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Datasheet for the decision of 31 January 2008

Case Number: T 0224/05 - 3.2.07

Application Number: 94102721.1

Publication Number: 0612852

IPC: C21D 9/04

Language of the proceedings: EN

Title of invention:
Process for manufacturing high-strength bainitic steel rails with excellent rolling-contact fatique resistance

Patentee:
Nippon Steel Corporation

Opponents:
I. Voestalpine Schienen
II. Corus UK Ltd.

Headword:
-

Relevant legal provisions:
EPC Art. 54, 56, 84, 123(2)(3)
EPC R. 139
RPBA Art. 13

Relevant legal provisions (EPC 1973):
EPC R. 88

Keyword:
"Allowability of amendments (main request - yes, auxiliary requests 2-9 - no)"
"Novelty (main request - yes; E21 enabling disclosure)"
"Inventive step (main request - no)"
"Auxiliary requests filed during oral proceedings - not admitted into the proceedings"

Decisions cited:

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Catchword:

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0224/05 - 3.2.07

D E C I S I O N
of the Technical Board of Appeal 3.2.07
of 31 January 2008

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Decision under appeal:
Decision of the Opposition Division of the European Patent Office posted 3 January 2005 revoking European patent No. 0612852 pursuant to Article 102(1) EPC.

Composition of the Board:

Chairman: P. O'Reilly
Members: H. Hahn
I. Beckedorf

Summary of Facts and Submissions

I. The patent proprietor lodged an appeal against the decision of the Opposition Division to revoke European patent No. 0 612 852.

II. Two oppositions were filed against the patent in its entirety under Article 100(a) EPC (opponents I and II), for lack of novelty and inventive step, and under Articles 100(b) and 100(c) EPC (opponent II), that the patent does not disclose the invention in a manner sufficiently clear and complete for it to be carried out by the person skilled in the art and for extending beyond the content of the application as originally filed.

The Opposition Division held that claim 1 of the single request dated 11 June 2003 (which contained only linguistic printing error corrections compared to claim 1 as granted) met the requirements of Rule 88 EPC, of Article 123(2) EPC and of Article 100(b) EPC. The later filed document E21 was considered to be relevant and thus introduced into the proceedings. The Opposition Division further considered that the subject-matter of claim 1 of the single request was novel, particularly with respect to E2, E3, E4, E5 and E21. The subject-matter of claim 1, however, was considered to lack an inventive step with respect to a combination of either E9 or E20 with E21.

III. With a communication accompanying the summons to oral proceedings dated 19 November 2007 the Board presented its preliminary opinion based on claims 1 to 3 of the main request, and claims 1 to 3 of the auxiliary

requests 1 to 5, all as filed with the grounds of appeal dated 12 May 2005.

The Board gave its preliminary opinion that the request for correction of claim 1 of the main request did not appear to be allowable as a request under Rule 88 EPC 1973 (as of 13 December 2007: Rule 139 EPC) since there was no error in the document filed at the EPO. The errors were printing errors for which the Examining Division is responsible and if the patent is maintained amended then these printing errors no longer arise. Furthermore, the subject-matter of claim 1 of each auxiliary request appeared to extend beyond the content of the application as originally filed and thus to contravene Article 123(2) EPC.

With respect to novelty of claim 1 of the main request the Board remarked that it neither specifies that **only** the rail head surface is cooled (so that it appeared to cover also the case wherein the whole rail is cooled such that the entire cross-section should reveal an essentially uniform structure) nor that a specific bainite structure, namely lower bainite, is obtained.

Claim 1 of the main request **only** requires that the head of a hot rail having a certain composition is cooled from the austenite temperature region with a cooling rate of 1-10°C/sec to a specific cooling stop temperature of from 500-300°C and then further cooled according to features f1) or f2).

With respect to the alternative f1) it has to be considered that there will always be a temperature gradient between the centre of the rail and its surface

when the surface of the rail is cooled which only will be zero when the entire rail eventually has reached the temperature of the surrounding medium.

Therefore with respect to E21 it needed to be discussed whether this can be the case within a period of 900 seconds or 780 seconds according to the embodiment described at column 7, lines 50 to 60 and whether or not this implies that the condition of feature f1), i.e. that the surface of the rail head is heated to a temperature of not more than 150°C **above the temperature reached on completion of the accelerated cooling** is fulfilled. It appeared that the cooling rate for this embodiment according to E21 should be considered to be at least 1.3°C/sec in the forced cooling step whereas there will be natural cooling of the rails at point H after the fluidised bed treatment. Hence it seemed that claim 1 of the main request might lack novelty provided that the temperature gradient/rail head surface heating question is answered positively (compare Case Law of the Boards of Appeal of the European Patent Office, 5th edition 2006, section I.C.4.2.2).

The Board then remarked that provided that novelty would be acknowledged the issue of inventive step would be dealt with for all formally allowable requests taking into consideration the problem-solution approach. It should be discussed whether E9 or E20 represented the closest prior art for claim 1 - and taking account of the problem to be solved, which will be based on the effect of the distinguishing features - it will be discussed whether or not the available prior art, particularly E9, E20 and E21, renders the subject-

matter claimed obvious, particularly when considering the common general knowledge of the skilled person, e.g. with respect to the TTT-diagrams for rail steels. In this context it should also be discussed whether E21 represents a non-enabling disclosure as argued by the appellant and whether or not the skilled person would modify the known bainitic steel rails in a specific manner in order to improve some properties of the rails using a specific heat treatment process in order to obtain an improved bainitic structure.

The Board also remarked that neither respondent had defined an objective problem with respect to E20 as the closest prior art and that if necessary the combination of E20 and E21 should also be discussed.

The parties were given the opportunity to file observations to the communication which should be filed well in advance, i.e. at least one month, before the date of the oral proceedings.

