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D E C I S I O N
of 15 February 1995

Case Number: T 0020/93 - 3.2.5

Application Number: 86103158.1

Publication Number: 0194628

IPC: B22D 11/06

Language of the proceedings: EN

Title of invention:

Double drum type continuous casting machine

Patentee:

HITACHI, LTD
NISSHIN STEEL CO., LTD.

Opponent:

Voest-Alpine Industrieanlagenbau GmbH

Headword:

-

Relevant legal provisions:

EPC Art. 56

Keyword:

"Inventive step - yes (after amendment)"

Decisions cited:

-

Catchword:

-



Case Number: T 0020/93 - 3.2.5

D E C I S I O N
of the Technical Board of Appeal 3.2.5
of 15 February 1995

Appellant: Voest-Alpine Industrieanlagenbau GmbH
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Decision under appeal: Interlocutory decision of the Opposition Division
of the European Patent Office dated 9 November
1992 concerning maintenance of European patent
No. 0 194 628 in amended form.

Composition of the Board:

Chairman: C. V. Payraudeau
Members: A. Burkhart
W. D. Weiß

Summary of Facts and Submissions

I. An opposition was filed against the grant of the European patent No. 0 194 628 on the grounds that the subject-matter of the European patent was not patentable within the terms of Articles 52 to 57 EPC (Article 100(a) EPC).

II. In an interlocutory decision the Opposition Division held that the grounds for opposition mentioned in Article 100(a) EPC did not prejudice the maintenance of the patent as amended by the proprietor during the opposition proceedings.

The documents US-A-3 817 317 (D1) and US-A-3 447 590 (D5) referred to in the decision of the Opposition Division are also relevant to the present decision.

III. The amended Claim 1, on the basis of which the patent was maintained, reads after correction of a clerical error ("one off the" should read "one of the") as follows:

"1. A continuous casting machine having a container (1) for accommodating a molten metal (7), a nozzle (2) provided on said container (1) for enabling a pouring of the molten metal (7), a pair of rotatable rolls (3, 4) for cooling the molten metal (7) poured from the nozzle (2) to form a solidified shell (8, 9) on a surface of each of said rolls (3, 4) and for compressing the solidified shells (8, 9) to produce a cast metal sheet (10), a drive equipment (27) for rotating the rolls (3, 4), and a pair of housing parts (14) for said pairs of rolls (3, 4), a pair of fixed plates (6) disposed adjacent to a surface of the rolls (3, 4) for forming a pool of molten metal (7) received from said nozzle (2),

two pairs of bearing boxes (11, 12) respectively disposed in the housing parts (14) for rotatably supporting respective end portions of each roll (3, 4), a pair of rigid members (30; 32, 33) disposed between adjacent bearing boxes (11, 12) in each of said housing parts (14) for fixing a narrowest gap portion between the rolls (3, 4), and a pressure adding device (25, 26) disposed adjacent one of the bearing boxes (12) in each of the housing parts (14) to act an initial force to the rolls (3, 4) as a clamping force (F) on the rigid member (30; 32, 33) through the associated bearing box (11, 12), characterized in that a load detector (20) is disposed between the bearing boxes (11, 12) for detecting a load caused by a separating force (P) occurring at a compression of the solidified shells (8, 9), and a controller (100) is provided for controlling a value of the separating force (P) occurring at the compression of the solidified shells (8, 9) in accordance with a detected signal of the load detector (20), said controller (100) comprises equipment for regulating a rotating speed of the drive equipment (27) to maintain the separating force (P) substantially constant."

IV. The Appellant (Opponent) lodged an appeal against this interlocutory decision requesting that the decision under appeal be set aside and that the patent in suit be revoked.

V. Oral proceedings were held.

(i) The Appellant requested that the decision under appeal be set aside and that the patent be revoked.

- (ii) The Respondent (Patentee) requested that the appeal be dismissed, and the patent be maintained in amended form on the basis of the following documents:

Description: Column 1 with insert denoted by -1- as filed on 12 February 1992 and column 2 to column 9, line 3, of the patent as granted;

Claims: No. 1 as filed at the oral proceedings of 15 February 1995 and No. 2 to 10 as filed on 1 February 1991;

Drawings: Sheets 1 and 2 as filed at the oral proceedings of 15 February 1995 and sheets 3 and 4 of the patent as granted.

