Ms point or lower, and
heating and holding the steel in a temperature region of the cooling stop temperature T+50°C or higher and 550°C or lower for 200 seconds or more, and thereafter cooling the steel to room temperature,

wherein the Ms point is calculated on the basis of the following formula (iv), wherein brackets [] indicate the content of each element in mass% and Vf indicates the area ratio of ferrite relative to the whole of the metal structure,

$$Ms\ point\ (°C) = 561 - 474 \times [C]/(1 - Vf/100) - 33 \times [Mn] - 17 \times [Ni] - 17 \times [Cr] - 21 \times [Mo] \quad ...(iv)."$$

"6. A method for producing a high-strength hot-dip galvanized steel sheet having a tensile strength of 980 MPa or more and being excellent in formability and crashworthiness, the method comprising:

using a steel satisfying a component composition as set forth in claim 1,
hot rolling the steel with a rolling rate at a final stand of finish rolling being 5 to 20% and with a finish rolling end temperature being an Ar_3 point or higher to 900°C or lower, coiling the steel with a coiling temperature being 600°C or lower, and cooling the steel to room temperature,
cold rolling the steel,
heating the steel, at an average heating rate of 10°C/second or more, to a temperature region of 800°C or higher and lower than an Ac_3 point, and soaking the steel while holding the steel in the temperature region for 50 seconds or more,
cooling the steel at an average cooling rate of 10°C/second or more, to an arbitrary cooling stop temperature T°C that lies in a temperature range of 70°C or higher and an Ms point or lower, and
a reheating of heating and holding the steel in a temperature region of the cooling stop temperature T+50°C or higher and 550°C or lower for 200 seconds

or more, and after performing hot-dip galvanizing within a holding time, cooling the steel to room temperature, wherein
in the reheating, there are three patterns of (I) to (III) as a combination of the hot-dip galvanizing and only the heating without performing the hot-dip galvanizing,

(I) only the heating is carried out, and thereafter, the hot-dip galvanizing is carried out;
(II) the hot-dip galvanizing is carried out, and thereafter, only the heating is carried out;
(III) only the heating is carried out, and thereafter, the hot-dip galvanizing is carried out, and further, only the heating is carried out, in this order,

wherein the Ms point is calculated on the basis of the following formula (iv), wherein brackets [] indicate the content of each element in mass% and Vf indicates the area ratio of ferrite relative to the whole of the metal structure,

Ms point (°C) = 561 - 474 x [C]/(1 - Vf/100)
- 33 x [Mn] - 17 x [Ni] - 17 x [Cr] - 21 x [Mo]
...(iv)."

"7. A method for producing a high-strength hot-dip galvannealed steel sheet having a tensile strength of 980 MPa or more and being excellent in formability and crashworthiness, the method comprising:

using a steel satisfying a component composition as set forth in claim 1,

hot rolling the steel with a rolling rate at a final stand of finish rolling being 5 to 20% and with a finish rolling end temperature being an Ar_3 point or higher to 900°C or lower, coiling the steel with a coiling temperature being 600°C or lower, and cooling the steel to room temperature,
cold rolling the steel,
heating the steel, at an average heating rate of 10°C/second or more, to a temperature region of 800°C or higher and lower than an Ac_3 point, and soaking the steel while holding the steel in the temperature region for 50 seconds or more,
cooling the steel at an average cooling rate of 10°C/second or more, to an arbitrary cooling stop temperature T°C that lies in a temperature range of 70°C or higher and an Ms point or lower, and
a reheating of heating and holding the steel in a temperature region of the cooling stop temperature T+50°C or higher and 550°C or lower for 200 seconds or more, and after performing hot-dip galvanizing within a holding time, further performing an alloying treatment and thereafter cooling the steel to room temperature, wherein
in the reheating, there are three patterns of (I) to (III) as a combination of the hot-dip galvanizing and only the heating without performing the hot-dip galvanizing,

(I) only the heating is carried out, and thereafter, the hot-dip galvanizing is carried out;
(II) the hot-dip galvanizing is carried out, and thereafter, only the heating is carried out;
(III) only the heating is carried out, and thereafter, the hot-dip galvanizing is carried

out, and further, only the heating is carried out, in this order,

wherein the Ms point is calculated on the basis of the following formula (iv), wherein brackets [] indicate the content of each element in mass% and Vf indicates the area ratio of ferrite relative to the whole of the metal structure,

$$\text{Ms point (°C)} = 561 - 474 \times [C]/(1 - Vf/100) - 33 \times [Mn] - 17 \times [Ni] - 17 \times [Cr] - 21 \times [Mo] \quad ...(iv)."$$

Dependent claims 2 to 4 relate to specific embodiments.

