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D E C I S I O N
of 20 July 1999

Case Number: T 0879/97 - 3.2.1

Application Number: 90110360.6

Publication Number: 0401685

IPC: B21B 13/14

Language of the proceedings: EN

Title of invention:
Multi-roll cluster rolling apparatus

Patentee:
Kawasaki Steel Corporation

Opponent:
SMS Schloemann-Siemag AG

Headword:
-

Relevant legal provisions:
EPC Art. 56, 84

Keyword:
"Claims - clarity - main request (no)"
"Claims - clarity - auxiliary request (no)"
"Inventive step (yes)"

Decisions cited:
-

Catchword:
-

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Case Number: T 0879/97 - 3.2.1

D E C I S I O N
of the Technical Board of Appeal 3.2.1
of 20 July 1999

Appellant: (Opponent)
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Decision under appeal: **Interlocutory decision of the Opposition Division of the European Patent Office posted 10 June 1997 concerning maintenance of European patent No. 0 401 685 in amended form.**

Composition of the Board:

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

Summary of Facts and Submissions

I. The mention of the grant of European patent No. 0 401 685 in respect of European patent application No. 90 110 360.6, filed on 31 may 1990, was published on 25 May 1994.

II. Notice of opposition was filed by the present appellant (opponent) on 24 February 1995 on the grounds of Article 100(a) EPC. In respect of an alleged lack of inventive step the opposition was supported in particular by the documents:

D1: EP-A-0 294 544

D2: EP-A-0 255 714

D5: DE-C-3 038 865

D7: EP-A-0 249 801

III. By its decision announced at oral proceedings on 14 May 1997 and posted on 10 June 1997, the Opposition Division maintained the patent in amended form.

In the Opposition Division's opinion the subject-matter in accordance with each of the independent claims 1 and 5 (renumbered 3) as filed with letter dated 28 May 1996, was based on an inventive activity since none of the documents in the proceedings disclosed or taught the use of rolls having a crown approximating two pitches of a sine wave curve or the combination of such rolls with T-rolls for improved control of the rolling gap in 20-high and 12-high multi-roll cluster rolling apparatus.

IV. On 13 August 1997 the appellant filed a notice of appeal against the above decision and payed the appeal fee on the same day.

The statement of grounds of appeal was filed on 20 October 1997.

With letter dated 11 November 1997 the appellant introduced an alleged prior use based on a number of documents and a statement by a witness.

V. In a communication for preparation of oral proceedings the Board expressed the preliminary opinion that the closest state of the art as represented by D2 was not sufficiently acknowledged and that therefore further amendment of the patent documents appeared to be necessary. In respect of the issue of inventive step the Board was of the view that, starting from the arrangement disclosed in D2, further discussion was necessary to determine if the skilled person would select a roll profile approximating two pitches of a sine wave when trying to overcome the problems encountered with this known roll arrangement.

The Board further addressed the alleged prior use introduced by the appellant with letter dated 11 November 1997. In view of the deficiencies in respect of substantiation and relevance the Board envisaged disregarding the alleged prior use in accordance with Article 114(2) EPC.

VI. Oral proceedings were held on 20 July 1999 in the presence of both parties.

The appellant requested that the decision under appeal be set aside and that the patent be revoked in its entirety.

In the course of the oral proceedings the respondent filed amended claims 1 to 3 and an adapted description.

The respondent requested that the appeal be dismissed and that the patent be maintained in amended form basically as accepted by the first instance (main request) or according to the documents submitted during the oral proceedings and the drawings as granted (auxiliary request).

The independent claims 1 and 3 of the respondent's main request read as follows:

"1. A 20-high multi-roll cluster rolling apparatus having

a pair of work rolls (2),

a plurality of first intermediate rolls (3),

a plurality of second intermediate rolls (4) and

a plurality of backup rolls (5) arranged successively

behind each said work roll (2),

characterised in that

either said first intermediate rolls (3) include at least a pair of rolls which have a crown in which the diameter of each roll decreases toward one end thereof and said second intermediate rolls (4) include at least a pair of rolls which have a crown approximating two pitches of a sine wave curve,

or said first intermediate rolls (3) include at least a pair of rolls which have a crown approximating two pitches of a sine wave curve and said second intermediate rolls (4) include at least a pair of rolls which have a crown in which the diameter of each roll decreases toward one end thereof,

the rolls of each said pair being arranged in axially opposite directions to each other,

each roll of said at least a pair of first intermediate rolls (3) and said at least a pair of

second intermediate rolls (4) being independently shiftable in the axial direction so as to realize a control of the profile of the rolled material in terms of end elongation difference ratio Λ_2 given by the following formula (1) and the quarter elongation difference ratio Λ_4 given by the following formula (2):

$$\Lambda_2 = (l_2 - l_0)/ l_0$$

$$\Lambda_4 = (l_4 - l_0)/ l_0$$

wherein

l_0: length (mm) of the material after rolling as measured at breadthwise mid portion of said material

l_2: length (mm) of the material after rolling as measured at breadthwise end portion of said material

l_4: length (mm) of the material after rolling as measured at breadthwise quarter of said material."