Finally, the parties were advised to take note of the RPBA, in force as of 1 May 2003 and especially of Article 10b (as of 13 December 2007: Article 13).

IV. With letter dated 19 December 2007 the appellant (patent proprietor) filed an amended main request and auxiliary requests 1 to 9 replacing its previous requests in combination with arguments concerning the basis of the amendments and the patentability of the respective requests. Annexes C to E were also submitted with the same letter.

V. With letter dated 20 December 2007 the appellant submitted Annex F.

VI. With letter of 21 December 2007 respondent II submitted arguments with respect to the amended requests of the appellant.

VII. Respondent I submitted further arguments together with an annex A with its letter dated 28 December 2007.

VIII. With letter dated 17 January 2008 the appellant submitted further arguments as response to the submissions of the two respondents.

IX. Oral proceedings before the Board were held on 31 January 2008. Auxiliary request 1 was withdrawn by the appellant during the oral proceedings.

(a) The appellant requested that the decision under appeal be set aside and that the patent be maintained in amended form on the basis of the main request or alternatively on the basis of auxiliary requests 2 to 9, all as filed with letter dated 19 December 2007, or alternatively on the basis of auxiliary requests 10 and 11 as filed during the oral proceedings.

(b) The respondents (opponent I and opponent II) each requested that the appeal be dismissed.

(c) During the oral proceedings the following documents were discussed:

E1 = GB-A-1 450 355

E2 = Atlas zur Wärmebehandlung von Stählen, Vol. 1, page 105
E5 = ETR (1989), No.12, December pages 775-481
E9 = Tech. Mitt. Krupp, Werksberichte, Vol. 37(1979), No. 3, pages 79-87
E20 = Bainite in Steels, 1992, pages 378-387
E21 = DE-A-1 533 982 (and its patent family member E21a = GB-A-1 131 662)
Annex F = M. Ueda et al., "Development of Bainitic Steel Rail with Excellent Surface Damage Resistance", IHHA'99 STS-Conference, Session 3, Contributed Papers, Sub-Session 3.2, pages 259 to 266

At the end of the oral proceedings the Board announced its decision.

X. Claim 1 of the main request reads as follows (amendments compared to claim 1 as granted with deletions put between brackets are in bold; emphasis added by the Board):

"1. A process for manufacturing high-strength bainitic steel rails with an excellent rolling-contact fatigue resistance comprising the steps of hot-rolling steels consisting of 0.15 % to 0.45 % carbon, 0.15 % to 2.00 % silicon, 0.30 % to 2.00% manganese, and 0.50 % to 3.00 % chromium, and optionally at least one element selected from a first group consisting of 0.10 % to 0.60 % molybdenum, 0.05 % to 0.50 % copper and 0.05 % to 4.00 % nickel, a second group consisting of 0.01 % to 0.05 % titanium, 0.03 % to 0.30 % vanadium, and 0.01 % to 0.05 % niobium, and a third group consisting of 0.0005 % to 0.0050 % boron the remainder consisting of iron and unavoidable impurities, subjecting the head of

an as-rolled rail still hot or of a rail heated to a high temperature to an accelerated cooling from the austenite region to a cooling stop temperature of 500° to 300° C at a rate of 1° to 10° C per second, and then **[either]** heating the rail head surface of the rail head to a temperature not more than 150° C above the temperature reached on **[g]c**ompletion of the accelerated cooling by means of heat recuperation from the interior of the rail, and then naturally cooling to a lower temperature zone **[, or cooling the rail head subjected to the accelerated cooling to the vicimity of room temperature at a rate of 1° to 40°C per mimute]**."

XI. Claim 1 of auxiliary request 2 differs from claim 1 of the main request in that the additional feature "**at which the bainite transformation is not completed**" has been inserted between the wording "temperature of 500° to 300°C" and "at a rate of 1° to 10° per second".

XII. Claim 1 of auxiliary request 3 differs from claim 1 of auxiliary request 2 in that the additional feature "**by using air, mist or an air-atomized liquid from nozzles disposed on both sides of the rail head**" has been inserted between the term "at a rate of 1° to 10°C per second" and the term "and then heating the rail head surface …".

XIII. Claim 1 of auxiliary request 4 differs from claim 1 of the main request in that the feature "**by using air, mist or an air-atomized liquid from nozzles disposed on both sides of the rail head**" has been inserted between the term "at a rate of 1° to 10°C per second" and the term "and then heating the rail head surface …", and that as second feature ", **wherein the rail has a**

hardness of Hv 300 to 400 in the center of the rail head surface and a minimum of Hv350 in the gage corner, with the hardness of the gage corner being greater than that of the center of the rail head surface by a minimum of Hv 30." has been added after the term "… lower temperature zone"

XIV. Claim 1 of auxiliary request 5 differs from claim 1 of the main request in that the feature "to a cooling stop temperature of 500° to 300°C" has been deleted and that the feature "**for avoiding the formation of coarse-grained bainite structures and starting bainite transformation with fine-grained bainite structures in a lower temperature region, the accelerated cooling being performed by air, mist or an air-atomized liquid from nozzles disposed on both sides of the rail head, stopping the accelerated cooling at a cooling stop temperature of 500 to 300°C,**" has been inserted between the term "at a rate of 1° to 10°C per second" and the term ", and then heating …". Additionally, the feature "**for making stable growth of the fine-grained bainitic structures**" was inserted between the term "… from the interior of the rail" and the term "and then naturally cooling …" and that the identical hardness feature of auxiliary request 4 ", **wherein the rail has a hardness of Hv 300 to 400 …"** was also added.

XV. Claim 1 of auxiliary request 6 differs from claim 1 of auxiliary request 5 in that the upper value of the cooling stop temperature has been restricted to "**450**" °C.

