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Case Number: T 1036/18 - 3.3.05

Application Number: 04727389.1

Publication Number: 1614761

IPC: C22C38/00

Language of the proceedings: EN

Title of invention:
STEEL MATERIAL WITH EXCELLENT ROLLING FATIGUE LIFE AND METHOD OF PRODUCING THE SAME

Patent Proprietor:
JFE Steel Corporation
JTEKT Corporation

Opponent:
Aktiebolaget SKF AB

Headword:
Steel/JFE

Relevant legal provisions:
EPC Art. 100(a), 54, 56

Keyword:
Novelty - (yes)
Inventive step - main request (no) - auxiliary requests (no)

Decisions cited:
T 0355/97, T 1097/09, T 0862/11, T 0219/83

Catchword:

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Case Number: T 1036/18 - 3.3.05

D E C I S I O N
of Technical Board of Appeal 3.3.05
of 3 December 2020

Appellant: (Opponent)	Aktiebolaget SKF AB 415 50 Gothenburg (SE)
Representative:	Boult Wade Tennant LLP Salisbury Square House 8 Salisbury Square London EC4Y 8AP (GB)
Respondent: (Patent Proprietor 1)	JFE Steel Corporation 2-3, Uchisaiwai-cho 2-chome Chiyoda-ku Tokyo, 100-0011 (JP)
Respondent: (Patent Proprietor 2)	JTEKT Corporation 5-8, Minamisemba 3-chome Chuo-ku, Osaka-shi Osaka 542-8502 (JP)
Representative:	Hoffmann Eitle Patent- und Rechtsanwälte PartmbB Arabellastraße 30 81925 München (DE)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 14 February 2018 rejecting the opposition filed against European patent No. 1614761 pursuant to Article 101(2) EPC.**

Composition of the Board:

Chairman	E. Bendl
Members:	S. Besselmann
	S. Fernández de Córdoba

Summary of Facts and Submissions

I. The appeal in this case lies from the opposition division's decision to reject the opposition against European patent No. EP 1 614 761 B1. The patent in suit concerns a steel material with an excellent rolling contact fatigue life and a method of producing that steel material.

II. The decision under appeal referred to, *inter alia*, the following documents:

D1	EP 1 048 744 A1 (KAWASAKI STEEL CO [JP]; KOYO SEIKO CO [JP]) 2 November 2000
D5	JP 2002 012919 A (KOYO SEIKO CO; DAIDO STEEL CO LTD) 15 January 2002
D5b	Human translation into English of D5 (version submitted on 2 January 2018)
D10	F. Hengerer: Wälzlagerstahl 100Cr6 - ein Jahrhundert Werkstoffentwicklung, HTM 57 (2002) 3, 144-155
D12	Declaration of Professor Hans W. Zoch

III. With its statement of grounds of appeal, the opponent (now appellant) raised objections including lack of novelty and, alternatively, lack of inventive step in view of Example 19 of document D1.

IV. With its reply to the appeal, the patent proprietor (now respondent) refuted the appellant's objections and maintained the claims filed on 26 January 2018 before the opposition division as its first auxiliary request. It submitted a second auxiliary request on

28 April 2020.

V. Oral proceedings were held on 3 December 2020 by videoconference.

VI. The claims of the main request (i.e. the patent as granted) relate to a steel having an excellent rolling contact fatigue life (claim 1) and a method for manufacturing a steel having an excellent rolling contact fatigue life (claim 2) and read as follows:

Claim 1: "*A steel having excellent rolling contact fatigue life, consisting of 0.7 to 1.1% C, 0.2 to 2.0% Si, 0.4 to 2.5% Mn, 1.6 to 4.0% Cr, 0.1% or more and less than 0.5% Mo, 0.010 to 0.050% Al, and 0.0010 to 0.0050% Sb by mass, optionally at least one element selected from the group consisting of 0.5 to 2.0% Ni, 0.05 to 1.00% V, 0.005 to 0.50% Nb, by mass, and balance of Fe and inevitable impurities; being treated by quenching and tempering; and having residual cementite grain sizes ranging from 0.05 to 1.5 µm, and prior-austenite grain sizes of 30 µm or smaller.*"

Claim 2: "*A method for manufacturing steel having excellent rolling contact fatigue life, comprising the steps of: spheroidizing a steel having a composition as defined in claim 1, by heating to temperatures ranging from 750°C to 850°C, and then by cooling to 700°C or lower temperature at 0.015°C/s or lower cooling rate; and quenching and tempering the spheroidized steel.*"

VII. The first auxiliary request differs from the main request in that the antimony content in claim 1 is specified as being "*more than 0.0010 to 0.0050% Sb by mass*".