- (iii) The Appellant argued essentially as follows:

A suitable starting point to assess inventive step was document D5. This document would disclose the subject-matter of Claim 1, except for the following features, all relating to the problem of mounting the rolls: a pair of housing parts for the rolls, a pair of rigid members and a pressure adding device. Document D5 was silent about how the roll shafts were to be mounted. The person skilled in the art would however immediately realise that a fixed mounting would hinder an adjustment of the gap between the rolls and that, when the total spreading force would become very high, damage to the rolls would then be unavoidable. A suitable construction for mounting the rolls not having these disadvantages was known

from document D1, which showed substantially the same mounting as in the opposed patent. In particular, this document disclosed that the clamping force is exerted on the rigid members through the bearing boxes of the casting rolls. This was true notwithstanding the fact that the disclosed casting machine comprised in addition back-up rolls exerting a force on the casting rolls.

With respect to the independent problem of regulating the rotation speed of the rolls, there was no substantial difference between the pressure sensitive electrical transducers in the bearings according to document D5 and the load detectors disposed between the bearing boxes according to the opposed patent.

(iv) The Respondents argued essentially as follows:

The present invention was primarily directed to improving the rigidity of the casting machine in order to reduce the gap between the rolls and the fixed plates due to the separating force, and to keep the gap between the rolls constant. This problem was solved by providing a preset force directly on the bearing boxes of the rolls. In this way the rigid members, which fixed the gap between the rolls and which are disposed between the bearing boxes in the housing, were firmly clamped together. In contrast, the clamping force in the casting apparatus according to document D1 was applied to the bearing boxes of the stiff, large diameter back-up rolls, which in turn exerted a force on the small-diameter casting rolls. In this way the bearing boxes of the casting rolls were freely suspended, and not

clamped together as in the invention. The person skilled in the art would not have any incentive to dispose of the back-up rolls, since providing these rolls was the central teaching of document D1.

Document D5 was primarily directed to the problem of preventing the jamming of metal between the roll surface and the end walls, which problem was solved by driving the rolls and by providing diverging end walls. In the casting apparatus according to this document **four** load detectors would be needed to measure the absolute pressure of the roll shaft on the bearing. In contrast thereto, according to the invention **two** load detectors would suffice to measure the (relative) separating force between the rolls. Also, document D5 would not disclose load detectors **disposed between** the bearing boxes.

Reasons for the Decision

1. *Admissibility of the amendments*

1.1 Claim 1 as filed at the oral proceedings differs from Claim 1 filed on 12 February 1991, on the basis of which the interlocutory decision of the Opposition Division was based (see point III above) and which itself is based on Claims 1, 7 and 9 as originally filed, by the following amendments:

- (i) the phrase "a pair of rotatable rolls (3, 4)" is replaced by "**one** pair of rotatable rolls (3, 4)",

- (ii) the phrase "disposed adjacent one of the bearing boxes (12)" is amended by the following addition:
"disposed adjacent **to and directly acting on** one of the bearing boxes (12)",
- (iii) the phrase "characterized in that" is replaced by "wherein".

1.2 A basis for amendments (i) and (ii) can be found in the Figures 1 to 4, on page 8, paragraphs 1 and 2, of the application documents as filed (cf. column 4, lines 37 to 51, of the patent as granted) and on page 12, second paragraph, of the application documents as filed (cf. column 6, lines 33 to 44, of the patent as granted).

The quoted passages refer to "the twin rolls (3, 4)", and state that "the initial or preset force F acts upon (is applied to) the bearing boxes (11, 12)".

Since a correct delimitation of the claim with respect to either the prior art according to document D1 or the prior art according to document D5 would require a complete redrafting of the claim, the board considers it in the present case more appropriate to employ the one-part form.

The dependent Claims 2 to 9 filed on 1 February 1991 are based on Claims 2 to 6, 8, 10, 14 and 18 as originally filed, respectively.