XVI. Claim 1 of auxiliary request 7 differs from claim 1 of the main request in that the feature "to a cooling stop

temperature of 500° to 300°C" has been deleted and that the feature "**for avoiding the formation of coarse-grained bainite structures and starting bainite transformation with fine-grained bainite structures in a lower temperature region, the accelerated cooling being performed by air, mist or an air-atomized liquid from nozzles disposed on both sides of the rail head, stopping the accelerated cooling at a cooling stop temperature of 400 to 300°C for suppressing excessive heat recuperation from the interior of the rail,**" has been inserted between the term "at a rate of 1° to 10°C per second" and the term ", and then heating …". Additionally, the feature "**to make stable growth of the fine-grained bainitic structures without coarsening bainitic structures**" was inserted between the term "… from the interior of the rail" and the term "and then naturally cooling …" and that the identical hardness feature of auxiliary request 4 ", **wherein the rail has a hardness of Hv 300 to 400 …"** was also added.

XVII. Claim 1 of auxiliary request 8 differs from claim 1 of the auxiliary request 6 in that the first feature "for avoiding the formation … 450 to 300°C" has been replaced by "**the accelerated cooling being performed by air, mist or an air-atomized liquid from nozzles disposed on both sides of the rail head, stopping the accelerated cooling at a cooling stop temperature of 500 to 300°C**" while the second feature "for making stable growth of the fine-grained bainitic structures" has been replaced by "**wherein fine-grained bainitic structures in the steel rails are formed both in the course of the accelerated cooling to a cooling stop temperature of 500 to 300°C where the accelerated**

cooling is stopped and in the heat recuperation process following the accelerated cooling".

XVIII. Claim 1 of auxiliary request 9 differs from claim 1 of auxiliary request 8 in that the second feature "wherein fine-grained bainitic structures … heat recuperation process following the accelerated cooling" has been replaced by "**wherein fine-grained bainite transformation begins in the course of accelerated cooling on the temperature range of 500 to 300°C where the accelerated cooling is stopped and ends in the subsequent heat recuperation process, or it begins and ends in the heat recuperation process immediately after the accelerated cooling**".

XIX. Claim 1 of auxiliary request 10 differs from claim 1 of auxiliary request 3 in that the feature "at which the bainitic transformation is not completed" has been deleted and in that the wording "**wherein depending on the selected steel composition and accelerated cooling rate bainite transformation begins in the course of accelerated cooling on the temperature range of 500 to 300°C where the accelerated cooling is stopped and ends in the subsequent heat recuperation process, or it begins and ends in the heat recuperation process immediately after the accelerated cooling**" has been inserted after the feature "by using air, mist … of the rail head" and before "and then heating the rail head surface …".

XX. Claim 1 of auxiliary request 11 differs from claim 1 of auxiliary request 10 in that the feature "wherein depending on the selected steel composition … the accelerated cooling" has been deleted.

XXI. The appellant argued essentially as follows:

Claim 1 of the main request corresponds to claim 1 as granted with the deletion of the alternative according to feature f2). Hence the requirements of Articles 123(2) and (3) are met.

E21/E21a relates to a process and installation for the thermal treatment to provide bainitic steel rails having a high carbon content of 0.4-1.0% (see E21a, page 3, line 68), which is not very popular in the art (see E1, page 1, line 73; E5, page 775; E9, page 81, left-hand column, first paragraph; E20, page 380, Table 13.4, page 383, last paragraph). E21 represents a non-enabling disclosure and should thus be disregarded. The aim of E21a is to provide a uniform structure throughout the whole mass (see page 3, lines 75 to 80) but it does not teach how this should be achieved over the whole carbon concentration range. E21a contains only one statement concerning the cooling time and the person skilled in the art has to assume that this time applies not to the surface but to the whole rail. There is a contradiction *per se* between locally cooling at the surface and the cooling of the (real) whole rail which is not possible within said short time of 3 minutes according to said embodiment. Only samples having a small cross-section can be cooled in such a manner to obtain a homogenous structure but not real steel rails. E21a specifies an isothermal transformation, i.e. a transformation at constant temperature and does not mention any temperature increase of the rail heads surface. The bainitic transformation is completed in the fluidized bed

wherein the rail is cooled (see page 5, lines 38 to 45 and lines 64 to 68). Moreover, when reading the disclosed steel composition of E21a in the context of the whole description it is only a preferred one (see page 3, lines 36 to 38 and lines 49 to 57 and lines 63 to 74). The optional suppression of the heat recuperation according to the patent in suit is done by selecting the cooling rate, the cooling stop temperature, and the temperature increase of the rail head surface during said heat recuperation (i.e. re-heating the surface by heat from the interior of the steel rail) must be measurable, e.g. as low as 1°C (see table 7, example B). Furthermore, E21a being published in 1968, is not mentioned in the relevant state of the art considered in E20, which was published in 1992.

The closest prior art is represented by E1 for disclosing a process for producing bainitic steel rails (see page 1, line 68 to page 2, line 6). The problem to be solved is to provide high-strength steel rails having fine grained strong bainitic structure on the rail head and improved rolling-contact fatigue resistance (compare patent, [0016]). This problem is solved by the subject-matter of claim 1 of the main request (compare Table 1, examples A-J and comparative example L which is similar to E1). Neither D2 nor D7 inducing the claimed process, and E21 clearly teaches a different way of carrying out the bainitic transformation process which is much more complicated for obtaining fine-grained lower bainite. Furthermore, E21a refers to disadvantages and thus does not encourage the skilled person (see page 1, lines 18 to 30). The simplicity of the process of claim 1 is an indication for inventive step. Starting from E9 or E20

would make no difference. Claim 1 therefore involves an inventive step.

