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**Datasheet for the decision
of 11 January 2008**

Case Number: T 0044/05 - 3.2.07

Application Number: 96107594.2

Publication Number: 0743370

IPC: C21D 8/12

Language of the proceedings: EN

Title of invention:

Grain oriented electrical steel having high volume resistivity
and method for producing same

Patentee:

ARMCO INC.

Opponent:

ThyssenKrupp Electrical Steel GmbH

Headword:

-

Relevant legal provisions:

EPC Art. 56, 123(2)

RPBA Art. 13(1)

Relevant legal provisions (EPC 1973):

RPBA Art. 10b(1)

Keyword:

"Admissibility of new formal objections with respect to
feature not changed since the grounds of appeal (no - prima
facie not relevant)"

"Inventive step (main request - no)"

"Admissibility of amendments (auxiliary requests I and II -
no)"

Decisions cited:

T 0201/83, T 0925/98

Catchword:

-



Case Number: T 0044/05 - 3.2.07

D E C I S I O N
of the Technical Board of Appeal 3.2.07
of 11 January 2008

Appellant:
(Patent Proprietor)

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Respondent:
(Opponent)

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Decision under appeal:

Decision of the Opposition Division of the
European Patent Office posted 26 October 2004
revoking European patent No. 0743370 pursuant
to Article 102(1) EPC.

Composition of the Board:

Chairman: H. Meinders
Members: H. Hahn
E. Dufresne

Summary of Facts and Submissions

- I. The patent proprietor lodged an appeal against the decision of the Opposition Division to revoke European patent No. 0 743 370.
- II. An opposition had been filed against the patent as a whole under Article 100(a) EPC on the grounds of lack of novelty and inventive step, and under Article 100(b) EPC, 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.

The Opposition Division held that claims 1 to 11 of the main request dated 26 July 2004 and of the auxiliary requests I and II as filed at the oral proceedings of 6 October 2004 met the requirements of Articles 123(2) and (3) EPC and of Article 100(b) EPC. The Opposition Division further considered that the subject-matter of claims 1 and 7 of the main request was novel with respect to D1 to D4 but that the subject-matter of claim 11 was not novel as it did not meet the requirements for a selection invention with respect to D2 (EP-A-0 566 986). Furthermore, the subject-matter of claims 1 and 11 of the main request was considered to lack an inventive step with respect to D1 (JP-A-05 306 410). The subject-matter of claims 1, 7 and 11 of auxiliary requests I and II was considered to be novel but the subject-matter of claim 11 of both requests was considered to lack an inventive step in view of D2.

- III. With a communication dated 10 September 2007 annexed to the summons to oral proceedings the Board presented its preliminary opinion based on claims 1 to 11 of the main

request and of the auxiliary requests I to III, all requests as submitted with the grounds of appeal dated 23 February 2005.

- III.1 The Board gave its preliminary opinion that, among others, the main request seemed to meet the requirements of Article 123(2) EPC while the independent claims of auxiliary request I appeared to contravene Article 123(2) EPC.

With respect to the "closed definition" (=100%) of the steel compositions in claims 1, 7 and 11 as granted ("comprises in weight percent, ..., the balance being iron and unavoidable impurities") these steels **cannot** contain any deliberately added elements other than those specified, but may contain other elements falling under the definition "unavoidable impurities". Thus, there would be an inconsistency between paragraphs [0035] and [0046] of the description concerning the deliberate additions of molybdenum or of other elements and claims 1, 7 and 11 of all requests.

- III.2 The subject-matter of claim 11 of all requests seemed to be novel, particularly with respect to the steel compositions of D2.

With respect to inventive step the Board stated that D2 seemed to represent the closest prior art. Furthermore, taking account of the different steel compositions of all examples of the patent in suit and the "comparative" examples therein, which correspond to the teaching of prior art documents different from D2 (see patent, Tables 1-8) it seemed to be difficult to derive which effect is caused by the feature Mn_{eq} and the

content of Si, Mn, Cr, Ni, Cu, etc. and whether there exists any improvement over the electrical steel sheets according to D2 since no comparison was available.