1.3 Since the amendments to the claims clearly restrict the scope of the granted claims and can be derived from the original disclosure, the amended claims do not contravene Article 123(2) and (3) EPC.

- 1.4 The amended drawings differ from the drawings as filed in that the differential force, erroneously denoted "P - F" in Figures 1 and 2, is denoted "F - P" in these Figures. This is immediately evident, since the value of the initial force F must be higher than the value of the separating force P (see also page 8, last paragraph, and page 13, second paragraph, of the application documents as filed (cf. column 4, line 61, and column 5, line 54, of the patent as granted)).

The amended drawings therefore do also not contravene Article 123(2) EPC.

2. *Novelty*

It is not disputed by the parties that none of the cited documents discloses a casting machine comprising all the features of the new Claim 1 as filed at the oral proceedings. There is no need for further substantiation of this matter.

The subject-matter of this Claim 1 is therefore new within the meaning of Article 54 EPC.

3. *Closest state of the art, technical problem and solution*

- 3.1 The present invention relates to continuous casting machines with twin rolls for manufacturing a thin sheet metal, whereby a molten metal is poured between the rotating rolls, and cooled by the rolls so as to be formed into a solidified shell.

A disadvantage of such casting machines resides in the fact that, due to the large separating force occurring when the shells are formed, it is difficult to prevent leakage of molten metal through the gap between the rolls and the fixed plates, which cooperate to hold a

pool of molten metal. Another disadvantage is that the action of the separating force makes it difficult to keep the gap between the rolls defining the thickness of the shells constant.

- 3.2 The problem to be solved by the present invention can be divided into two substantially independent sub-problems: firstly, to reduce the actual separating force and to improve the rigidity of the casting machine in order to keep the gap between the rolls constant and to reduce the gap between the rolls and the fixed plates due to the separating force, thus preventing leakage of the molten metal, and secondly, to maintain the separating force substantially constant.

Consequently, the features of Claim 1 can be grouped into two groups, each of which solving one of said sub-problems.

In particular, the first problem is solved by providing a pressure adding device adjacent to and directly acting on one of the bearing boxes, which exerts a clamping force higher than the separating force on the rigid members between the bearing boxes. In this way a change of the separating force P due to the casting operation gives rise to a much smaller change in terms of percentage of the actual separating force $F - P$, and hence to a smaller gap change.

The second problem is solved by providing a load detector for measuring the separating force and a controller comprising equipment for regulating the rotating speed of the rolls in order to regulate the rotation speed of the rolls. In this way, if the actual separating force increases or decreases, the rotating speed of the rolls can be increased or decreased

accordingly, so as to maintain the separating force substantially constant and to obtain a constant thickness of the metal sheet.

3.3 The choice of the best starting point to assess inventive step depends of course on which part of the problem is considered first: document D1 is the most relevant prior art as concerns the first problem area, whereas document D5 is the most relevant prior art as concerns the second problem area. If one starts out from document D5, as the Appellant did, and which was not objected to by the Respondent, the following is noted:

3.4 Document D5 discloses (see column 2, line 32 to 59, and Figures 1 and 2) a continuous casting machine having a container (2a) for accommodating a molten metal (2) with a nozzle for pouring the molten metal, one pair of rotatable rolls (1) for cooling the molten metal (7) to form a solidified shell on a surface of each of said rolls and for compressing the solidified shells to produce a cast metal sheet, a drive equipment (7, 10) for rotating the rolls, a pair of fixed plates (3) disposed adjacent to a surface of the rolls for forming a pool of molten metal, two pairs of bearing boxes (6) for rotatably supporting respective end portions of each roll, wherein a load detector for detecting a load caused by a separating force (P) occurring at a compression of the solidified shells, and a controller (11) is provided for controlling a value of the separating force (P) occurring at the compression of the solidified shells in accordance with a detected signal of the load detector, said controller (11) comprises equipment for regulating a rotating speed of the drive equipment (7, 10) to maintain the separating force (P) substantially constant.

