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D E C I S I O N
of 29 October 1996

Case Number: T 0700/94 - 3.2.1

Application Number: 85301178.1

Publication Number: 0152849

IPC: B21B 31/18, B21B 13/14

Language of the proceedings: EN

Title of invention:
Hot rolling method

Patentee:
Kawasaki Steel Corporation

Opponent:
Mannesmann AG

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (yes)"

Decisions cited:
-

Catchword:
-

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Case Number: T 0700/94 - 3.2.1

D E C I S I O N
of the Technical Board of Appeal 3.2.1
of 29 October 1996

Appellant: (Opponent)
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Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted 5 July 1994 rejecting the opposition filed against European patent No. 0 153 849 pursuant to Article 102(2) EPC.**

Composition of the Board:

Chairman: F. A. Gumbel
Members: P. Alting van Geusau
J. van Moer

Summary of Facts and Submissions

I. European Patent No. 0 153 849 was granted on 15 January 1992 on the basis of European patent application No. 85 301 178.1 which was filed on 22 February 1985.

Claim 1 of the patent reads as follows:

"1. A hot rolling method using a hot finishing mill including a pair of axially adjustable work rolls (1') each having a tapered portion (4') at one end of its barrel (4) and arranged one above the other with the tapered portions (4') being on opposite sides of the rolling path and being so axially adjustable as to locate each edge of strip material (3) to be rolled in a roll gap zone determined by the respective tapered portion (4') of one of the work rolls characterised in that, during the course of rolling a sequence of discrete lengths of strip material, each of substantially the same width, in the interval between succeeding lengths said work rolls (1') are cyclically axially displaced relative to each other within a range of displacement such that said edges of the material remain within the roll gap zone delimited by said tapered portions thereby preventing edge build-ups of the material, whereby the upper limit of the cyclical values of the distance (E_L) from an edge of the material to the transition point between said tapered portion of the work roll nearest to said edge of the material and the central portion of the roll is set so as to decrease as the thermal expansion of the work rolls increases."

II. Notices of opposition were filed on 14 October 1992 by the appellant (opponent 02) and by the former opponent 01 on the grounds of Article 100(a) EPC. In respect of an alleged lack of novelty and inventive step the oppositions were supported by

D1: DE-C-200 426
D2: JP-A-55-77 903
D3: DE-C-955 131
D4: EP-A-0 086 934
D5: Hitachi Review Vol 28 (1979), No. 5 "Crown and Shape Control of Hot Strip by 6-High Mill (HC-Mill)", pp 223 to 226
D6: EP-A-0 112 969
D7: EP-A-0 049 789

III. By a decision which was given at the end of oral proceedings held on 21 June 1994 and posted in writing on 5 July 1994 the Opposition Division rejected the oppositions.

The Opposition Division held that the subject-matter of the granted claim 1 was novel and, since none of the cited documents disclosed or suggested that the work rolls should be cyclically axially displaced with decreasing amplitude with increasing thermal expansion of the rolls, the subject-matter of claim 1 was considered to be based on an inventive activity.

IV. On 29 and 30 August 1994, respectively, notices of appeal against the above decision were filed by both opponents together with payment of the appeal fee. The statements of grounds of appeal were filed on 28 October and 2 November 1994, respectively.

With the statement of grounds of appeal, the opponent 02 (appellant) filed a translation of D2 in the German language and further cited:

D8: Kawasaki Steel Technical Report No.1, September 1980, Pages 60 to 69.

V. With telecopy dated 10 June 1996 opponent 01 withdrew its appeal.

VI. Oral proceedings were held on 29 October 1996.

The appellant requested that the decision under appeal be set aside and that the European patent No. 0 153 849 be revoked.

The respondent (patent proprietor) requested that the appeal be dismissed and that the patent be maintained, as a main request, in its granted form and, as an auxiliary request, on the basis of claims 1 to 4 filed with a letter dated 18 September 1996.

V. In support of its request the appellant relied essentially on the following submissions:

D2, which was considered the closest prior art, disclosed in addition to the precharacterising features of claim 1 a strip crown control method in which conically ended work rolls of the rolling mill were axially shifted. Such shifting was apparent from Table 1 on page 15 of D2.

Furthermore, there was explicitly stated in the last two paragraphs of point 3 of the description (page 7 of the translation of D2) that the method disclosed in D2 was very effective, at the same time, for crown control and reduction of edge drop of the rolled strip as well as for achieving equalised wear of the work rolls.

D8 showed the background knowledge of the skilled person when considering roll wear, edge-drop and thermal crown and, in particular disclosed the interrelation of growth of wear and thermal crown.