Claim 11 of the main request appeared to be distinguished from D2 by a minimum Mn_{eq} value of at least 0.5%, a minimum volume resistivity of at least $50 \mu\Omega cm$, a certain range for the %Si-0.45 % Mn_{eq} value from 2 to 4.4 and a minimum volume fraction of the austenite of at least 5%. Taking account of the missing comparison with D2 in the patent in suit and of the overlap of the concentration ranges of the relevant elements of the electrical steel sheet composition according to D2 it had to be considered that some compositions based on the preferred Si-content of 3.4% Si, the C-content of from 0.025-0.075 % and the maximum Mn-content of 0.8% (optionally additionally comprising 0.03-0.2% Cr) met these four claimed requirements, even though the latter were not explicitly mentioned in D2. Thus it seemed reasonable to define a less ambitious objective technical problem of simply providing an alternative steel composition for a process for producing grain oriented electrical steel sheet having an aluminium nitride inhibitor system (see Case Law of the Boards of Appeal of the European Patent Office, 5th edition 2006, chapter I.D.4.5). Thus it needed to be discussed whether or not the person skilled in the art would seriously contemplate to work in the mentioned overlapping ranges, particularly as there appeared to exist no prejudice to use a Mn-content of up to 0.8%.

III.3 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 Rules of Procedure of the BoA, in force as of 1 May 2003 and especially of Article 10b (as of 13 December 2007: Article 13).

IV. With letter dated 10 December 2007 the appellant (patent proprietor) filed an amended main request and amended auxiliary requests I to III.

V. Oral proceedings before the Board were held on 11 January 2008. With respect to the main request the discussion concentrated on the issues of admissibility of the amendments and inventive step with respect to claim 11 in relation to documents D2, D3 (Houdremont, Handbuch der Sonderstahlkunde, 1956, pages 473 and 474) and D4 (US-A-5 250 123) - all documents of the opposition proceedings and referred to in the appeal proceedings. With respect to auxiliary requests I and II only their admissibility under Articles 123(2) and (3) EPC was discussed. In the course of the oral proceedings four consecutive versions of auxiliary requests I and two consecutive versions of auxiliary request II, each time replacing the previously submitted version, were discussed. Auxiliary request III dated 10 December 2007 was withdrawn at the oral proceedings.

(a) The appellant requested that the decision under appeal be set aside and the patent be maintained

on the basis of the main request filed with letter dated 10 December 2007 or, in the alternative, on the basis of auxiliary request I or II filed at the oral proceedings.

- (b) The respondent (opponent) requested that the appeal be dismissed.

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

VI. Claim 11 according to the main request reads as follows:

"11. A grain oriented electrical steel melt, comprising, in weight percent, greater than 2.25 - 5% Si, 0.01 - 0.08% C, 0.015 - 0.05% Al, up to 0.01 % S, 0.001 - 0.011 % N, 0.5 - 4.5 % Mn, Mn_{eq} of at least 0.5 %, said Mn_{eq} being defined as

$\% Mn_{eq} = \%Mn + 1.5(\%Ni) + 0.5(\%Cu) + 0.1 (\%Cr)$, and

optionally up to 3% Cr, up to 1% Cu, up to 2% Ni, the balance being iron and unavoidable impurities to provide a volume resistivity of at least 50 micro-ohm-cm of the final electrical steel, said volume resistivity being defined as

$vol. resistivity = 9.2 + 12.2\% Si + 4.6(\%Mn + \%Cr) + 2(\%Cu) + \%Ni$, said steel composition balanced such that