VI. The arguments put forward by the appellant during the appeal proceedings, where relevant to the present decision, can be summarised as follows.

Claims 5 to 7 of the main request (granted version) did not meet the requirements of Article 123(2) EPC.

The subject-matter of claims 1 and 5 to 7 did not meet the requirements of Article 56 EPC in view of Example M-38 of D2, Example A-6 of D2, the general disclosure of D2 and Example F-17 of D4.

VII. The patent proprietor's (respondent's) arguments at the appeal stage are reflected in the reasons below.

VIII. Oral proceedings were held on 14 January 2025. The parties' final requests were as follows.

IX. The appellant requested that the decision under appeal be set aside and that the patent be revoked.

The respondent requested that the appeal be dismissed. Alternatively, it requested that the patent be maintained in amended form on the basis of one of nine auxiliary requests submitted with the respondent's reply to the grounds of appeal.

Reasons for the Decision

Main request

The main request corresponds to the granted version of the patent.

1. Amendments

For the reasons set out below, the main request meets the requirements of Article 123(2) EPC, as already concluded by the opposition division.

1.1 Claim 5

In the appellant's view, selections from four lists were necessary when selecting:
(i) the decreased upper limit of the hot-rolling rate at a final stand of 20% from paragraph [0061] of the application as originally filed,
(ii) the increased lower limit of the cooling stop temperature T°C of 70°C from paragraph [0071],
(iii) the increased lower limit of the reheating and holding temperature of T+50°C from paragraph [0074],
(iv) the increased minimum holding time during the reheating and holding step of 200 seconds from paragraph [0076].

In the appellant's opinion, in particular the following features were closely interrelated:

- (ii) and (iii), in particular because of the definition of the reheating and holding temperature as a function of the cooling stop temperature T°C,
- (iii) and (iv), in particular because the reheating and holding temperature and the reheating and holding time were parameters of the same step, i.e. the holding step.

The appellant asserted that there was no pointer to this specific combination. Moreover, particularly advantageous Example 39 of the patent no longer fell within the scope of claim 5.

However, this reasoning is not convincing: there is a pointer to this specific combination. Claim 6 of the application as originally filed already comprised ranges for all these parameters in combination, and the respondent chose the most preferred option for each parameter.

There is no obligation to keep an advantageous example within the scope of the claims.

1.2 Claims 6 and 7

1.2.1 The reasoning of point 1.1 also applies to the corresponding amendments in claims 6 and 7.

1.2.2 In the appellant's view, claims 6 and 7 of the main request moreover violated the requirements of Article 123(2) EPC, because the holding time of "200 seconds or more" of paragraph [0076] of the application as originally filed applied to a different embodiment. It

argued that claims 5 to 7 of the main request related to three distinct embodiments, namely:
(i) a method for producing a cold-rolled steel sheet (supported by claim 6 and the passage starting in paragraph [0057] of the application as originally filed)
(ii) a method for producing a hot-dip galvanised steel sheet (supported by claim 7 and the passage starting in paragraph [0082] of the application as originally filed)
(iii) a method for producing a hot-dip galvannealed steel sheet (supported by claim 8 and the passage starting in paragraph [0086] of the application as originally filed)

In the appellant's opinion, paragraph [0076], which discloses the holding time of 200 seconds or more, referred to embodiment (i).

Referring to embodiment (ii), paragraph [0082] of the application as originally filed indicated that "the steps until heating to the temperature region of higher than the cooling stop temperature T°C and 550°C or lower are the same as those of the above-described method for producing a high-strength cold-rolled steel sheet according to the present invention" (emphasis added by the board) and thereby referred back to process steps of embodiment (i).

The appellant argued that this back-reference related only to the process up until reheating and not to the process steps thereafter. In particular, there was no link to the holding time at the reheating temperature of the first embodiment disclosed in paragraph [0076] of the application as originally filed, let alone to the reheating temperature and reheating holding time as amended (see point 1.1 above).