D1 already suggested a cyclical shifting of work rolls in order to level out the wear of areas of the work rolls.

Therefore, when starting from the method known from D2 the skilled person had sufficient information available to achieve edge- and crown control as well as compensation of wear at the same time by appropriately shifting the work rolls. Moreover, in view of the fact that the same objects of compensating the effects of roll wear, crown building and edge-drop as mentioned in the patent in suit were addressed in D2, the skilled person being well aware of the growth of roll thermal crown and wear during rolling would try also to compensate these deviations from the ideal rolling gap by a suitable axial shifting pattern of the work rolls and could, with his background knowledge, immediately arrive at the method of claim 1 of the patent in suit. Therefore the method according to claim 1 of the patent was arrived at in an obvious manner when taking into account the relevant prior art and thus the patent should be revoked for lack of an inventive step as required by Article 56 EPC.

VI. The respondent disputed the appellants findings and arguments and argued substantially as follows:

Indeed D2 represented the closest prior art. However, neither a disclosure nor suggestion was given in this document to cyclically shifting of the work rolls in the manner as claimed in the patent in suit. The shift values given in Table I on page 15 merely showed examples of work roll settings without any indication of a particular sequence to be followed during the rolling process of distinct lengths of strip.

Furthermore no relation whatsoever between the thermal crown formation and the amount of shifting was derivable from D2 or any other cited document. D8 in fact related to various experiments carried out by the respondent. This document indicated that thermal crown could be controlled by changing the reduction distribution in subsequent roll mill stands. As regards roll wear no particular suggestion for its reduction was given or suggested in this document.

D1 addressed the problem of non-uniform roll wear and proposed shifting of the work rolls so as to use the entire length of the rolls. Also here there was no suggestion to cyclically shift the work rolls in a manner as claimed to avoid edge build up and to compensate the effects of thermal crown at the same time.

Reasons for the Decision

1. The appeal is admissible.

2. *Novelty*

Novelty of the subject-matter of claim 1 of the patent as granted follows from the fact that none of the cited prior art documents discloses a hot rolling method

using a hot finishing mill including a pair of axially adjustable work rolls with tapered ends in which during the course of rolling a sequence of discrete lengths of strip material with substantially the same width the work rolls are cyclically axially displaced relative to each other within a range of displacement which is variably set so as to decrease as the thermal expansion of the work rolls increases. In particular none of the cited prior art documents discloses shifting of work rolls in relation to their formation of thermal crown.

Novelty was, in fact, not contested during the appeal proceedings.

3. *Inventive step*

3.1 The Board concurs with the parties that the closest prior art is represented by D2. This document discloses a rolling method in accordance with the precharacterising part of claim 1 of the patent in suit.

3.2 The taper end rolling method known from D2 is effective to prevent edge drops and is adaptable to various width of strip material. However, as the number of rolled strips having the same width increases during hot finish rolling, the work rolls progressively wear to form tracks or traces whose edge portions usually wear deeper than the centre portions and such deficiency gives rise to the phenomenon of edge build-up in the strips to be rolled.

Furthermore, during the rolling process the work rolls heat up, which leads to thermal crown formation on the work rolls and consequential deficiencies of the strip profile.

The object of the present patent can be seen in the provision of a hot-rolling method in which these deficiencies of the strip profile are avoided (see also the description of the patent, page 2, lines 26 to 32).

3.3 This object is achieved by the features of claim 1 in that the cyclical shifting of the work rolls defined in this claim enables both equalisation of local wear on the tapered ends of the work rolls and compensation of the thermal expansion of the work rolls during rolling. The method of claim 1 thus effectively suppresses edge build-up on rolled strips without detrimentally affecting the crowns of the strips so as to eliminate the disadvantages in conventional roll-change-free rolling.

3.4 The appellant was of the opinion that D2 also disclosed cyclical axial displacement of the work rolls in the interval between rolling of succeeding lengths of strip material and in this respect relied on Table 1 and the explanations given in D2 on pages 6 and 7 of the German translation.

The Board cannot follow this interpretation of the technical content of D2.

Indeed in Table 1 various values for the distance E_L, which is the distance from an edge of the strip material to the transition point between the tapered portion of the work roll nearest to the material and the central portion of the roll, are given. Their influence on the strip profile is shown in Figure 4 of D2.