$2.0 \leq [(\% Si) - 0.45 (\% Mn_{eq})] \leq 4.4$ and such that a volume fraction of austenite $\gamma_{1150^{\circ}C}$ in a hot rolled band produced from said melt is at least 5 % up to 40%, said $\gamma_{1150^{\circ}C}$ being defined as

$\gamma_{1150^{\circ}C} = 15.1 (\%Mn_{eq}) + 784 (\%C) - 33.7 (\%Si) + 88.7."$

VII. Claims 1, 4 and 7 according to auxiliary request I read as follows:

"1. A method of producing grain oriented electrical steel having an aluminum nitride inhibitor system, said method comprising the steps of:

- a) providing a hot rolled band which comprises, in weight percent, 3.72 - 5 % Si, 0.054 - 0.08 % C, 0.024 - 0.05 % Al, 0.002 up to 0.01 % S, 0.8 - 4.5 % Mn, at least 0.82 % Mn_{eq}, said Mn_{eq} being defined as $\% \text{Mn}_{\text{eq}} = \% \text{Mn} + 1.5(\% \text{Ni}) + 0.5(\% \text{Cu}) + 0.1(\% \text{Cr})$, 0.007 - 0.011 % N, up to 3 % Cr, up to 1% Cu, up to 2% Ni, 0.001 up to 0.1% Sn, 0.014 up to 0.5% P, up to 0.01 % Se and up to 0.1 % Sb, the balance being iron and unavoidable impurities to provide a volume resistivity of at least 58.6 micro-ohm-cm, said volume resistivity being defined as $\text{vol. resistivity} = 9.2 + 12.2 \% \text{Si} + 4.6(\% \text{Mn} + \% \text{Cr}) + 2(\% \text{Cu}) + \% \text{Ni}$, said steel composition balanced such that $3.35 \leq [(\% \text{Si}) - 0.45 (\% \text{Mn}_{\text{eq}})] \leq 4.4$;
- b) providing $\gamma_{1150^\circ\text{C}}$ in said band of at least 5 % up to less than 40 % ; said $\gamma_{1150^\circ\text{C}}$ being defined as $\gamma_{1150^\circ\text{C}} = 15.1(\% \text{Mn}_{\text{eq}}) + 784(\% \text{C}) - 33.7(\% \text{Si}) + 88.7$;
- c) initial annealing said band by heating said band to a temperature of 900 to 1150°C for a soak time of 180 seconds or less and heating said band to a secondary soaking temperature of 775 - 950°C for a soak time of from 0 - 300 seconds and cooling;
- d) cold rolling said annealed band in 1, 2 or more stages to a final strip thickness,
- e) decarburizing said strip to a carbon level below 0.005%;
- f) nitriding said band following primary recrystallization and prior to secondary grain growth

to provide excess nitrogen;
g) providing said strip with an annealing separator coating at a stage selected from the group of before nitriding, after nitriding or between nitriding treatments;
h) final annealing said coated strip at a temperature of at least 1100°C (2010°F) for at least 5 hours to effect secondary grain growth and purification."

"4. A method for producing regular grain oriented electrical steel having at least 94.1% of saturation at 795.77 A/m (10 oersteds), comprising the steps of:

a) providing a band having a thickness of from 1.0 - 3.0 mm, said band comprising, in weight percent, 3.72 - 5 % Si, 0.054 - 0.08 % C, 0.024 - 0.05 % soluble Al, 0.002 up to 0.01 % S, 0.8 - 4.5 % Mn, up to 3 % Cr, up to 1 % Cu, up to 2 % Ni, greater than 0.82 % Mn_{eq}, said Mn_{eq} being defined as

$$\% \text{ Mn}_{\text{eq}} = \% \text{ Mn} + 1.5(\% \text{ Ni}) + 0.5(\% \text{ Cu}) + 0.1(\% \text{ Cr}),$$

