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D E C I S I O N
of 14 February 2001

Case Number: T 0350/97 - 3.2.2

Application Number: 89313663.0

Publication Number: 0376733

IPC: C21D 8/04

Language of the proceedings: EN

Title of invention:
Method of manufacturing steel sheet having excellent deep-drawability

Patentee:
KAWASAKI STEEL CORPORATION

Opponent:
HOOGOVENS STAAL BV

Headword:
-

Relevant legal provisions:
EPC Art. 52(1), 56

Keyword:
"Novelty (yes) - after amendment"
"Inventive step (yes)"

Decisions cited:
-

Catchword:
-

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Case Number: T 0350/97 - 3.2.2

D E C I S I O N
of the Technical Board of Appeal 3.2.2
of 14 February 2001

Appellant: (Proprietor of the patent)
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Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted 18 February 1997 revoking European patent No. 0 376 733 pursuant to Article 102(1) EPC.**

Composition of the Board:

Chairman: W. D. Weiß
Members: S. S. Chowdhury
J. C. M. De Preter

Summary of Facts and Submissions

I. The Appellant (patent proprietor: Kawasaki Steel Corporation) lodged an appeal against the decision of the opposition division to revoke European patent No. 0 376 733. The decision was dispatched on 18 February 1997.

The appeal and the fee for the appeal were received on 27 March 1997 and 10 April 1997, respectively. The statement setting out the grounds of appeal were received on 11 June 1997.

The opposition was filed against the whole patent and was based on Article 100(a) EPC (lack of novelty and inventive step).

The opposition division had found that, starting from the document D6, the subject-matter of claims 1 to 6 did not involve an inventive step.

Only the following prior art documents among those regarded as relevant by the opposition division have been considered further during the appeal proceedings:

D2.3: Conference on Physical Metallurgy of Thermomechanical Processing of Steel and other Metals, THERMEC 88, 6 to 10 June 1988, Keidanren Kaikan, Tokyo, "Effects of hot rolling conditions on r-value of hot rolled and annealed extra low carbon steels", Hashimoto et al, pages 652 to 659

D6: Texture Formation of Ti-added Extra Low Carbon Sheet Steels Hot-rolled below Ar_3 Transformation Temperature, T. Senuma, et al., JISI publication, 1987, pages 156 to 163

D6a: Translation of the document D6 into English.

Oral proceedings before the Board took place on 14 February 2001, at which only the Appellant was represented. The Respondent (opponent) was not represented as stated in its letter dated 15 January 2001.

II. Requests

At the end of the oral proceedings the Appellant requested that the decision under appeal be set aside and that the patent be maintained on the basis of the following documents presented during the oral proceedings held before the Board on 14 February 2001:

Claims: 1 to 8

Description: pages 3 to 16 with insertion page 4a to page 4

Figures: 1 to 5.

In its letter dated 15 January 2001, the Respondent requested that the appeal be dismissed.

III. Claim 1 reads as follows:

"A method of manufacturing a steel sheet having excellent deep-drawability, the method including the step of rolling a steel sheet of known thickness such that the rolling reduction at temperatures below the Ar_3 transformation point is not less than 60%, the rolling including at least one pass in which the rolling is conducted at a temperature of from not less than 500°C to less than the Ar_3 transformation point and in which

the relationship between the known thickness of the steel sheet before rolling t (mm), the roll radius R (mm) and the coefficient of friction μ satisfy the following conditions:

$R \leq 180$,

$R^2\sqrt{t} \leq 80000$, and

$\mu \leq - 0.2 \log (R/t) + 0.55$,

wherein the steel sheet contains:
not more than 0.008% by weight C,
not more than 0.5% by weight Si,
not more than 1.0% by weight Mn,
not more than 0. 15% by weight P,
not more than 0.02% by weight S,
not more than 0.008% by weight N,
not less than 0.010 to not more than 0.10% by weight Al,
at least one of Ti and Nb in an amount satisfying the relationship, $1.2 (C/12 + N/14) \leq (Ti/48 + Nb/93)$,

and optionally from not less than 0.0001 to not more 0.0020% by weight B and from not less than 0.001 to not more 0.020% by weight Sb, the balance being iron and incidental impurities".

Claims 2 to 8 are dependent on claim 1.

IV. The Appellant presented the following arguments:

Novelty: The document D2.3 had three different parts, relating respectively to Figures 1, 2, and 4 and the respective accompanying descriptions, that could not be combined since they related to different conditions. Thus, section 2.2 and Figure 1 specified the steel composition, rolling temperature, and reduction rate,

but not the roll radius or the sheet thickness. Section 3.1 discussed the effect of lubrication on the r-value and referred to rolling condition (1) of section 2.2 but did not give the roll radius. Figure 4 and the paragraph linking pages 654 and 655 gave a roll radius of 150 mm but did not mention the other conditions of claim 1.