The subject-matter of Claim 1 differs from the casting machine according to document D5 in that

- (i) a pair of housing parts for said pair of rolls and said pair of bearing boxes is provided,
- (ii) a pair of rigid members disposed between adjacent bearing boxes is provided for fixing a narrowest gap portion between the rolls,
- (iii) a pressure adding device is disposed adjacent to and directly acting on one of the bearing boxes to exert an initial force through the associated bearing box to the rolls as a clamping force (F) on the rigid member, and
- (iv) the load detector is disposed between the bearing boxes.

The first three differences pertain to the problem of reducing the actual separating force and improving the rigidity of the casting machine, whereas the fourth difference pertains to the problem of maintaining the separating force substantially constant.

3.5 Document D5 is silent about how the bearings for the roll shafts are supported. However, it appears from the drawing and the description of document D5 that the casting machine has a rigid structure, wherein the bearings (6) and the shafts (8) of the relatively thick casting rolls (1) are fixedly mounted with respect to the common gear-box (7).

In any case, document D5 does not address the problem of adjusting the gap between the casting rolls and does not disclose any means for such adjustment. Therefore, in the presence of the disclosure of document D5, the

person skilled in the art is by no means incited to take an adjustment of the gap between the casting rolls into consideration.

Hence, the person skilled in the art had no reason to consider the specific construction of a casting machine according to document D1, which, in fact, comprises means for adjusting and determining the spacing between the rolls.

- 3.6 Document D1 discloses (see column 2, line 51, to column 3, line 62, and Figure 1) a continuous casting machine comprising: nozzles (44) for pouring molten metal, one pair of rotatable casting rolls (16, 17) for cooling the molten metal to form a solidified shell on a surface of each of said rolls and for compressing the solidified shells to produce a cast metal sheet, a drive equipment for rotating the casting rolls, a pair of fixed plates disposed adjacent to a surface of the rolls for forming a pool of molten metal, two pairs of bearing blocks (14, 15) for rotatably supporting respective end portions of said casting rolls, a second pair of bearing blocks (20, 21) that rotatably support the ends of back-up rolls (22, 23), rigid members or wedges (38), which space the bearing blocks (14, 15) apart against the pressure exerted by hydraulic pre-load cylinder (36).

However, the central teaching of document D1 is that the separating forces between the casting rolls of casting machines can be diminished by employing casting rolls, which are relatively small in diameter, and are backed up by the relatively large-diameter back-up rolls, which press against the casting rolls and prevent them from bending outwardly at their midpoints, thus allowing shells with a larger width to be cast.

Therefore, the person skilled in the art would never consider to dispose of the back-up rolls, since they are the "backbone" of the teaching of document D1.

Moreover, document D1 does not disclose the distinguishing feature (iii), viz. "a pressure adding device is disposed **adjacent to and directly acting** on one of the bearing boxes to exert an initial force through the associated bearing box to the (casting) rolls as a clamping force (F) on the rigid member" (see point 3.4), since each bearing block (14, 15) is not clamped between the rigid member and the pressure adding device as in the present invention. In the casting machine according to document D1 the bearing blocks are pressed together through the force exerted by the back-up rolls on the casting rolls, i.e. they are spaced apart by the rigid members, whereby the other end of the bearing blocks is freely suspended.

Thus, even if the person skilled in the art would try to combine the teachings of documents D5 and D1, he would not arrive at the subject-matter of Claim 1.

3.7 Therefore, the subject-matter of Claim 1 according to the main and only request is not obvious in the presence of the documents cited by the Appellant, but involves an inventive step in the meaning of Article 56 EPC.

4. In view of the above, the patent as amended at the oral proceedings can be maintained with independent Claims 1 together with the dependent Claims 2 to 10 concerning particular embodiments of the invention.

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 grant a patent on the basis of the following documents:

Description: Column 1 with insert denoted by -1- as filed on 12 February 1992 and column 2 to column 9, line 3, of the patent as granted;

Claims: No. 1 as filed at the oral proceedings of 15 February 1995 and No. 2 to 10 as filed on 1 February 1991;

Drawings: Sheets 1 and 2 as filed at the oral proceedings of 15 February 1995 and sheets 3 and 4 of the patent as granted.

The Registrar:


A. Townend

The Chairman:


C. Payraudeau