0.007 - 0.011 % N and balance being iron and unavoidable impurities to provide a volume resistivity of at least 50 micro-ohm-cm, said volume resistivity being defined as

$$\text{vol. resistivity} = 9.2 + 12.2 \% \text{ Si} + 4.6(\% \text{ Mn} + \% \text{ Cr}) + 2(\% \text{ Cu}) + \% \text{ Ni}, \text{ said steel composition balanced such that } 3.35 \leq [(\% \text{ Si}) - 0.45 (\% \text{ Mn}_{\text{eq}})] \leq 4.4;$$

b) annealing said band at a temperature of from 900 - 1125°C (1650 - 2050°F) for a time up to 10 minutes, said annealed band having

$\gamma_{1150^\circ\text{C}}$ of at least 10 % up to less than 40 %, said $\gamma_{1150^\circ\text{C}}$ being defined as

$$\gamma_{1150^\circ\text{C}} = 15.1(\% \text{ Mn}_{\text{eq}}) + 784(\% \text{ C}) - 33.7(\% \text{ Si}) + 88.7;$$

c) cold rolling said annealed band in a single stage with a final reduction of greater than 75 to 93 % to

final gauge strip;

d) decarburizing said strip to a carbon level less than 0.005%;

e) nitriding said strip to provide a minimum level of nitrogen of at least 150 ppm;

f) providing said strip with an annealing separator coating; and

g) final annealing said coated strip for a time and temperature sufficient to develop secondary recrystallization and provide a percent of saturation of at least about 94.1 %, said percent of saturation being defined as

% saturation at 795.77 A/m = $B(\text{in Teslas at } H = 795.77 \text{ A/m}) / [\text{Atomic \% Fe} + \text{Atomic \% Ni}] / 0.0002115.$ "

"7. A grain oriented electrical steel melt, comprising, in weight percent, 3.72 - 5% Si, 0.054 - 0.08% C, 0.024 - 0.05% Al, 0.002 up to 0.01 % S, 0.007 - 0.011 % N, 0.8 - 4.5 % Mn, Mn_{eq} of at least 0.82 %, said Mn_{eq} being defined as

% $Mn_{eq} = \%Mn + 1.5(\%Ni) + 0.5(\%Cu) + 0.1 (\%Cr)$, up to 3 % Cr, up to 1 % Cu, up to 2 % Ni, the balance being iron and unavoidable impurities to provide a volume resistivity of at least 58.6 micro-ohm-cm of the final electrical steel, said volume resistivity being defined as

vol. resistivity = $9.2 + 12.2\% Si + 4.6(\%Mn + \%Cr) + 2(\%Cu) + \%Ni$, said steel composition balanced such that $3.35 \leq [(\% Si) - 0.45 (\% Mn_{eq})] \leq 4.4$ and such that a volume fraction of austenite $\gamma_{1150^\circ C}$ in a hot rolled band produced from said melt is at least 5 % up to less than 40 %, said $\gamma_{1150^\circ C}$ being defined as

$\gamma_{1150^\circ C} = 15.1 (\%Mn_{eq}) + 784 (\%C) - 33.7 (\%Si) + 88.7.$ "

VIII. Claim 1 according to auxiliary request II reads as follows:

"1. A method of producing grain oriented electrical steel having an aluminum nitride inhibitor system, said method comprising the steps of:

a) providing a hot rolled band which comprises, in weight percent, 3.69 - 5 % Si, 0.049 - 0.08 % C, 0.027 - 0.05 % Al, 0.002 up to 0.01 % S, 0.81 - 4.5 % Mn, at least 1.08 % Mn_{eq}, said Mn_{eq} being defined as
$$\% \text{Mn}_{\text{eq}} = \% \text{Mn} + 1.5(\% \text{Ni}) + 0.5(\% \text{Cu}) + 0.1(\% \text{Cr}),$$
0.008 - 0.011 % N, 0.27 up to 3 % Cr, 0.16 up to 1% Cu, 0.11 up to 2% Ni, 0.013 up to 0.1 % Sn, 0.022 up to 0.5% P, up to 0.01 % Se and up to 0.1 % Sb, the balance being iron and unavoidable impurities including at least 0.035 % Mo to provide a volume resistivity of at least 59.9 micro-ohm-cm, said volume resistivity being defined as