The same applied to the reference to the first embodiment in paragraph [0086] of the application as originally filed, which relates to embodiment (iii).

In this regard, paragraph [0074] of the application as originally filed could not prove that the reheating step also encompassed holding, since the title of paragraph [0074], "[Reheating step]" (in square brackets), had to be ignored in line with the findings of T 1437/07.

The appellant also argued that, as galvanising could expressly occur before or during heating (see "patterns" (II) and (III) in claims 6 and 7), the steps up until and including re-heating and holding in embodiments (ii) and (iii) might simply be the same as those in embodiment (i).

1.2.3 However, this is not convincing. The disclosure of the application as originally filed is directed to the skilled person.

The skilled person understands that the references to the first embodiment in paragraphs [0082] and [0086] relate to the "Reheating step" (see the title of paragraph [0074] of the application as originally filed), which encompasses both reheating and holding, as lines 2 to 4 of this paragraph make clear ("the steel sheet is reheated ... and ... held in this temperature region"). Similarly, reheating and holding are addressed in the same process step in claims 6 to 8 of the application as originally filed ("heating and holding the steel ...").

There is no reason to believe that the reheating and holding step of the second and third embodiment differs from the first embodiment in aspects other than the additional "hot-dip galvanizing" and/or "alloying treatment".

The skilled person therefore understands that the reference to the first embodiment also applies to the preferred reheating temperature and reheating holding time.

T 1437/07 (see in particular Reasons 3.1 and 3.2) confirms that a heading within the description (such as the heading of paragraph [0074] of the application as originally filed in the case at hand) can be considered as a basis when amending a claim. This is not the case for the title of the application. The use of square brackets in the heading of paragraph [0074] of the application as originally filed is no reason for ignoring the heading either.

Paragraphs [0082] to [0084] and [0086] of the application as originally filed make clear that the steps up until heating and holding are the same for the different embodiments, but that a galvanising step has to be included for embodiments (i) and (ii), according to patterns (I) to (III).

1.2.4 Compared with claims 7 and 8 of the application as originally filed, the step "heating and holding" was relabelled as "a reheating of heating and holding" in claims 6 and 7. Moreover, the "three patterns of (I) to (III)" of paragraph [0084] of the application as originally filed were inserted into claims 6 and 7.

The appellant also argued that there was no basis in the application as originally filed for considering that reheating encompassed both heating and holding. Claims 6 and 7 violated the requirements of Article 123(2) EPC because the "patterns" also related to reheating holding and not only to reheating.

However, even if paragraph [0075] of the application as originally filed indicates that "reheating" means "raising the temperature", reference is again drawn to paragraph [0074] of the application as originally filed and its title (see point 1.2.2), which subsume reheating and holding under "Reheating step".

2. Inventive step (Article 56 EPC)

For the reasons set out below, the main request meets the requirements of Article 56 EPC, as already concluded by the opposition division.

2.1 Preliminary remarks

The patent in suit contains 41 examples to show the influence of various parameters and to prove that the claimed subject-matter successfully solves the problem posed. By contrast, the appellant did not carry out any experiments of its own.

As will be shown below, the appellant raised a significant number of inventive-step objections starting from different prior-art embodiments. The appellant tried to indirectly deduce the effect related to the respective distinguishing feature. That is to say that for a given embodiment chosen as closest prior art, the appellant alleged that the effect related to the respective distinguishing feature had to be the same as that shown in a different context for *another* steel sheet.

However, in the specific context of the case at hand, this approach is speculative, as the effect related to a distinguishing feature is hardly predictable without carrying out experiments. This is because the effect generally depends on multiple factors, such as the composition of the steel sheet and/or the method steps for its preparation.

In the case at hand, the appellant has not cast sufficient doubt to reverse the finding, based on numerous examples in the patent in suit, that the distinguishing features justify an inventive step.

2.2 Subject-matter of product claim 1 in view of Example M-38 of D2

2.2.1 The invention relates to a high-strength cold-rolled steel sheet.

2.2.2 Example M-38 of D2 (see Table) also relates to a high-strength cold-rolled steel sheet (paragraph [0001]).

It is undisputed that Example M-38 has a chemical composition in the claimed range (see Table 1).

The product tensile strength TS x elongation EL of Example M-38, which is a measure of the compromise between strength and ductility, is in the claimed range (see Table 5 of D2).