The second auxiliary request differs from the main request in that the antimony content in claim 1 is specified as being "*more than 0.0010% Sb to 0.0050% or less Sb by mass*".

VIII. The appellant's arguments, where relevant to the present decision, can be summarised as follows.

Example 19 of D1 already discloses a steel composition within the scope of claims 1 and 2 at issue because its antimony contents cannot reliably be distinguished from the claimed range. The spheroidizing step in D1 implicitly involves slow cooling as required by claim 2; the microstructure recited in claim 1 is the inevitable consequence. Furthermore, even if the subject-matter of claims 1 and 2 could be distinguished from D1, it would be obvious for the skilled person in view of D1 as the closest prior art.

IX. The respondent's arguments, where relevant to the present decision, can be summarised as follows.

The steel according to claim 1 differs from Example 19 of D1 on account of the antimony content and the microstructure. The method according to claim 2 also differs from D1 on account of the antimony content and the spheroidizing annealing treatment feature, which is a counterpart to the microstructure feature of claim 1.

The distinguishing features are functionally interdependent, with the antimony content contributing to the microstructure and thus to the excellent rolling contact fatigue life. It is therefore necessary to formulate a single objective technical problem, namely that of providing steels exhibiting a superior rolling contact fatigue life. The experimental data in the patent in suit, in particular Samples 10 and 21 and Samples 18 and 19, confirm that an improvement is obtained. By contrast, the opponent, which bore the burden of proof under the Case Law of the Boards of Appeal of the EPO, 2019, 9th Ed. ("Case Law") (III.G. 5.1.2b, in particular T 862/11, and III.G.5.1.1, in particular T 219/83), did not provide any proof of its assertion that no improvement was obtained.

Starting from D1 as the closest prior art, neither the claimed steels nor the claimed method would have been obvious to the skilled person.

D1 teaches away from increasing the antimony content, as is clear from Figure 1 of D1. Moreover, the skilled person would not have found any guidance towards the claimed microstructure and the specific spheroidizing annealing treatment. In particular, the skilled person would not have applied the spheroidizing annealing treatment described in D5 to the steels known from D1, but rather would have modified the composition of the steel in line with the teaching of D5.

Even if the objective technical problem were merely the provision of further steels with a good rolling contact fatigue life, the skilled person would have been discouraged by Figure 1 of D1 from further increasing the antimony content.

The auxiliary requests define a minimum antimony content of more than 0.0010 mass% and are therefore even further distinguished from D1.

X. The appellant requests that the decision under appeal be set aside and the patent be revoked.

The respondent requests that the appeal be dismissed or, alternatively, that the patent be maintained on the basis of the first auxiliary request of 26 January 2018 or the second auxiliary request of 28 April 2020.

Reasons for the Decision

Main request

1. Novelty

1.1 The steel in claim 1 is defined in terms of, *inter alia,* its microstructure, namely the residual cementite grain sizes and prior-austenite grain sizes.

D1 does not explicitly mention these microstructure features. It therefore has to be decided whether they are inevitably obtained in D1.

The microstructure depends on the heat treatments performed. The heat treatment performed in D1, including the relevant Example 19, is similar to the general disclosure of the patent in suit and involves spheroidizing annealing in the range of 760 to 800 °C, but there is no mention of any cooling rate associated with this step.

The cooling rate affects the residual cementite grain size, as shown by comparing Samples 18 and 19 of the patent in suit. When a slow cooling rate of 0.005°C/s is used, the resulting residual cementite grain size is within the claimed range; when a fast cooling rate of 0.020°C/s is used, the resulting residual cementite grain size is lower than the claimed range.