$$\text{vol. resistivity} = 9.2 + 12.2 \% \text{ Si} + 4.6(\% \text{Mn} + \% \text{Cr}) + 2(\% \text{Cu}) + \% \text{Ni},$$
said steel composition balanced such that $3.2 \leq [(\% \text{ Si}) - 0.45 (\% \text{Mn}_{\text{eq}})] \leq 4.4;$

b) providing $\gamma_{1150^\circ\text{C}}$ in said band of at least 5 % up to less than 40 % ; said $\gamma_{1150^\circ\text{C}}$ being defined as

$$\gamma_{1150^\circ\text{C}} = 15.1(\% \text{Mn}_{\text{eq}}) + 784(\% \text{C}) - 33.7(\% \text{Si}) + 88.7;$$

c) initial annealing said band by heating said band to a temperature of 900 to 1150°C for a soak time of 180 seconds or less and heating said band to a secondary soaking temperature of 775 - 950°C for a soak time of from 0 - 300 seconds and cooling;

d) cold rolling said annealed band in 1, 2 or more stages to a final strip thickness,

e) decarburizing said strip to a carbon level below 0.005%;

f) nitriding said band following primary

recrystallization and prior to secondary grain growth to provide excess nitrogen;

g) providing said strip with an annealing separator coating at a stage selected from the group of before nitriding, after nitriding or between nitriding treatments;

h) final annealing said coated strip at a temperature of at least 1100°C (2010°F) for at least 5 hours to effect secondary grain growth and purification."

IX. The appellant argued essentially as follows:

The amendments made to claim 11 of the main request, which is based on claim 11 as granted, are based on claim 10 as originally filed in combination with page 7, lines 22 to 29, page 8, line 27 to page 9, line 6 and lines 12 to 15, page 10, lines 7 to 12 and lines 13 to 33 of the application as originally filed and are in line with the practice of the Boards of Appeal (see Case Law of the Boards of Appeal of the European Patent Office, 5th edition 2006, section III.A.2.1; see T 925/98 of 13 March 2001, not published in OJ EPO). The respondent's belated objections under Article 123(2) EPC, made for the first time in the oral proceedings before the Board, violate Article 10b of the RPBA (2003) and no inconsistencies can be seen to exist between Figures 1 and 2 on the one hand and the description and the ranges of claims 1, 7 and 11 on the other hand. The quoted passage at page 10, lines 7 to 10 of the application as originally filed states that the Mn content "is typically about 0.5 to about 3.0% with about 3.1 to about 4.75% Si" which definition does not exclude that the Mn-concentration may be different. Thus the requirements of Articles 123(2) and (3) EPC are met for claim 11 of the main request.

The subject-matter of claim 11 of the main request is novel for the reasons as set out in the Board's communication accompanying the summons to oral proceedings. In respect of inventive step: as derivable from the description of the patent, composition claim 11 relates to a specific class of alloy materials based on an AlN grain growth inhibitor system and "low reheat technology" which must have transcritical behaviour to be suitable for low reheating in order to achieve a high degree of orientation during the secondary grain growth and to obtain excellent magnetic properties of the resulting electrical steel sheets (see page 1, lines 25 to 30; page 2, lines 3 to 6 and lines 21 to 36; page 3, lines 10 to 22). Furthermore, to achieve a specific volume resistivity and a specific austenite fraction the concentrations of Si, C, Mn, etc. had to be carefully adapted (see page 8, lines 5 to 10 and line 35 to page 9, line 8, and line 30 to page 10, line 2, and line 34 to page 11, line 5). D2 does not suggest such a composition and is silent about Mn_{eq} . The person skilled in the art taking account of the 57 examples in D2, which all involve Mn in the low range of about 0.13-0.14% and thus are far distant from the claimed range of 0.5-4.5% Mn according to claim 11, would not seriously contemplate to work in the higher part of the range of 0.05-0.8% Mn claimed in D2, i.e. would not use high Mn-contents, particularly since they deteriorate the magnetic properties (see D2, page 4, line 13 ff; page 8, lines 19 to 23). The question of inventive step in the present case is a typical "could-would" issue. In any case, the claims of D2 do not reflect the actual teaching of D2.