"3. A 12-high multi-roll cluster rolling apparatus having

a pair of work rolls,

a plurality of intermediate rolls,

a plurality of backup rolls arranged successively behind each said work roll,

characterised in that

either said work rolls have a crown in which the diameter of each roll decreases toward one end thereof and said intermediate rolls include at least a pair of rolls which have a crown approximating two pitches of a sine wave curve,

or said work rolls have a crown approximating two pitches of a sine wave curve and said intermediate rolls include at least a pair of rolls which have a crown in which the diameter of each roll decreases toward one end thereof,

the rolls of each said pair being arranged in axially opposite directions to each other,

each roll of said work rolls and said at least a pair of intermediate rolls being independently shiftable in the axial direction so as to realize a control of the profile of the rolled material in terms of end elongation difference ratio Λ_2 given by the following formula (1) and the quarter elongation difference ratio Λ_4 given by the following formula (2):

$$\Lambda_2 = (l_2 - l_0)/ l_0$$

$$\Lambda_4 = (l_4 - l_0)/ l_0$$

wherein

l_0: length (mm) of the material after rolling as measured at breadthwise mid portion of said material

l_2: length (mm) of the material after rolling as measured at breadthwise end portion of said material

l_4: length (mm) of the material after rolling as measured at breadthwise quarter of said material."

Claims 1 and 3 in accordance with the auxiliary requests differ from claims 1 and 3 according to the main request in that the feature "approximating two pitches" is replaced by "which is a two-pitch section".

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

The closest prior art as represented by D2, disclosed a 20-high multi-roll cluster rolling apparatus having most of the features of claim 1 of the main and auxiliary requests. In fact only the specific configuration of the CVC (continuous variable contour) roll surface used for the second intermediate rolls in

the first alternative of claim 1 and the feature according to which also the second intermediate rolls were independently shiftable, was not disclosed in D2. However, considering that D2 already indicated that the combined action of the first and second intermediate rolls allowed thickness control of the side and middle sections of the strip to be rolled, it would be obvious to the skilled person to select, in line with the suggestion given in column 3, lines 25 to 30 of D2, a specific surface configuration of the rolls so as to optimize control of the strip surface over of the entire width thereof. A suitable surface configuration for the CVC rolls so as to influence the flatness of the rolled strip was given in D1. The roll pairs disclosed therein allowed quarter elongation control of the strip surface and a roll contour corresponding to a fifth order polynomial was suggested to this effect. As was further apparent to the skilled person from Figure 3 of D1, which showed a fifth order polynomial, such contour came very close to a sine curve and no inventive activity was necessary to apply this teaching to the 20-high rolling apparatus according to D2 (in this respect a number of drawings were handed over at the oral proceedings for substantiation of the submission according to which a fifth order polynomial may correspond to a sine curve).

Since the control of CVC rolls implied axial displacement of the rolls as well as the arrangement of the contours of the rolls radially opposite to each other, the skilled person would arrive immediately and thus without any inventive activity at the claimed 20-high rolling mill.

Furthermore, the skilled person was well aware of the fact that the corrections achieved were the result of the sum of the corrections resulting from the corrections obtained by the combined action of the

individual rolls and that therefore the sequence of the positions of the correcting rolls in the rolling mill could be changed in accordance with the prevailing circumstances without affecting the wanted correction. Therefore the second alternative in claim 1 was also deprived of any inventive subject-matter.

Obviously, the use of different roll contours for correcting strip flatness suggested by D2 would be applicable to any multi-roll cluster rolling apparatus and in view of the fact that D1, D5 and D7 showed that the working rolls themselves could be profiled, similar considerations in respect of lack of inventive step applied to the 12-high multi-roll cluster rolling apparatus according to claim 3.

VIII. The respondent disputed the appellant's views and argued substantially as follows:

Although it was accepted that D2 disclosed the principle of a two fold correction of the strip to be rolled and that therefore this prior art was the starting point of the present invention, it did not suggest the use of a W-crown roll having two pitches of a sine curve for effecting correction of complicated profile defects in the strip to be rolled.