On the other hand, hole expansion ratio λ and bending angle VDA are not disclosed in D2, and therefore the values of TS x λ (measure of stretch-flangeability) and TS x VDA (measure of crashworthiness) of Example M-38 of D2 are unknown.

Moreover, this example has a ferrite area ratio of only 5% (Table 5), which is below the claimed range and is only given on a volume basis.

2.2.3 According to the patent in suit, the problem to be solved is the provision of a high-strength steel sheet with improved stretch-flangeability and crashworthiness (paragraphs [0009] and [0017] of the patent).

2.2.4 It is suggested that this problem be solved by means of the steel sheet of claim 1 characterised by a ferrite area ratio of 10% to 65%.

Since an inventive step can in any case be acknowledged (as will be shown below), it can be left open whether the "Maximum MA size" of Example M-38 of 2 µm (Table 5) anticipates the claimed "average circle-equivalent diameter" of 2.0 µm or less once rounding conventions are taken into account.

2.2.5 The appellant disputed that the ferrite area ratio had an influence on the values of TS x λ (a measure of stretch-flangeability) and TS x VDA (a measure of crashworthiness), and referred to Examples 34 and 7 of the patent in suit. These examples had a ferrite area fraction below the claimed range (Table 3-1) but nonetheless favourable values of TS x λ and TS x VDA. The appellant also argued that a comparison of the patent in suit with **D7** proved the absence of an effect.

However, for the reasons set out below, these arguments are not convincing.

(a) Experiment 34 of the patent in suit is not relevant since it is based on alloy "R", which has an Si content of 0.55%, below the range of claim 1 (see Tables 1 and 2-1).

(b) As far as comparative Example 7 of the patent in suit is concerned, its ferrite area ratio and TS x EL (Table 3-1: 12810 MPa·%) are below the ranges of claim 1. While the value of the product TS x VDA (105042 MPa·°) - representing the compromise between strength and crashworthiness - is within the claimed range, the VDA value of 82° - a measure of crashworthiness - is relatively low. A closer look shows that this is only compensated by a relatively high TS of 1281 MPa so that the product TS x VDA is sufficiently high.

Consequently, Example 7 cannot prove the absence of a negative influence of a low ferrite area ratio on the VDA bending angle and thus on crashworthiness, and does not justify the view that the desired effect is not present.

(c) **D7** requires the same steel composition ranges as the patent in suit but a lower ferrite area ratio range (claim 1). According to paragraphs [0078] to [0080] of D7, which form part of the general disclosure, following the teaching of D7 results in:
- an increased TS x λ range
- the same TS x VDA range
when compared to the respective ranges of claim 1 of the patent in suit.

The appellant deduced from this that the insufficiently high ferrite area ratio of Example M-38 of D2 should, by analogy, result in values of TS x λ and TS x VDA that still fell within the ranges of claim 1 of the patent in suit.

This is not persuasive, the question of the admission of **D7** notwithstanding. Properties of a steel sheet in this technical field are a consequence of both its composition and the operating parameters applied during the process of its manufacture. As these operating parameters are not the same, alleging that modifying the ferrite area ratio in Example M-38 must have the same consequence as that shown by a comparison of the patent in suit and D7 is speculative.

Thus, paragraphs [0048] and [0049] of the patent in suit indicate that stretch-flangeability and crashworthiness also depend on the claimed hot-rolling conditions. However, the hot-rolling "end temperature" of 920°C in D2 (paragraph [0107]) is higher than that used in the patent in suit of between the Ar_3 point and 900°C (see for example claim 5 of the patent in suit). Moreover, while claim 5 requires a hot-rolling rate at a final stand between 5% and 20%, D2 is silent on this feature. Under these circumstances, it cannot be concluded that Example M-38 of D2 necessarily has values of TS x λ and TS x VDA in the ranges of claim 1 of the patent in suit.

These findings are not altered by either of the following.

- Paragraph [0021] of the patent in suit (in the paragraph bridging pages 5 and 6) only mentions the influence of the ferrite area ratio on ductility, since this passage does not indicate that the ferrite area fraction has no influence on stretch-flangeability and crashworthiness.

- The patent in suit indicates, for example in paragraph [0021] (page 6, lines 45 to 46), that low stretch-flangeability and crashworthiness are a consequence of a coarser particle size of the MA structure, since nowhere in the patent in suit is it stated that the stretch-flangeability and crashworthiness are exclusively a consequence of the particle size of the MA structure.