There is no evidence that slow cooling would be the only option available to the skilled person for the spheroidizing annealing in D1. As indicated above, the patent itself shows that both a faster cooling rate and a different cementite grain size are possible in principle.

Hence, the steel defined in claim 1, having the indicated microstructure and in particular the residual cementite grain size in the specified range, has not been directly and unambiguously disclosed in D1, and is therefore novel (Article 100(a) EPC in conjunction with Article 54(1), (2) EPC).

1.2 For the same reasons, the method of claim 2, in which spheroidizing involves cooling to 700°C or less at a cooling rate of 0.015°C/s or less, is novel over D1.

2. Inventive step

2.1 The patent in suit relates to a steel suitable for anti-friction bearings and having an excellent rolling contact fatigue life even when used in more severe environments (paragraph [0001]).

2.2 D1 relates to the same purpose (paragraph [0001]) and may therefore be regarded as the closest prior art.

2.3 According to the respondent, the subject-matter of claim 1 differs from D1 on account of not only the specified microstructure (see the comments regarding novelty), but the antimony content too since the value of 9 ppm (0.0009 mass%) in Example 19 of D1 is outside the claimed range of 0.0010 to 0.0050 mass%.

The appellant contested that an antimony content of 0.0010 mass% could be distinguished from an antimony content of 0.0009 mass% due to measuring precision, citing, *inter alia*, D12.

In the following the board has assumed, to the respondent's benefit, that the antimony content constitutes a further distinguishing feature.

2.4 Need to formulate partial problems

2.4.1 The patent in suit does not teach any synergistic effect that would justify formulating a single technical problem.

Antimony is described as suppressing the decarbonising during heat treatment and refining the prior-austenite grains after quenching and tempering, thus improving the rolling contact fatigue life (paragraph [0024]).

The spheroidizing step, with cooling to 700°C or less at a cooling rate of 0.015°C/s or less, or the residual cementite grain size, as the associated microstructural feature of the steel, is also taught to lead to an improved rolling contact fatigue life (paragraphs [0009], [0011], and [0037]).

The above distinguishing features are therefore aimed at solving the same technical problem of improving the rolling contact fatigue life. This, however, does not imply any functional interrelation or synergistic effect, which would require an effect going beyond the sum of the individual effects.

In particular, the examples on which the respondent relied are designed to assess the individual effects of these features, namely one pair of examples (Samples 10 and 21) for illustrating the effect of the antimony content and another pair of examples (Samples 18 and 19) for illustrating the effect of the cooling rate on the residual cementite grain size and hence the rolling contact fatigue life (expressed as the B50 life ratio) in the absence of antimony.

It is seen that the presence of antimony is not essential, neither for the desired microstructure nor for obtaining a good rolling contact fatigue life. This can be taken not only from Sample 18 mentioned above, but also from each of Samples 9, 10, 11-17 in Table 1, which exhibit the desired microstructure and the required B50 life ratio of 10 or more (paragraph [0032]) despite not containing any antimony.

The comparison of Samples 10 and 21 addresses the additional presence of antimony. However, neither this comparison nor the observation that the best B50 values are obtained with antimony-containing alloys (Samples 24 and 25) supports any actual synergy in terms of an effect going beyond the sum of the individual effects.

Consequently, partial problems need to be formulated.

2.5 Partial problem associated with the antimony content

2.5.1 According to the respondent, the technical problem associated with the antimony content should be considered to be the provision of an improved steel having an improved rolling contact fatigue life (paragraphs [0001] and [0024] of the patent in suit).

2.5.2 The closest prior art D1 already addresses the same problem of improving the rolling contact fatigue life (paragraph [0001]).

The relevant question is therefore whether a further improvement is obtained in comparison with this closest prior art, namely Example 19 of D1. In particular, it needs to be decided whether the desired improvement is obtained by increasing the antimony content from 0.0009 mass% (Example 19 of D1) to 0.0010 mass% (lowest value encompassed by the claims at issue).