The conditions given in these three parts of the document were quite different to each other so it was not possible to read values from one part onto another. For example, the rolling velocity was given as 0.31 m/s in Figure 4 and the hot rolling reduction as 40%, while the corresponding values were 20 m/s and 73% in section 2.2.

Therefore, no single experiment described in document D2.3 was novelty destroying for the method of claim 1.

Inventive step: The documents D6 and D2.3 taught that the r-value could be improved by providing lubrication, they did not recognise that the roll radius or the parameter $R^2\sqrt{t}$ affected the r-value. On the other hand the patent in suit made available this teaching for the first time, so that the rolling reduction could now be done without lubricant, which could cause slippage of the sheets and consequent operational difficulties.

V. The Respondent, in its written submissions, presented the following arguments:

Documents D2.3 and D6 were novelty destroying for original claims 1 to 4. Document D2.3 was novelty destroying for claim 1 since it disclosed the steel composition as well as the processing conditions of claim 1, in particular $R \leq 180$ and $R^2\sqrt{t} \leq 80000$. A roll diameter of 300 mm was disclosed in Figure 4.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments*

The amendments to claim 1 involve the change of the relationships $R \leq 200$ and $R^2\sqrt{t} \leq 100000$, in granted claim 1, to $R \leq 180$ and $R^2\sqrt{t} \leq 80000$, respectively.

There is explicit support for the amendment $R \leq 180$ on page 4, line 8 and in Figure 1 of EP-A-0 376 733. There is no specific support for the amendment $R^2\sqrt{t} \leq 80000$ in the description, but this feature is supported by Figure 2 of the patent. Since Figure 2 is a graph, it is a scale representation of the results depicted, so readings may be taken from it. The figure of 80,000 for the parameter $R^2\sqrt{t}$ corresponds to one particular point on the graph, the third point, at which the r-value falls rapidly, and the error in reading this figure off the graph is within the range of a few percent. The closest prior art figure for this parameter is 84,852 (see point 4.4. below), which is outside the error range, and there is no other prior art that could render the determination of the exact value of the parameter critical. Therefore, this amendment is allowable.

Since the above amendments are supported by the original disclosure, and they narrow the scope of claim 1, they are allowable under Article 123(2)(3) EPC.

The description and drawing have been revised for consistency with the new claims.

Therefore, all the amendments are allowable.

3. *Novelty*

Only the document D2.3 is alleged by the respondent to anticipate the method of claim 1. The question of novelty hinges on whether the document D2.3 discloses a roll radius of 150 mm together with the other process parameters defined in claim 1 of the patent in suit, or whether it discloses this radius only in connection with a rolling reduction of 40%, which lies outside the range defined in the claim.

The document D2.3 presents the results of a study of the effects of hot rolling conditions on r-value of annealed extra low carbon steels. It concludes that a steel sheet having excellent deep-drawability (or high r-value) could be obtained during hot rolling when the following conditions were fulfilled: (1) Good lubrication during hot rolling; (2) Finishing hot rolling in the non-recrystallisation ferrite region; and (3) Minimising the solute carbon content during hot rolling (see the synopsis).

This document has different sections of which the section "2-1 Materials" describes the chemical compositions of the steels used, and Table 1 lists steels A to G, all of which except A have the composition defined in claim 1 of the patent in suit.

The section "2-2 Experimental procedure" describes, with reference to figure 1, hot rolling conditions (1) and (2), and discloses a rolling reduction at temperatures below the Ar_3 transformation point of 73%, the rolling including at least one pass in which the rolling is conducted at a temperature of from not less than 500°C to less than the Ar_3 transformation point. The coefficient of friction μ was kept low by the use of tallow as a lubricant. This section discloses all

the steps and parameters of claim 1 save that it is silent about the roll radius and, therefore, as to whether the inequalities in claim 1, involving the roll radius, are satisfied.

The section "3-1, Effect of lubrication condition on r-value", describes studies of the lubrication condition on r-value using steel sheet hot rolled at 700°C in the rolling condition (1). According to these studies, the r-value is increased as a result of reducing the load exerted by the roll on the surface of the strip being hot rolled (see Figure 2), by changing the thickness of the lubricant used in the hot strip mill. It is concluded that these changes are the consequence of textural changes through the thickness direction (page 654, first complete paragraph), which in turn, are due to non-uniform deformation during hot rolling. This effect is illustrated in Figure 4 in which, in a separate test, the flection of a stainless wire inserted along thickness direction of the strip is assessed after a hot rolling step (see the last paragraph on page 654). According to the legend of Figure 4 the hot rolling step was performed using a roll having a radius of 150 mm and effecting a reduction of 40%.

Following the detailed analysis above, the process disclosed in section 2-2 of document D2.3 would anticipate the claimed method only if it could be deduced that it was performed on a rolling mill having the same roll radius as the one used to perform the "inserted wire"-test the results of which are depicted in Figure 4 and which, according to its legend, uses a roll having a radius of 150 mm.