Furthermore, not only did D2 lack any suggestion to use a roll with a roll crown as disclosed in D1, but even when using such a roll the skilled person would not arrive at the subject-matter according to the patent in suit. Clearly a crown profile defined by a fifth order polynomial was not sufficiently accurate to describe a two pitch section of a sine curve, the latter crown profile being more suitable for simplified control of the correction in the axial shifting range of the rolls.

In this respect D5 also did not give any hint in the direction of a roll crown having a two pitch sine wave section or the combination of such rolls with tapered end rolls to improve control performance.

Since the cited prior art did not disclose or suggest the arrangement of rolls in accordance with any of the alternatives specified in the independent claims 1 and 3 of both requests, inventive step of these alternatives was to be accepted.

Reasons for the Decision

1. The appeal is admissible

2. *Amendments (main request)*

2.1 The Board agrees with the Opposition Division that the independent claims 1 and 3 of the main request meet the requirements of Article 123(2) and (3) EPC (see also the decision under appeal point 10), but is of the opinion that the subject-matter of these independent claims lacks clarity in respect of the feature according to which

- the second intermediate rolls (first alternative in claim 1) or
- the first intermediate rolls (second alternative in claim 1) or
- the intermediate rolls (first alternative in claim 3), or
- the work rolls (second alternative in claim 3)

"have a crown approximating two pitches of a sine wave curve".

2.2 Such a definition of the roll crown is considered ambiguous because it is firstly not clear in what is "approximated" (the two pitches, the sine wave curve or both) and secondly in how far the approximation applies.

Although lack of clarity is not a ground of opposition this requirement must be met when amended claims are filed, see Article 102(3) EPC.

Moreover, when addressing the patentability of the subject-matter of the patent in suit the respondent placed particular emphasis both on the full two pitch section and the exact sine wave shape of the crown profile so as to achieve accurate control over the entire shifting stroke of the rolls, which features are not clearly defined in the independent claims.

For these reasons the Board is of the opinion that the independent claims 1 and 3 of the main request do not meet the requirements of Article 84 EPC in respect of clarity and therefore for this reason alone the main request must be rejected.

3. *Amendments (auxiliary request)*

3.1 The independent claims 1 and 3 of the auxiliary request are mainly based on the subject-matter of granted claims 1, 2 and 3 (present claim 1) and 5 (present claim 3). The subject-matter of these claims is disclosed in the originally filed application documents in relation to the 20-high rolling apparatus of Examples 1 to 3 and the 12-high rolling apparatus of Examples 4 and 5). The profile control performance

expressed in terms of the elongation difference Λ is disclosed on page 9, line 24 to page 10, line 16 of the originally filed description (see also column 5, lines 28 to 52 of the patent in suit).

When compared to claim 1, respectively claim 3, of the main request the feature "approximating two pitches of a sine wave curve" was replaced by "which is a two pitch section of a sine wave curve" so that the shape of the roll crown is now clearly specified. Such further specification of the roll crown is disclosed on page 13, lines 20 to 25 of the originally filed description (see also column 7, lines 23 to 26 of the patent in suit).

3.2 Claim 2 corresponds to the granted claim 4. Its subject-matter is disclosed in relation to Example 4 of the originally filed application and granted patent (see also Figure 13a).

3.3 In view of these assessments no objections in respect of the requirements of Article 123(2) and (3) or Article 84 EPC arise against the set of claims in accordance with the auxiliary request.

The Board is also satisfied that the provisions of Rule 29(1) EPC are fulfilled in the present case.

3.4 The description of the documents of the auxiliary request was amended to bring it in agreement with the scope of the respective claims and to further specify the known features of the 20-high multi-roll cluster rolling apparatus disclosed in D2 and for the rest includes some clerical corrections. These amendments do also not give rise to objections under the EPC.

4. *Novelty (auxiliary request)*

The subject-matter of the independent claims 1 and 3 is clearly novel because the available prior art does not disclose a 20- or 12-high multi-roll cluster rolling apparatus having a pair of intermediate rolls or work rolls having a roll crown consisting of a two-pitch section of a sine curve.

Novelty has not, in fact, been in dispute in the proceedings.

5. *Inventive step (auxiliary request)*

5.1 The Board and parties are in agreement that the 20-high multi-roll cluster rolling apparatus disclosed in D2 represents the closest prior art and in so far the features of the precharacterising part of claim 1 are related to this known rolling apparatus.