Auxiliary request 2 corresponds to auxiliary request III as filed with the grounds of appeal and only the alternative f2) has been deleted. The auxiliary requests 3-9 were made to take account of the comments made in the Board's communication and filed as a reaction thereto. Consequently, they were filed in time. The feature "at which bainite transformation is not completed" of auxiliary requests 2 and 3 is a consistent generalisation of the definition of auxiliary request 9.

Claim 1 of auxiliary request 10 is based on claim 1 of auxiliary request 2 and page 18, lines 18 to 24 of the application as originally filed so that the requirements of Articles 123(2) and (3) should be met and it should also be clear since the hardness feature has been deleted. To change a possibility ("may begin") into a fact ("begins") represents no violation of Article 123(2) EPC. This new auxiliary request was filed in order to deal with formal objections raised the first time during the oral proceedings.

The reason for filing a further auxiliary request at this stage of the proceedings is that claim 1 of auxiliary request 11 is a combination of claims 1 and 2 as granted which were combined with the remaining features from the description as originally filed (page 19, lines 20 to 22) to meet the requirements of Article 123(2) EPC. Furthermore, the patentee should have the opportunity to save as much as possible of his patent.

XXII. Respondent I argued essentially as follows:

The appellant makes assumptions with respect to the person skilled in the art without giving any evidence. Claim 1 does not specify that only the surface area is cooled and it is unusual to measure the surface temperature. Isothermal transformation according to E21a means that the temperature of the fluidised bed is kept constant (see page 2, lines 12 to 22; page 5, lines 16 to 19 and lines 38 to 41). E21a acknowledged that it uses a higher carbon content than the prior art (see page 3, lines 36 to 48). The heat recuperation is the result of the latent heat in the steel rail and of the exothermic transformation reaction so that any rail is heated. These heats are removed by the fluidised cooling medium of E21a. Claim 1 only defines the upper limit of a temperature increase but not the lower limit. Furthermore, according to the patent in suit said heat recuperation can be suppressed within certain limits (see patent, paragraph [0049]). The fast cooling according to E21a takes place within less than 3 minutes whereas according to the patent in suit when starting from 700°C to 500°C with a cooling rate of 10°C/s it takes 20 seconds while with a cooling rate of 1°C/s it takes 200 seconds. Hence no problem can be seen with such parameters which would disable the skilled person. The transformation reaction needs about 3-4 minutes after reaching the cooling stop temperature. Locally does not mean the surface but means that there may be some points somewhere in the rail which may have undergone improper cooling. The argument that E20 has not considered E21a is no proof that the process of E21a has not been put into practice. Thus E21a is an

enabling disclosure and claim 1 of the main request lacks novelty over E21a.

E1 taken as the closest prior art by the appellant is arbitrarily chosen since the steel compositions for the steel rails according to E9 or E20 are closer to the steel composition of the patent in suit. There exists no reason for not combining E9 or E20 with E21 since after the hot rolling operation the transformation to bainitic structures has to be carried out. This, however, belongs to the common general knowledge (see E2/E7) and the person skilled in the art would apply this teaching if the transformation from austenite to lower bainite is desired. The heat recuperation occurs in any case and it cannot be inventive to carry out the transformation within the region of the (desired) lower bainite because otherwise a different structure would be obtained, e.g. if the temperature increase during the heat recuperation would be too high so that the region of e.g. pearlite could be reached. The heat recuperation must also take place according to E21 since it is a physical law. The heat recuperation according to claim 1 of the main request cannot make any difference with respect to inventive merit.

The auxiliary requests 3-9 were late filed and due to their late filing the features thereof could not be searched. The feature "at which the bainitic …" of auxiliary request 2 contravenes Article 123(2) EPC. The feature "by using air, …" of auxiliary request 3 may contravene Article 123(3) EPC. The hardness feature of auxiliary request 4 in combination with the cooling means represents a *desideratum* which cannot be used in a process claim since the expert does not know how to

proceed to obtain such hardness values. The features "for avoiding …" and "for making stable …" of auxiliary requests 5 to 7 contravene Article 123(2) EPC. The first added feature of auxiliary request 8 contravenes Article 84 EPC while the second contravenes Article 123(2) EPC. Likewise auxiliary request 9 violates Articles 84 and 123(2) EPC.

Claim 1 of auxiliary request 10 contravenes Article 83 EPC since the skilled person would have to make too many attempts to succeed ("undue burden"). Otherwise this unclear feature "depending on …" is superfluous since it only defines what happens during said process. The second feature "by using air, …" has not been searched, is taken from the description and does not contribute to the accelerated cooling rate.

Auxiliary request 11 is filed too late and its features are arbitrarily chosen and not linked with the features of the invention as set out in the description of the contested patent. Thus it should not be admitted.

XXIII. Respondent II argued essentially as follows:

The person skilled in the art is always needed to interpret the documents. Claim 1 teaches him that the rail head is cooled but this implies to him that also the other part of the steel rail are cooled. Furthermore, he understands from E21 that the whole rail is bainitic but not that it is homogeneous in the sense alleged by the appellant (see E21, column 3, lines 35 and 36). Claim 1 only requires a certain steel composition, a certain fast cooling rate to a certain stop temperature and then it is allowed to naturally

cool so that the result of heat recuperation can be obtained. E21 tells exactly the same, e.g. 400 seconds from a temperature from 800°C to 400°C with a cooling rate of 1°C/s. E21 mentions an isothermal transformation (see column 7, lines 31 to 37). The patentee argued during the examination proceedings that the heat recuperation in the claimed process is an isothermal transformation (see letter dated 3 August 1998, page 2, point 2.2.1 c)). This transformation starts somewhere in the temperature region and starts in the cooler parts and then continues so that there will also be a heat recuperation according to E21 since it is implied by the accelerated cooling rate as argued by the appellant (compare grounds of appeal, page 7). Consequently, there should be an increase of the surface temperature. Therefore claim 1 of the main request lacks novelty with respect to E21.