2.5.3 The patent in suit does not specifically address this question, nor is any direct comparison to this effect available. The relevant examples of the patent in suit (Samples 21 and 10) merely compare the presence of 0.0025 mass% antimony with the absence of antimony.

2.5.4 The respondent was of the opinion that the examples could be interpolated, so that there was a steady increase of the B50 life ratio between 0 and 0.0025 mass% antimony, including an increase between 0.0009 and 0.0010 mass%. The respondent acknowledged that the latter increase might be small but stressed that even a small improvement represented a worthwhile technical problem that should be considered for the assessment of inventive step.

2.5.5 The board does not agree. The patent provides no experimental data or express teaching on how the B50 life ratio evolves with the antimony content between the aforementioned examples in order to support the alleged steady increase. It is mentioned in general terms that a minimum of 0.0010 mass% is necessary for a "satisfactory effect" (paragraph [0024]), but there is no data supporting the criticality of this lower limit of 0.0010% mass%.

The claimed value of 0.0010 mass% is not only very close to the known value of 0.0009 mass%, but also closer to the unsatisfactory Sample 10 (conventional, no antimony) than to the relevant invention example (Sample 21, 0.0025 mass% antimony) for which the improvement has been shown.

Contrary to the respondent's arguments, these examples, which merely compare the presence and absence of antimony, do not lead to the conclusion that the rolling contact fatigue life would increase between antimony contents of 0.0009 mass% and 0.0010 mass%.

Moreover, for such an increase to be considered when assessing inventive step, it can indeed be small but it has to be measurable.

2.5.6 Under these circumstances, the respondent cannot be given the benefit of the doubt that increasing the antimony content from the known value of 0.0009 mass% to 0.0010 mass% would provide a measurable improvement of the rolling contact fatigue life. This conclusion is in line with the Case Law I.D.4.2., according to which the burden of proof for the alleged improvement rests upon the patent proprietor; see in particular T 355/97 (Reasons, 2.5.1) and T 1097/09 (Reasons, 2.3.3). It also follows the general principle that each party bears the burden of proof for the facts it alleges (Case Law III.G.5.1.1).

The respondent relied on Case Law III.G.5.1.2b, in particular T 862/11, and Case Law III.G.5.1.1, in particular T 219/83, to support its view that the appellant (opponent) bore the burden of proof.

These decisions are, however, less relevant to the case in hand.

Unlike in the case in hand, it could be derived from the patent under consideration in T 862/11 that the technical problem of achieving an improvement was successfully solved (Reasons, 6.3 and 6.5.1).

T 219/83 (OJ EPO 1986, 211) related to an allegation of fact regarding available prior methods (Reasons, 12) and is consequently also less relevant to the case at issue here.

2.5.7 The objective technical problem associated with the antimony content therefore needs to be formulated in a less ambitious manner as merely the provision of an alternative steel exhibiting a good rolling contact fatigue life.

2.5.8 The respondent was of the opinion that, even if no further improvement in comparison with D1 was acknowledged, the technical problem was still the provision of further steels exhibiting a good rolling contact fatigue life. In its opinion, the skilled person would therefore have only considered modifications which did not pose any risk of obtaining an inferior rolling contact fatigue life.

According to the respondent, D1 taught away from increasing the antimony content. The respondent argued, in particular, that Figure 1 of D1 showed that the rolling contact fatigue life ratio dropped significantly once the antimony content reached a level of 8 ppm (0.0008 mass%) or more. It held that the skilled person would have given preference to this technical reality over the subjective teaching of D1 in paragraph [0010] and would therefore have been discouraged from increasing the antimony content in Example 19 of D1.

2.5.9 The board does not agree. Claim 1 of D1 defines an antimony content range of 0.0010 mass% or less, so the value of 0.0010 mass% is expressly included. Moreover, D1 shows examples of an antimony content of 0.0009 mass% (several examples, Tables 1 and 2), in which it can be seen that good results are obtained when working at the high end of this range.