Thus, there is no evidence that the problem has not been successfully solved.

2.2.6 Starting from Example M-38 of D2, there is thus nothing to suggest that increasing the ferrite ratio could improve stretch-flangeability and crashworthiness, either in D2 itself or in **D8/D8a**, **D9** and **D10/D10a** (the question of the admission of D8, D9 and D10/D10a notwithstanding).

The subject-matter of claim 1 therefore involves an inventive step over Example M-38 of D2 even when combined with D8, D9 or D10.

2.3 Subject-matter of product claim 1 in view of Example A-6 of D2

The appellant considered Example A-6 of D2 to be an alternative closest prior art.

While the product TS x EL is in the claimed range (see Table 4), D2 does not indicate values for TS x λ or TS x VDA in Example A-6.

The ferrite ratio is in the claimed range (Table 4). Since the ferrite volume fraction of D2 is determined from the area fraction (see paragraphs [0116] and [0117]), there is no difference in the case in hand between a ferrite *area* fraction (claim 1 of the patent in suit) and a ferrite *volume* fraction (Table 4 of D2).

However, the area ratio V_{MA} of the MA structure and the ratio V_{MA}/V_{γ} of Example A-6 are too low (Table 4). This has not been disputed.

As regards the effect related to these distinguishing features, paragraphs [0021] and [0022] of the patent in suit explain that area fraction ratio V_{MA} and ratio V_{MA}/V_{γ} are important for ductility and crashworthiness.

The appellant argued that Example 10 of the patent in suit was the only example with an insufficiently high area ratio V_{MA} and ratio V_{MA}/V_{γ} (see Table 3-1). While the compromises between
- strength and stretch-flangeability (TS x λ), and
- strength and crashworthiness (TS x VDA)
achieved in this example were already sufficient (as shown by values in the claimed ranges), this was not the case for the compromise between strength and ductility (insufficiently high TS x EL). Hence, the only possible effect related to the claimed ranges of V_{MA} and the ratio V_{MA}/V_{γ} was to provide an improved compromise between strength and ductility. However, as the product TS x EL of Example A-6 of D2 was already in the range of claim 1 (see Table 4 of D2), the problem to be solved might be merely the provision of an alternative.

This is not convincing. As already explained in relation to Example M-38 of D2, the hot-rolling conditions of the examples of D2 are different from those of the patent in suit. As the hot-rolling parameters have an influence on stretch-flangeability and crashworthiness (see for example paragraphs [0048] and [0049] of the patent in suit), there is no proof that the products TS x λ and TS x VDA of Example A-6 are in the claimed ranges. Example 10 of the patent in suit also shows a lower ductility, and there is no evidence that the ductility of Example A-6 of D2 would not even be higher if V_{MA} and the ratio V_{MA}/V_Y were in the claimed ranges. There is thus no reason to believe that the problem of the provision of a steel sheet having improved ductility is not solved.

The appellant argued that in this event, when trying to improve the ductility of Example A-6, the skilled person would consider paragraph [0031] of D2 and find a hint there that a V_{MA} of 3% or more could increase ductility.

This is not convincing, however. When trying to solve the problem, the skilled person would start directly from an example of D2 that has a higher ductility (such as M-38). Hence, the skilled person would not increase the V_{MA} of Example A-6.

Consequently, the subject-matter of claim 1 also involves an inventive step over Example A-6 of D2.

2.4 Subject-matter of method claims 5 to 7 in view of Examples M-38 and A-6 of D2

The appellant acknowledged that Examples M-38 and A-6 of D2 did not disclose:

- the claimed hot-rolling rate at a final stand (D2 discloses only an overall rolling rate) in paragraph [0107]
- the claimed hot-rolling end temperature (D2 discloses 920°C in paragraph [0107])
- the claimed heating rate during annealing

The appellant argued that the hot-rolling conditions and the heating rate during annealing only had an *indirect* influence on ductility, stretch-flangeability and crashworthiness, namely *via* the small average circle-equivalent diameter of the MA structure. The appellant pointed to paragraphs [0048], [0049] and [0053] of the patent in suit in this regard. However, Examples M-38 and A-6 also had small particle sizes of this kind (Tables 4 and 5 of D2).