Claim 1 was considered to be novel over E21 due to feature f1) which is not known therefrom. The other features a) to e) are known from E21. E21 does not say anything about said heat recuperation which does not add anything since it takes place after such accelerated cooling. It was, however, already known that such heat recuperation takes place (see E21a, page 1, lines 18 to 24). Furthermore, the patent in suit shows that a temperature increase of more than 150°C never occurs (see Table 1, examples F and K). Hence feature f1) is not inventive. E21 has solved the problem with the steep temperature gradient during the accelerated cooling step which according to the Board's calculations is about 1.3°C/s (see communication dated 19 November 2007, point 3.2). So, even if it is not mentioned the heat recuperation will take place.

Measuring a temperature increase of 1°C at 400°C is not very accurate and within the measuring accuracy. But what is the additional effect if the temperature difference is about 1°C only? The effect will be about the same as that of the rail at said temperature without such heat recuperation. The cooling fluid according to E21 may even be a heating medium when the latent heat and the heat of transformation of the rail have been removed by it.

The feature "at which bainitic …" of auxiliary requests 2 and 3 contravenes Article 123(2) EPC and the negative definition is also not allowable as such. Auxiliary requests 4-9 contain mostly features which were not addressed before and do not relate to the appeal arising from the decision of the Opposition Division. Thus these requests bring forward new matter which has not been discussed before and therefore should not be admitted with respect to Article 12 of the new Rules of Procedure of the Boards of Appeal.

Claim of auxiliary request 10 represents a new request which is not based on the requests dated 19 December 2007. Furthermore, the wording "begins" of claim 1 is inconsistent with the disclosed "may begin and end" so that Article 123(2) EPC is contravened. The latter wording implies that there may be a third possibility, e.g. that the transformation ends after the heat recuperation phase. For example, if the temperature difference is very small such as 1°C then the duration of the heat recuperation would also be very short so that the transformation may not be completed or even may not have been started.

Auxiliary request 11 should not be admitted, mainly because the respondents were not in a position to prepare for such a combination of features. It is too late now for its filing.

Reasons for the Decision

Main request

1. *Novelty (Article 54 EPC)*

Both respondents argued that the subject-matter of claim 1 of the main request lacks novelty in view of document E21/E21a.

1.1 *Document E21 - enabling disclosure*

The appellant's arguments that E21/E21a represents a non-enabling disclosure cannot be accepted for the following reasons.

1.1.1 First of all, E21/E21a (all following quotations are based on E21a) clearly teaches the person skilled in the art a method for improving the properties of a steel rail which comprises the step of immersing the rail, while still hot on leaving the rolling mill, in a cooling medium maintained at constant temperature so that the cooling effect acts on parts of substantially equal mass and surface area to equalise the rate of cooling and effect uniform isothermal bainitic transformation at a temperature between 380 and 460°C, with an immersion time corresponding to a temperature-level period in the range 300 and 900 seconds (see

claims 1 and 4). Said cooling medium is a fluidised bed of refractory powder and the rail is introduced into this bed with the head of the rail at the bottom and the flange at the top with its flat face horizontal (see page 2, lines 12 to 22; claim 2). The installation for carrying out the process comprises means to ensure constant temperature of said fluidised bed (see page 5, lines 16 to 19). Isothermal transformation according to E21/E21a means that the bainitic transformation is carried out at a constant temperature of the fluidised bed (see page 2, lines 12 to 22 and lines 118 to 127). After the rail steel has been transformed isothermally in the described installation according to figure 1 it is removed from said cooling bed into position F and then shifted laterally to position G and laid down at H on the final cooling area 9 (see figure 1; page 5, lines 38 to 47). According to an embodiment of the installation shown in figure 3 the cooling time is less than or equal to 3 minutes and the time of maintenance at temperature is 10 minutes so as to ensure the transformation of the steel (see page 5, lines 58 to 69).

1.1.2 Considering an austenite region temperature of 800°C for the rail after the rolling mill, the range of the temperature difference with respect to said cooling stop temperature of 460-380°C for the lower bainite is between 340-420°C. This assumption would result in a cooling rate of about 2.2°C/sec. Taking account of a lowest temperature of 700°C after the rolling for the austenite region according to example C of Table 7 of the patent in suit, this temperature difference range would be 240-320°C resulting in a cooling rate of about 1.3°C/sec. Thus the cooling rate for this embodiment

according to E21/E21a should be considered to be at least 1.3°C/sec in the forced cooling step in the fluidised bed. Such a cooling rate in the order of 1-2°C/sec is considered not to be very high and it is credible that such a rate is obtainable with a fluidised bed of a refractory powder (see page 2, lines 23 to 40). The heat transfer rate of a mixture of refractory powder and gas as cooling medium is to be expected to be at least comparable to that of air as cooling medium. Consequently, higher cooling rates, such as 10°C/sec, are to be expected by the person skilled in the art.

1.1.3 In this context it is also remarked, that the person skilled in the art knows that there will always be a temperature gradient between the interior of the rail and its surface - due to the laws of thermodynamics - until the rail has reached exactly the same temperature as its surrounding medium.

1.1.4 Although E21/E21a states that the structure is uniform throughout the whole mass, and in consequence over the whole of any section (see page 3, lines 75 to 80) it is clear to the person skilled in the art that this statement has to be seen in the context that the **average cooling rate** of the head and the flange of the rail is **substantially the same** since their masses are of the same order of magnitude (see page 2, lines 70 to 90). Consequently, there can be slight differences in the cooling rates of the head and the flange which necessarily will result in a structure which **cannot** be homogeneous throughout the entire rail. The structure obtained by this process is stated to be pure lower bainite, without any trace of martensite (see page 3,

lines 98 to 104). This lower bainite structure is credible since the temperature range of 460-380°C is within the bainitic region (see E2, page 105) and is also within the range specified in claim 1 of the main request.