D1 teaches that the rolling contact fatigue life improved when the antimony content in the steel was decreased to 0.0015 mass%; at approximately 0.0010 mass%, the effect was saturated (paragraph [0010]). Figure 1 shows a better rolling contact fatigue life ratio at the above-mentioned antimony contents than at higher antimony contents. There is no discrepancy between the teaching of D1 and the supporting experimental data in Figure 1, i.e. the figure does not depict a different technical reality. Nor is there any indication that an antimony content of 8 ppm is a critical limit, which in any event would be inconsistent with the examples (Tables 1 and 2).

The conclusion drawn in D1 itself is that the antimony content should be 0.0010 mass% or less (claim 1 of D1), although D1 explicitly mentions that an effect can also be achieved at 0.0015 mass%.

This antimony content is simple to implement by decreasing the antimony content to no further than

0.0015 mass% or 0.0010 mass%, respectively, in line with the explicit teaching in D1 that the antimony content may be limited by controlling scraps (paragraph [0038]). In view of this explicit teaching in D1, it is irrelevant whether alternative steelmaking processes are available in which the skilled person would need to intentionally add antimony.

Starting from Example 19 of D1, therefore, the skilled person would have contemplated using an antimony content of 0.0010 mass%, on the expectation of achieving a good rolling contact fatigue life, without the need of performing an inventive step.

2.6 Partial problem associated with the microstructure

2.6.1 The objective technical problem associated with the microstructure is considered to be the provision of a bearing steel with an improved rolling contact fatigue life (paragraphs [0001] and [0009]).

2.6.2 The proposed solution is the claimed steel having the specified microstructure.

2.6.3 The above-mentioned technical problem has been successfully solved, as shown by the experimental data provided in the patent in suit, in particular the comparison of Samples 18 and 19 and Samples 8 and 10 (paragraphs [0034], [0035] and [0037]).

2.6.4 According to the appellant, this solution is obvious from D5.

2.6.5 D5 (considered in the form of its translation D5b) describes a bearing steel in which the maximum carbide grain size is 1.5 µm and the amount of carbide is 2 to

7% in terms of area ratio, after a spheroidizing annealing treatment, including furnace cooling at a cooling rate of 10°C/hour (0.0028°C/s), and a quenching treatment and a tempering treatment have been carried out (paragraph [0017]). It is taught that this bearing steel has superior cold workability, a longer rolling contact fatigue life when used as a bearing component and lower costs than conventional high-carbon chromium bearing steel such as JIS SUJ2 (same paragraph). According to D5, the rolling contact fatigue life shortens if the maximum carbide size exceeds 1.5 µm (paragraph [0012]).

2.6.6 D5 thus addresses the same technical problem, namely improving the rolling contact fatigue life, and proposes a similar solution, i.e. adjusting the maximum carbide (cementite) grain size to 1.5 µm or less. The embodiments of D5 exhibit maximum carbide grain sizes ranging from 0.69 to 0.94 µm (Table 1).

2.6.7 The skilled person faced with the technical problem of improving the rolling contact fatigue life would have readily applied this teaching of D5 to D1. The skilled person would have been aware that the teaching of D5 merely fills in aspects missing in D1, namely the details regarding the cementite grain size and those regarding the associated spheroidizing annealing step (specifically the cooling rate), without requiring any modification of D1.

2.6.8 As follows from the considerations regarding novelty (see point 1.), the only reason why the cementite size is not inevitably obtained in D1 is because D1 does not specify any cooling rate during spheroidizing annealing. As can be taken from the patent in suit, the required cementite size is automatically obtained by using a cooling rate of 0.015°C/s or less (paragraphs [0011] and [0027]; examples).

2.6.9 The skilled person would have been aware that the steel microstructure is governed by both the composition and the heat treatment performed. D5 itself relates these to the maximum carbide grain size (paragraph [0012]). D5 mentions in particular the spheroidizing annealing treatment, which includes furnace cooling, and specifies the cooling rate, thereby implicitly linking this step to obtaining the desired maximum carbide grain size (same paragraph). This understanding is furthermore supported by paragraph [0017] of D5.

At the same time, the skilled person would have been aware that D1 is silent as to the steel microstructure and lacks some details regarding the spheroidizing annealing, namely its duration and any temperature holding or controlled cooling steps; D1 only mentions "spheroidizing annealing in the range of 760 to 800°C" (paragraph [0034]).