In the alternative embodiments referred to in column 3, lines 31 to 48 and column 6, lines 9 to 24 of D2, the 20-high multi-roll cluster rolling apparatus comprises first intermediate rolls including at least one pair of tapered-end rolls which are arranged in opposite directions to each other ("T-crown rolls", see Figure 4), and second intermediate rolls having a "contoured" profile according to the profile of the rolls 41 and 42 of Figure 6. The first intermediate rolls are independently shiftable in the axial directions (column 5, lines 33 to 39).

5.2 The appellant considered that it could further be derived from D2 that the second intermediate rolls were independently shiftable in the axial directions.

In this respect the Board draws attention to the fact that although a relative shiftability of the further rolls is mentioned (see column 6, lines 1 to 8) there is no clear indication that such relative axial displacement is independent for each roll.

5.3 Although the prior art multi-roll cluster rolling apparatus in accordance with D2 allows correction of both the ends and the middle portion of the rolled strip material, control performance is limited with respect to effecting correction of complicated profile defects such as quarter elongation and complicated composite defects for which a large control range is necessary.

It is the object of the present patent to overcome these limitations of the prior art (see column 2, lines 40 to 49 of the patent in suit).

5.4 In a 20-high multi-roll cluster rolling apparatus known from D2 such object is achieved in accordance with the characterising features of the independent claim 1 essentially by

a(1) the first intermediate rolls include at least a pair of rolls which have a crown in which the diameter of each roll decreases toward one end thereof and the intermediate rolls include at least a pair of rolls which have a crown which is a two-pitch section of a sine wave curve (first alternative of the roll sequence) or

a(2) the first and second intermediate rolls are arranged such that said first intermediate rolls include at least a pair of rolls which have a crown which is a two-pitch section of a sine wave

curve and said second intermediate rolls include at least a pair of rolls which have a crown in which the diameter of each roll decreases toward one end thereof (second alternative of the roll sequence) wherein,

(b) each roll of said at least one pair of first and second intermediate rolls are independently shiftable in the axial directions and

(c) profile control of the rolled material is carried out with respect to the elongation difference ratio Λ_2 and quarter elongation difference ratio Λ_4.

As can be derived from the explanations given in the patent in suit the control area for actively effecting correction of roll defects is thereby substantially increased (see Figures 10(b) to 14(b)).

5.5 The effect achieved was not contested by the appellant. However, the appellant essentially considered that feature a(1) of the first alternative in claim 1 followed in an obvious manner from the teaching of D2 when taking into account the known roll crown profile disclosed in D1. Furthermore, the additional features allegedly resulting in an extended control area were inherent results from the normal control of CVC (continuous variable crown) rolls.

The Board acknowledges (see also the decision under appeal point 12.4) that document D2 mentions that the skilled person could easily choose the shape of the second intermediate rolls in accordance with the desired result (column 3, lines 23 to 30). However, since the strip control disclosed in D2 is related to

the edges and middle portion of the strip (see column 3, lines 14 and 54 to 58) no suggestion is derivable from D2 to effect independent correction of more complicated profile defects, such as quarter elongation or roll crown profiles leading to this effect.

5.6 The appellant also referred to D5 and D7 for substantiation of its submission according to which more complex forms of roll crown shapes were embraced by D2 or that their selection was at least obvious to the skilled person when corrections of specific defects were necessary.

In this respect the Board draws attention to the fact that D5 and D7 do not relate to multi-roll cluster rolling mills of the form disclosed in D2. Moreover, since the corrections addressed in these documents do not relate to complicated profile defects such as quarter elongation or combinations of such defects with edge/center composite elongation, the skilled person had no reason to consider this further prior art when looking for a solution of the underlying problem of the patent in suit. In any case these documents do also not address strip profile correction by means of rolls having a crown which is a two-pitch section of a sine wave.

5.7 The appellant further relied upon D1, which document in its opinion disclosed a pair of rolls allegedly suitable for use in the 20-high rolling mill of D2 and comprising a crown profile very close to a two-pitch section of a sine wave and intended to correct quarter elongation defects.

Considering D1 more in detail, this prior art concerns a two-, four- or six- high rolling mill (see column 1, lines 1 to 14) with work rolls having complementary crown profiles which, in accordance with a preferred embodiment, are defined by a fifth order polynomial.

Although part of a sine wave curve may be approximated by a polynomial of the fifth order, the evidence filed by the appellant during the oral proceedings not only failed to show that such an approximation led to a sufficiently accurate approximation of a full two-pitch section of a sine wave curve, but it is also apparent that the resulting shape of the curve is depéndent on the selection of specific values for the constants in the general formula given in D1 so as to arrive at the alleged conformity. In view of the fact that D1 clearly lacks any suggestion as to the selection of such specific constants, the evidence provided by the appellant is not considered probative.