1.1.5 The rails according to E21/E21a have a higher carbon content than those of the prior art and the steel can contain (in wt.%) 0.4-1 C, 0.5-2.5 Mn, 0.02-1.8 Si, 0-1.5 Cr, 0-0.5 Mo, 0-0.4 V and 0-0.25 Nb (see page 3, lines 36 to 53 and lines 63 to 73). Said range of Si, Mn and Cr broadly overlaps with that of claim 1 of the main request while that of C only overlaps in the range of 0.4-0.45 wt.%.

1.1.6 The appellant has not submitted any evidence that a rail having such a steel composition with a higher carbon content in the non-overlapping range of 0.45-1% does not result in a lower bainitic structure when having undergone the aforementioned process of E21/E21a. Furthermore, E20 discloses a bainitic steel comprising 0.5% carbon (see page 385, paragraph 13.8.2)

1.1.7 Taking account of the points 2.1 to 2.1.6 above it is clear that there are no "contradictions" comprised in the disclosure of E21/E21a and that the person skilled in the art is enabled by its teaching to carry out the process described therein.

As a consequence of the conclusion above, E21/E21a has to be considered for the issue of novelty.

1.2 Claim 1 of the main request neither specifies that only the rail head surface is cooled (so that it also covers

the case wherein the whole rail is cooled so that the entire cross-section reveals an essentially uniform structure) nor that a specific bainite structure, namely lower bainite, is obtained.

Claim 1, however, specifies that after the accelerated cooling to a cooling stop temperature of 500-300°C at a rate of 1°C to 10°C per second, the rail head surface of the rail head is heated to a temperature not more than 150°C above the temperature reached on completion of the accelerated cooling by means of heat recuperation from the interior of the rail.

1.2.1 This temperature increase may be very small but must be measurable, e.g. it can be as low as 1°C as stated by the appellant (see patent, Table 7, example B). Heat recuperation means according to the patent in suit that the surface of the rail is reheated by the heat stored in the interior of the rail (the accelerated cooling causes a temperature gradient between the rail surface and the rail interior) and optionally by the heat resulting from the exothermic bainite transformation (see patent, paragraph [0047]).

1.2.2 As mentioned in point 2.1.3 above, there will always be a small temperature gradient so that also the rail after having undergone the accelerated cooling according to E21/E21a will have one. However, it is not known how big this gradient is.

It appears that it may be rather small since it is stated that in the fluidised bed which constitutes a cooling medium and "this cooling is limited to the temperature to which the medium was previously heated,

so that the part is rapidly brought to that temperature throughout its whole mass, and is maintained at that temperature (see page 2, lines 31 to 40).

E21/E21a is silent with respect to any temperature increase of the rail surface, let alone of the rail head surface caused by a temperature gradient.

1.2.3 In this context it needs to be considered that after the accelerated cooling (in less than or equal to 3 minutes) according to E21/E21a the rail including its rail head is still immersed in the fluidised bed so that any heat present in the interior of the rail is expected to be removed by the cooling medium via its surface. Such heat removal via the rail surface is also dependent upon the conditions of said fluidised bed which are also not described. If, for example, the ratio of the cooling medium stream per time unit relative to the total surface of the rail is high then no temperature increase is to be expected. Furthermore, after some minutes immersion time it is plausible that the rail actually may be heated and no longer cooled by the fluidised bed.

The respondents' arguments that heat recuperation always automatically takes place due to the accelerated cooling step so that there must be a temperature increase at the surface of the rail head therefore cannot be accepted.

1.2.4 Consequently, taking account of the disclosure of E21/E21a there exists no proof to the level required for novelty that heat recuperation - with a temperature increase of e.g. 1°C - takes place in the described

process. Therefore the subject-matter of claim 1 of the main request is considered to be novel, particularly over E21/E21a. Thus the requirements of Article 54 EPC are met.

2. *Inventive step (Article 56 EPC)*

2.1 The appellant considered E1 to be the closest prior art while the two respondents considered either E9 or E20 to be the closest prior art for the subject-matter of claim 1 of the main request.

2.1.1 Since the steel compositions used for making bainitic steel rails disclosed in E9 (see page 80, Image 1, "Zwischenstufenstähle") and in E20 (see page 380, Table 13.4, No. 10) fall exactly within the steel compositions as defined by claim 1 of the main request, and thus need no modification, these documents are considered to represent a closer state of the art than E1. The general steel composition for producing bainitic rails according to E1 only broadly overlaps with that of claim 1 and that according to the example is even outside the ranges required by claim 1. Furthermore, the process of E1 requires an additional annealing step at 450-600°C over a period of up to one hour (see page 1, line 68 to page 2, line 7 and lines 77 to 92). Therefore in accordance with the longstanding practice of the Boards of Appeal (see Case Law of the Boards of Appeal of the European Patent Office, 5th edition, 2006, section I.D.3.1 to I.D.3.6.) either E9 or E20 is selected as the closest prior art.

2.1.2 The steel composition No. 10 of Table 13.4 of E20 specifies (in wt%) 0.30 C, 0.20 Si, 2.00 Mn, 0.50 Mo,

1.00 Cr, 0.003 B, 0.03 Al and 0.03 Ti, the balance being iron and unavoidable impurities, has been used for making bainitic steel rails.

2.1.3 Hence the subject-matter of claim 1 of the main request is distinguished from the disclosure of the bainitic steel rail of steel composition No. 10 according to E20 by the process steps of
a) subjecting the head of an as rolled rail still hot or a rail head heated to a high temperature to an accelerated cooling from the austenite region to a cooling stop temperature of 500° to 300°C at a rate of 1° to 10°C per second, and
b) then heating the rail head to a temperature not more than 150°C above the temperature reached on completion of the accelerated cooling by means of heat recuperation from the interior of the rail, and
c) then naturally cooling to a lower temperature zone.