2.6.10 The respondent argued that the skilled person would have been discouraged from complementing these details in the light of D5 because of the differences between the alloy compositions, in particular the carbon (C) and chromium (Cr) contents, which are relevant for cementite formation and stabilisation. Specifically, it was an essential feature of D5 that the carbon content is in the range of 0.6 to 0.8 mass%, which is below the range disclosed in D1 and in particular below the carbon content in the relevant Example 19 of D1 (1.05 mass%). A carbon content of 1.01 mass% is only used in a comparative example in D5 (Table 1). The chromium content required in D5 (0.4 to 1.2 mass%) is also lower than in D1 (2.01 mass% in Example 19). D5 does not mention any antimony.

However, the skilled person would have been aware that both D1 and D5 use the same steel grade, namely a conventional SUJ2 bearing steel, as the reference for calculating the B10 life ratio (paragraph [0035] of D1 and paragraph [0021] of D5). The skilled person would also have been aware that the cooling rate taught in D5 is an ordinary cooling rate for this reference steel grade, as follows from D12 (in conjunction with D10 cited in that document), given that the steel grade 100Cr6 corresponds to SUJ2. Moreover, D5 does not require the heat treatments to be adapted to the specific alloy composition used.

2.6.11 For these reasons, and in view of the similarity between the heat treatments in D1 and D5, the skilled person would readily fill in the gaps in the teaching of D1 in the light of the teaching of D5, namely the details of the spheroidizing annealing step, and in doing so would obtain the required cementite grain size.

2.6.12 The resulting heat treatment process as a whole, involving not only spheroidizing annealing at 760 to 800°C but also maintaining the temperature at 830°C for 30 minutes followed by quenching (paragraph [0034] of D1), fulfils the criteria set out in the patent in suit for obtaining not only the residual cementite grain sizes but also the prior-austenite grain sizes stipulated in claim 1 at issue (paragraphs [0027] and [0028] of the patent in suit). This conclusion is supported by comparing Example 19 of D1 with Examples 10, 10b and 10c of the patent in suit.

The skilled person starting from Example 19 of D1 would therefore have been prompted by D5 to complement the teaching of D1 and would have arrived in an obvious manner at a steel exhibiting the microstructure defined in claim 1 at issue.

2.7 For these reasons, the subject-matter of claim 1 does not involve an inventive step (Article 100(a) EPC in conjunction with Article 56 EPC).

2.8 For the same reasons, the skilled person would have been prompted by D5 to use a cooling rate in the claimed range and would thus have arrived at the method of claim 2 without exercising inventive skill.

Auxiliary requests

3. Claim 1 of the first auxiliary request differs from claim 1 of the main request in that the antimony content is specified as being "more than 0.0010 to 0.0050% Sb by mass". In claim 1 of the second auxiliary request, the antimony content is specified as being "more than 0.0010% Sb to 0.0050% or less Sb by mass".

The board does not concur with the appellant's interpretation of the first auxiliary request that the antimony content is to be more than 0.0050% Sb by mass. Both auxiliary requests have the same scope.

Compliance with the requirements of Articles 84 and 123 EPC notwithstanding, the same considerations regarding a lack of inventive step set out in view of the main request also apply to the auxiliary requests. In particular, there is no indication that the technical problem solved by the presence of more than 0.0010 mass% antimony would in any way differ from the technical problem solved by the presence of 0.0010 mass% antimony. Moreover, D1 clearly teaches that even though the claimed upper limit of the antimony content is 0.0010 mass%, a technical effect is also obtained at 0.0015 mass% antimony (see point 2.5.9). This teaching in conjunction with the indication in D1 that "at approximately 0.0010 mass%, the improvement effect was saturated" (paragraph [0010]) suggests to the skilled person that an antimony content of "more than 0.0010 mass%" is also suitable.

Hence, the subject-matter of claims 1 and 2 of both auxiliary requests also lacks an inventive step.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The patent is revoked.

The Registrar: The Chairman:

C. Vodz E. Bendl

Decision electronically authenticated