A comparison of the rolling velocities, used in these two tests, however, suggests that this cannot be the case. The "inserted wire"-test, was run in one pass only at a velocity of 0.31 m/s suggesting that this test was performed in the laboratory, whereas the "effect of lubrication condition on r-value"-test was done in up to four passes at a velocity of 20 m/s (see section "2-2 Experimental procedure") approximating the normal production velocity in an industrial plant.

Hence, the experimental conditions used in the tests to obtain the results presented in Figures 2 and 4, respectively, are quite different. Therefore, the roll radius used in the former test is not known, but may be assumed to be that normally used in production hot-rolling mills, i.e. in the order of 350 mm.

Therefore, no single experiment described in this document discloses all the process steps and parameters of claim 1, and the claimed method is novel.

4. *Inventive step*

4.1 The present patent relates to a method of manufacturing hot-rolled steel sheets having excellent deep-drawability which may be used in manufacturing automobile bodies. Such steel sheets are required to have high Lankford values (r-values) ≥ 1.4.

The prior art reviewed on page 3 of the patent specification describes methods of manufacturing hot-rolled steel sheets having high r-values, but which involve the steps of hot rolling followed by cold rolling to the final thickness, and annealing. These methods are disadvantageous since they entail high production costs and the steel suffers from cold-working embrittlement.

Documents D2.3 and D6/6a both aim at providing a method of obtaining a steel sheet suitable for use in deep drawing which possesses a high r-value of ≥ 1.4, when hot rolled, thus avoiding the disadvantages of the prior methods which included a cold working step. For this purpose these known methods, like the patent in suit, start from a Ti/Nb microalloyed extra low carbon steel (see Table 1 of these documents) and perform the hot rolling process in the ferrite region below the Ar_3 transformation point in a manner to attain a recrystallization texture with a comparatively uniform <111> main crystal orientation formed through the thickness from the surface to the midplane of the steel sheet. According to the state of the art documents D2.3 and D6, this structure is achieved by improving the lubrication condition, e.g. tallow is used in the hot strip mill thus reducing the coefficient of friction (see the synopsis of these documents).

The documents D2.3 and D6 are equivalent and either may serve as the closest prior art document, since they both, like the patent in suit, perform the hot rolling process in the ferrite region below the Ar_3 transformation point in a manner to attain a recrystallization texture with a comparatively uniform <111> main crystal orientation formed through the thickness from the surface to the midplane of the steel sheet, and avoid the cold working step.

4.2 The patent in suit, according to the features of Claim 1, solves the same problem by employing a previously unknown teaching: to reduce the roll radius R to 180 mm or less and simultaneously maintaining the inequalities $R^2\sqrt{t} \leq 80000$ and $\mu \leq - 0.2 \log (R/t) + 0.55$.

These measures allow for a marked increase of the r-value of the steel sheet to be attained whether or not lubricant is provided, as long as the specific operating parameters are adhered to. This may be ascertained from Figures 1 and 2 of the patent in suit, that show a dramatic change in the r-value at the claimed values of R and $R^2\sqrt{t}$ in the case where the final rolling was effected without using a lubricant. The use of lubricant is unsatisfactory owing to the risk of slippage, which could lead to failure of proper rolling and bunching of sheets between rolls.

Document D2.3 (see Figure 2) shows that the best r-value attainable without using lubricant was 1.3, and Document D6 gives an r-value of 1.038 when no lubricant was used (see Table 2). The patent in suit, on the other hand, shows that r-values up to 2.0 may be attained without the use of lubricant (see Tables 2 to 4) if the conditions set out in claim 1 are complied with.

4.3 Neither document D6 nor D2.3 teaches, in connection with the other hot rolling conditions, the measure to reduce the roll radius below the radius normal for conventional hot rolling mills nor does it give any hint that such a choice of the roll radius could have an effect on the deep-drawability of the hot rolled steel sheet. No other prior art document provides an insight into the relationship between the parameters roll radius R, $R^2\sqrt{t}$, and the r-value.

On the contrary, the prior art has consistently taught that the use of lubricant was indispensable for attaining good r-values in steels that are hot rolled. This situation is reviewed in the introductory

paragraphs on page 3 of the patent in suit and is also discussed in document D2.3 (synopsis) and D6a (page 9, paragraph 4)). The patent in suit departs from this and provides a new teaching, that proper selection of the roll radius is an alternative to the use of lubricant.

Therefore, claim 1 of the patent in suit involves an inventive step.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside

2. and the case is remitted to the first instance with the order to maintain the patent in amended form with the following documents submitted at the oral proceedings:

Claims: 1 to 8

Description: pages 3 to 16 with insertion page 4a to page 4

Figures: 1 to 5

The Registrar

V. Commare

The Chairman

W. D. Weiß