The appellant's further submission, according to which Figure 3 of D1 disclosed a crown profile coming very close to a sine curve and in so far suggested to the skilled person the use of such common profile, is not considered convincing either.

In this respect, attention is drawn to the fact that the profile shown in Figure 3 (or Figures 6 and 7) is different from a sine wave curve in that the radius of the curve in the left hand part of the roll is substantially smaller than the radius of the curve in the right hand part of the roll (upper roll). Therefore, no suggestion to a sine wave curve roll crown profile can be derived from the Figures of D1.

Furthermore, although D1 addresses correction of quarter elongation defects, no other teaching is given in D1 than that such defects can be corrected by using rolls having a crown profile corresponding to a fourth or fifth order polynomial (see column 2, lines 33 to 49). Also in this respect the skilled person was neither led to select higher order polynomials, more accurately approximating sine wave curve profiles, and much less a sine wave curve profile for the intermediate rolls, nor to make these rolls independently shiftable so as to achieve an extension of the effective control area of the 20-high rolling apparatus known from D2 in terms of both end elongation difference ratio Λ_2 and quarter elongation difference ratio Λ_4 (feature (c) in claim 1).

5.8 The appellant submitted that the roll profiles shown in the drawings of the prior art rolls were highly exaggerated and that in fact the crown profiles used in D2, D1 or D5 differed very little in reality. Already for this reason the skilled person would select the well known sine wave curve when being confronted with the profiles shown in Figure 3 of D1 or Figure 7 of D5.

The Board is aware of the fact that the actual crown profiles used are relatively small deviations from the cylindrical form of the roll. However, as will be clear from the available prior art, in particular from the known profiles disclosed in D2 and D1, it is indeed the selected profile that is the essential parameter for correcting specific defects in the different areas of the strip and therefore the selection of the specific crown profile is to be seen as an essential step in arriving at a solution to the underlying problem of the present patent.

5.9 The appellant did not further rely on the alleged prior use introduced with letter dated 11 November 1997. In view of the deficiencies in respect of substantiation and relevance notified to the parties with its communication dated 4 March 1999 the Board sees no reason to further consider this matter.

5.10 Therefore, since no disclosure or suggestion for solving the underlying problem of the present patent by using the claimed combination of roll crown profiles for the first and second intermediate rolls leading together with the other features of claim 1 to an extended control area of the profile of the rolled material are derivable from the available prior art, the subject-matter according to the first alternative according to claim 1 involves an inventive step.

The second alternative according to claim 1 differs from the first alternative by interchanging the two levels of intermediate rolls (see feature a(2))

Irrespective of whether such interchanging of intermediate rolls in a cluster rolling apparatus was obvious to the skilled person or not, inventive step of the subject-matter of the second alternative is at least supported by the non-obviousness of the selection of the combination of the features which are common in the first and second alternative of claim 1 for the same reasons as explained above with respect to the first alternative.

5.11 The subject-matter of the independent claim 3 concerns a 12-high multi-roll cluster rolling apparatus which differs from the subject-matter of claim 1 essentially in that the combination of rolls having a crown in

which the diameter of each roll decreases towards one end thereof and rolls having a crown which is a two-pitch section of a sine wave applies to the work rolls and intermediate rolls (first alternative) or to the intermediate rolls and work rolls (second alternative).

Inventive step of the subject-matter of this claim is also supported by the inventive combination of roll crown profiles for the first and second level rolls leading, together with the other features of claim 3 which are the same as the features (b) and (c) of claim 1, to an extended control area of the profile of the rolled material.

6. Summarising, in the Board's judgment, the proposed solutions to the technical problem underlying the patent in suit defined in the independent claims 1 and 3 are inventive and therefore these claims as well as the dependent claim 2 relating to a particular embodiment of the invention in accordance with Rule 29(3) EPC, can form the basis for maintenance of the patent in amended form (Article 52(1) EPC).

The description and drawings are in agreement with the wording and scope of the current Claims. Hence these documents are also suitable for maintenance of the patent in amended form.

Thus taking into account the amendments made by the respondent, the patent and the invention to which it relates meet the requirements of the EPC and the patent as amended is to be maintained in this form (Article 102(3) EPC).

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 maintain the patent in amended form with the following documents:

   - claims 1 to 3 and description filed at the oral proceedings held on 20 July 1999,

   - drawings as granted.

The Registrar: The Chairman:

P. Martorana F. Gumbel