2.2 Thus the objective technical problem to be solved by the person skilled in the art is considered the provision of a process for producing a bainitic steel rail having the composition of E20.

2.3 The solution to this problem is the process of claim 1 of the main request.

2.4 The solution according to claim 1 is, however, considered to be obvious in view of E20 and the TTT diagram representing common general knowledge of the person skilled in the art, as known from e.g. E2.

2.4.1 It is clear to the person skilled in the art that the rolling mill operation for producing the steel rail

takes place in the austenite region of the steel, i.e. in the order of 800°C. Thereafter the rail has to be transformed from austenite to bainite to obtain the desired structure of the steel. After the transformation into bainite the rails have to be cooled to ambient temperature and the simplest, cheapest and most common form of further cooling is natural cooling.

2.4.2 The temperature, time, and transformation (TTT) diagrams belong to the common general knowledge of the person skilled in the art. Such a TTT diagram teaches the person skilled in the art which temperature region and which cooling rates for a given steel composition he has to select to obtain a specific structure, such as ferrite, bainite, pearlite, martensite, etc. of this steel (compare E2, page 105).

2.4.3 The person skilled in the art further knows that in order to produce a steel of a specific composition having only a bainitic structure he has to maintain the steel the during its phase transformation in the temperature region of bainite since otherwise he would obtain a structure containing e.g. quantities of undesired pearlite or martensite, if the temperature would be to high or to low, respectively. According to E21/E21a, for example, a temperature between 460-380°C is chosen in combination with a cooling rate in the order of 1-2°C/sec for the disclosed steel composition (see point 2.1.2 above).

2.4.4 The person skilled in the art likewise knows that the accelerated cooling of a massive product, such as a steel rail, results in that the surface layers are re-heated by the heat diffused throughout the body of the

rail head which remained hotter. This effect is due to the temperature gradient between the surface and the interior of the rail generated by the cooling medium (compare E21a, page 1, lines 18 to 30).

Consequently, the person skilled in the art already knows the effect, that the surface of the steel rail is re-heated after the accelerated cooling step, which effect is designated "heat recuperation" according to the patent in suit. It is clear to him that the temperature increase of the surface has to be considered insofar that no part or region of the steel rail reaches during the phase transformation a temperature not being within the bainitic region. As a further consequence, the person skilled in the art is expected to select an accelerated cooling rate and a corresponding temperature in the bainitic region which are on the safe side.

2.4.5 The temperature increase caused by the heat recuperation according to the patent in suit may be as low as 1°C (see Table 7, example B). First of all, measuring such a temperature increase of 1°C at a temperature of 400°C of the rail is not very accurate. Furthermore, the additional effect of such a small temperature difference of about 1°C is considered to be about the same as when the identical rail would be treated without such heat recuperation.

2.4.6 The Board thus considers that by applying the common general knowledge the person skilled in the art when starting from the steel composition according to E20 would arrive at a process falling under the definitions

of claim 1 of the main request. Claim 1 of the main request therefore does not involve an inventive step.

The main request is therefore not allowable under Article 56 EPC.

Auxiliary requests 2-9

3. *Admissibility of Amendments (Articles 84, 123(2) and (3) EPC)*

Auxiliary requests 2 and 3

3.1 In the communication accompanying the summons the Board had already explained as to why the feature "at which the bainitic transformation is not completed" - now contained in claim 1 of auxiliary requests 2 and 3 - was held to extend beyond the content of the application as originally filed (see point III above).

3.1.1 No explicit counterpart to the feature "**at which the bainite transformation is not completed**" in combination with the other features of claim 1, let alone in the quoted passage on page 13, line 23 to page 14, line 12 can be found in the application as originally filed. From the quoted passage it may be derived that such bainite formation is not completed only for the heat recuperation case with natural cooling, whereas taking account of page 18, line 18 to page 19, line 7 of the application as originally filed, it seems that the steel composition and the accelerated cooling rate have to be matched to obtain this result. Moreover, considering the wording "may begin and end" - used in said passage at page 18, lines 18 to 24 - it can be

concluded that further possibilities exist (see point 6.1 and 6.1.1 down below).

3.1.2 When asked by the Board whether there exists a difference between the said definition "at which … not completed" of claim 1 of auxiliary requests 2 and 3 and the two alternative definitions according to auxiliary request 9 (i.e. "wherein fine-grained bainite transformation begins in the course of accelerated cooling on the temperature range of 500 to 300°C where the accelerated cooling is stopped and ends in the subsequent heat recuperation process, or it begins and ends in the heat recuperation process immediately after the accelerated cooling") the appellant stated that the first one is a generalisation of the definition of auxiliary request 9 which is consistent with the quoted page 18.

However, the fact that a generalisation is consistent with something does not mean or imply that it has been disclosed, i.e. that there exists a basis for the generalisation. Furthermore, either there is a difference between the two different definitions of auxiliary request 2 and of auxiliary request 9, then it is not allowable, or if there is no difference then the question arises of why change it?

3.1.3 Consequently, it is evident that the feature "at which the bainite transformation is not completed" is not directly and unambiguously derivable from the application as originally filed and particularly that it is valid for all steel compositions and all cooling rates.

3.1.4 The Board therefore concludes that claim 1 of auxiliary requests 2 and 3, both identically containing said feature, contravene the requirements of Article 123(2) EPC. The auxiliary requests 2 and 3 are therefore not allowable.