The appellant also argued that the cooling stop temperature T°C could be as high as the Ms point but that by definition no martensite was formed at this temperature, and that the resulting MA structure would become coarse according to paragraph [0060] of the patent in suit.

For these reasons, in the appellant's opinion the problem to be solved was merely the provision of an alternative.

However, Examples 3, 4 and 5 of the patent in suit show that hot-rolling conditions outside the claimed ranges (see Table 2-1) result in insufficient stretch-flangeability (see the values of TS x λ in Table 3-1). While these examples also yielded MA particles that were too large, this is not sufficient evidence that insufficient stretch-flangeability *only* occurs if the MA particle size is too large. The appellant has provided no experimental evidence of its own in this regard.

As regards the claimed range of the cooling stop temperature T°C, even if the desired effect was not achieved at a particular T°C at the limit of scope of the claim, namely at the Ms point, this does not alter the fact that the specification contains sufficient information to allow a large number of conceivable working alternatives to be found in which the desired MA structure is formed (see the catchword of T 629/22).

There is hence no reason to doubt that the problem posed has been successfully solved.

In the absence of any hint in the available prior art (in particular **D4**, **D5**, **D8**, **D11** and **D12/D12a**, the question of the admission of D11 and D12/D12a notwithstanding) that the problem could be solved in the claimed manner, the subject-matter of claims 5 to 7 involves an inventive step over Examples M-38 and A-6 of D2.

2.5 The general disclosure of D2 discloses numerous ranges that overlap with those of the claims. This has not been disputed by the appellant.

Hence, the general disclosure of D2 is considered to be more remote from the claimed subject-matter than Examples M-38 and A-6.

2.6 Subject-matter of product claim 1 and of method claims 5 to 7 in view of Example F-17 of D4

A similar reasoning applies to Example F-17 of D4, which undisputedly fails to disclose at least the claimed hot-rolling rate at a final stand (D4 is silent on this point).

While Example F-17 of D4 discloses TS x EL and TS x λ in the claimed ranges (Table 3), a value for TS x VDA (crashworthiness) is not disclosed.

Moreover, there is no evidence on file that the particle size of the MA structure of Example F-17 of D4 really equals that of the retained austenite (the latter being 1.6 µm according to Table 3 of D4) as the appellant alleged, even if martensite is formed from retained austenite.

Even if the appellant's deduction of the area ratio V_{MA} of the MA structure of Example F-17 of D4 from the amounts of martensite and of retained austenite (see page 54 of the grounds of appeal and Table 3 of D4) were correct, the resulting range of ratio V_{MA}/V_{Y} would only overlap with that of claim 1.

The appellant pointed to Examples 4 and 5 of the patent (see Tables 2-1 and 3-1) to conclude that a decrease in crashworthiness (TS x VDA bending angle) in cases where the final stand rolling rate was outside the claimed range was *necessarily* accompanied by a decrease in stretch-flangeability (TS x λ): it asserted that, as the stretch-flangeability of Example F-17 of D4 was in the claimed range, the invention could not lead to greater crashworthiness.

However, such a general conclusion is speculative and not convincing. In fact, the appellant has provided no experimental evidence of its own to prove that the crashworthiness of the invention (in particular with hot-rolling conditions and a particle size of the MA structure in the claimed ranges) is not greater than that of Example F-17 of D4 (see also the reasoning under point 2.4 above).

There is thus no reason to doubt that the problem has been successfully solved.

The appellant argued that a combination with **D5/D5a** rendered the object of claims 1 and 5 to 7 obvious, but there is no hint in D5/D5a (see in particular paragraphs [0006] and [0095]) that the claimed hot-rolling rate could improve crashworthiness.

The same holds true for **D11** and **D12/D12a** (the question of the admission of these documents notwithstanding). With regard to D11, the appellant alleged that Example 4B and paragraphs [0021], [0064] and [0065] provided a hint. However, D11 only discloses an "*accumulative* rolling reduction ratio", not the claimed "rolling rate at the final stand of finish rolling" (see paragraph [0106]).

In the absence of any hint in the available prior art that the problem posed could be solved in the claimed manner, the subject-matter of claims 1 and 5 to 7 thus also involves an inventive step over Example F-17 of D4.

2.7 The same reasoning also applies to dependent claims 2 to 4.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

C. Vodz E. Bendl

Decision electronically authenticated