However, neither a disclosure nor suggestion is derivable from these examples that the work rolls are shifted in a cyclical manner, thus in a particular sequence, so as to prevent edge build-up due to

increased wear on the tapered ends of the work rolls, or that the amplitude of shifting should be decreased in accordance with the increasing thermal expansion of the work rolls. On the contrary, in D2 is stated that the strip profile is best at the higher values of E_H (amount of tapering) and E_L (protrusion length of the strip into the tapered area).

Moreover, edge build-up due to wear of the tapered roll ends is nowhere mentioned or hinted at in D2 and nothing in D2 suggests that strip profile control is based on axial shifting of the work rolls in the interval between succeeding lengths of strip material of substantially the same width. Objective consideration of the disclosure of D2 rather leads to the conclusion that the crown- and edge-drop control is solely based on the amount of taper of the work roll ends and the lateral adjustment of the work rolls with respect to the strip edges, respectively (see page 4, lines 19 to 38 and page 6, last paragraph to page 7, line 2 of the translation of D2). In accordance with D2 uneven work roll wear is reduced by the reduction of contact pressure at the strip edges (see page 4, lines 28 to 38 of the translation) and thus there is no teaching to avoid edge build-up due to specific work roll wear in the area of the tapered work rolls were the strip edges pass nor is there a hint to a possible remedy to such wear by appropriate cyclical shifting of the work rolls in the interval between the rolling of succeeding lengths of strip.

3.5 As is apparent from D1 and D8 the skilled person was aware of the strip profile problems caused by roll wear and thermal expansion of the work rolls. However, none of solutions proposed in the prior art suggest a cyclical shifting of the work rolls.

In accordance with D1 the work rolls can be axially displaced so that the entire axial surface of the work rolls can be used for rolling of strip, thereby enabling uniform wear of the work rolls. However, not only relates D1 to a rolling mill stand with parallel cylindrical rolls where the particular problem of edge build-up in the area of the tapered ended rolls does not occur but this document also neither clearly suggests cyclical shifting nor addresses the thermal crown problems that require the range of cyclical shifting to be reduced during rolling.

D8 certainly refers to wear affecting edge profiles or edge drops but fails to suggest a solution to these problems. In respect of the crown control, D8 in fact suggests a totally different solution to that claimed in the patent in suit because here the thermal crown problem is encountered by changing the reduction distribution during the rolling process.

3.6 The appellant's opinion that the general knowledge of the skilled person in respect of roll wear and thermal crown and the apparent interaction between these roll parameters as represented by D1 and D8, respectively, enabled the skilled person to adapt the method known from D2 in a manner so as to arrive immediately at the hot rolling method of claim 1 which method therefore lacked an inventive activity, cannot be shared by the Board.

Although D1 and D8 relate to wear and thermal crown problem in rolling of strip, as follows from the above analysis, these prior art documents do not hint in the direction of the claimed solution. In particular none of these documents, and also none of the other

documents cited, suggests a range of cyclical axial displacement of the work rolls and, in particular that the limits of the range should be reduced in accordance with the formation of thermal crown on these rolls.

Furthermore, contrary to the appellant's opinion, the Board does not find any objectively verifiable proof of a suggestion in D2 for a cyclical axial displacement of the work rolls in whatever sequence for edge build-up- or wear- and crown control by axial displacement of the work rolls. In the absence of any explicit or implicit disclosure the appellant's interpretations of the teachings of D2 must be considered to be based on hindsight and are thus not appropriate for denying inventive step in respect of the subject-matter of claim 1 of the patent in suit.

Even considering that the rolling method presented in D2 is said to alleviate some of the rolling problems encountered during the rolling of strip such statement cannot be interpreted to mean that the method steps necessarily must be the same as those of claim 1, as was alleged by the appellant. Firstly the results achieved in D2 cannot be considered to be absolute, i.e. are not open for further improvement, and secondly the cited prior art shows that effective crown control of the strip profile can be achieved in other ways, for example by roll bending, also referred to in D2 (see page 2, line 23) or by varying the reduction distribution such as suggested in D8.

Moreover, as mentioned above, the skilled person did not find any incentive in D2 or the other cited documents, that thermal crown and edge build-up problems could be encountered by cyclical axial displacement of the work rolls, let alone by cyclical displacement with an amplitude that decreases with increasing thermal crown of the work rolls.

3.7 Summarising, the Board comes to the conclusion that the proposed solution to the technical problem underlying the invention as defined in claim 1 involves an inventive step and therefore this claim as well as its dependent claims 2 to 4, relating to particular embodiments of the invention in accordance with Rule 29(3) EPC are acceptable.

4. In view of the conclusions reached in relation to the respondent's main request, it is not necessary to consider its auxiliary request.

Order

for these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

S. Fabiani F. Gumbel