Auxiliary requests 4 to 9

3.2 Claim 1 of auxiliary request 4 comprises the feature ", wherein the rail has a hardness of Hv 300 to 400 in the center of the rail head surface and a minimum of Hv350 in the gage corner, with the hardness of the gage corner being greater than that of the center of the rail head surface by a minimum of Hv 30".

3.2.1 It belongs to the common general knowledge of the person skilled in the art that the Vickers hardness is measured by subjecting the surface of a sample to load (P) for a standardized length of time by means of a pyramid-shaped diamond resulting in an indentation on the surface of said sample. The hardness is then calculated from the size of said indentation. Thus the Vickers number is determined by dividing the load (P) by the surface area (A) of the indentation (H = P/A).

3.2.2 Since the measured hardness is dependent upon the load (in certain cases deviations of the Vickers hardness of up to 35% may be obtained) it is absolutely necessary to specify the load used for carrying out the measurements.

In Annex F, for example, it is specified that the Vickers hardness was measured with a load of 98N (see page 260, Table 1). The applied load is specified when

the Vickers number HV is cited. The Vickers hardness according to Annex F would thus normally be specified as Hv 10 since said load of 98N corresponds to 10 kp. Without that indication the person skilled in the art cannot repeat the Vickers hardness measurement in a reliable and precise manner.

3.2.3 The Vickers hardness values of claim 1 of auxiliary request 4, however, are given without specifying the load. Consequently, claim 1 of auxiliary request 4 is rendered unclear through this missing indication which is contrary to the requirements of Article 84 EPC. Auxiliary request 4 is thus not allowable.

3.3 The same conclusion applies *mutatis mutandis* onto claim 1 of each of the auxiliary requests 5 to 9 which comprise the identical feature. Auxiliary requests 5 to 9 are therefore not allowable under Article 84 EPC, either.

Auxiliary request 10

4. *Admissibility*

Claim 1 of auxiliary request 10 was submitted in the course of the oral proceedings after the Board had considered that claim 1 of auxiliary requests 2-9 contravenes Article 123(2) and/or Article 84 EPC. It differs from claim 1 of auxiliary request 3 in that the feature "at which the bainitic transformation is not completed" - which was considered to contravene Article 123(2) EPC - was deleted and that the feature "**wherein depending on the selected steel composition and accelerated cooling rate bainite transformation**

begins in the course of accelerated cooling on the temperature range of 500 to 300°C where the accelerated cooling is stopped and ends in the subsequent heat recuperation process, or it begins and ends in the heat recuperation process immediately after the accelerated cooling" has been inserted.

4.1 Said inserted feature was based on the second feature of auxiliary request 9 (see point XIX, above) which the Board had considered to contravene Article 123(2) EPC because it was a generalization of the passage at page 18, lines 18 to 24 of the application as originally filed. This passage actually discloses "Depending on the selected steel composition and accelerated cooling rate, bainite transformation **may begin** … **and end** in the subsequent heat recuperation process, or it **may begin and end** in the heat recuperation process immediately after the accelerated cooling".

4.1.1 Said wording "may begin and end" differs from the wording "begins" and implies that the two disclosed alternatives do not represent the only possibilities with respect to the bainite transformation - if the temperature increase is only 1°C then it is plausible that the bainite transformation may end after the heat recuperation or that it may even begin and end after the heat recuperation. Thus there may exist a problem with Article 123(2) EPC.

4.1.2 Furthermore, this inserted feature allows two interpretations.

If it is considered to restrict the subject-matter of claim 1 to only those steel composition and cooling

rates which result in bainite transformations which begin during the accelerated cooling and end in the heat recuperation process or to those which begin and end in the heat recuperation process then the patent does not provide sufficient information to the person skilled in the art as to how to select the steel compositions and/or cooling rates in order to obtain this desired result. This is due to the fact that the description and also the examples of the patent are silent in this respect. Hence the requirements of Article 83 EPC do not appear to be met since an undue burden is put on the person skilled in the art.

On the other hand, if this feature only defines what happens with all steel compositions then it does not restrict the scope of claim 1 and can be neglected.

4.2 Thus the modified claim 1 fails to overcome the formal objections and additionally raises new matters which have not previously been addressed and is therefore *prima facie* not allowable, at least with respect to Article 83 EPC.

Consequently, auxiliary request 10 was not admitted into the proceedings.

Auxiliary request 11

5. *Admissibility*

Auxiliary request 11 was filed separately after auxiliary request 10 had not been admitted into the proceedings.

In the view of the Board a party to oral proceedings does not have a right to file an unlimited number of requests and particularly, the party should file any request at the earliest point possible in the proceedings, i.e. not in a piecemeal fashion.

The appellant had been given an opportunity to file a further auxiliary request, i.e. auxiliary request 10, to address the issues of Article 123(2) and/or Article 84 EPC which were raised in the oral proceedings. It did not file auxiliary request 11 at this point, but in fact waited until it had heard the continued objections from the two respondents in this respect. The Board considers that the request could have been filed either along with auxiliary request 10 or even instead of it, since from the Board's point of view it seemed to be obvious that the then raised Article 83 EPC objection would be brought forward by the respondents.

The appellant's argument with respect to the late filing of this request, that the patentee should have the opportunity to save as much as possible in the opposition appeal proceedings, cannot be accepted by the Board since in *inter partes* proceedings it is necessary to balance the rights of the involved parties so that **all** of them are in equal position. If the patentee is allowed to file at late stage new requests then the right of the opponent to challenge the patent are infringed as they could not be prepared for this.

Since the request was not filed at the point in the proceedings when it was possible to file it and the appellant had already been given an opportunity to file

further auxiliary requests, the Board exercised its discretion in accordance with Article 13(1) of the Rules of Procedure of the Boards of Appeal not to admit this late filed request.

6. Consequently, none of the requests on file is allowable.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

G. Nachtigall P. O'Reilly