The calculations based on the equations of the patent in suit, using the values of the examples of D2, represent an ex-post facto analysis of this document. The teaching of D2 cannot be combined with that of D4 either, since the latter concerns a totally different system, i.e. ultra low carbon, which contains $\leq 0.015\%$ Al and uses a different $\%Si-0.45\%Mn_{eq}$ value, namely less than 2.0, which does not need any decarburizing treatment (see D4, column 2, lines 42 to 49; column 3, lines 9 to 17; column 11, lines 29 to 35).

The problem starting from D2 is to provide good magnetic properties and to provide a stable system for secondary grain growth. Although the composition of claim 11 according to the patent in suit provides similar magnetic properties as the compositions of D2 it provides a different, i.e. sharper, texture. Unfortunately, no evidence showing the improvements can be offered.

It is not relevant for inventive step that the patent in suit contains examples of which the concentrations for Mn are outside the ranges of claim 11.

The subject-matter of claim 11 is thus neither rendered obvious by D2 nor by a combination of D2 and D4.

The amended values of the ranges in claims 1, 4 and 7 according to auxiliary request I are based on example AE in the patent in suit. Taking account of the general disclosure of the application (see page 8, line 29; page 10, lines 10 to 33) underlying the patent in suit and in the light of decision T 201/83 (EPO OJ 1984, 481) it is not apparent that the subject-matter claimed

should be restricted to the combination of all the concentration, property and ratio values of this example as the minimum values of the ranges claimed. The specific amounts of Mo, Cr, Ni, Cu, P, Sn, etc. used in this example are not closely related with the other features of the example and thus can be neglected. These values therefore need not be incorporated in claims 1, 4 and 7. The value of 3.35 for the lower limit of the $[(\%Si) - 0.45(\%Mn_{eq})]$ -value was recalculated from the concentration values of 3.72% Si and 0.8% Mn taken from example AE.

The amended values of claim 1 according to auxiliary request II are taken from example AC. Furthermore, taking account of paragraph [0035] of the patent in suit, which mentions generally elements of minor importance, Mo can be present in the steel composition as an unavoidable impurity. The Mo-content of 0.035% represents the level of such an impurity. Consequently, the amendment "at least 0.035% Mo" contravenes neither Article 123(3) EPC nor Article 123(2) EPC.

X. The respondent argued essentially as follows:

The concentration range "0.5 to 4.5% Mn" of claim 11 of the main request has no basis in the application as originally filed. Figures 1 and 2 of the application show that the Mn-content or Mn_{eq} is connected with a specific Si-content and that a combination of the minimum values of 0.5% Mn and 2.25% Si is excluded. The same can be derived from the description where it is stated that the levels of Mn are varied depending on the amount of Mn_{eq} and Si and that 0.5% Mn is linked with a concentration of Si of at least 3.1% (see

page 10, lines 7 to 10). The arguments under Article 123(2) EPC were brought forward as late as the oral proceedings, because the file had only recently been taken over from a colleague, who had not seen this issue.

Novelty of the subject-matter of claim 11 of the main request was no longer contested.

Inventive step: D2 concerns also an electrical steel having a similar composition with concentration ranges broadly overlapping with those of claim 11 of the main request. D2 aims to provide a method which enables good magnetic properties to be stably obtained on the condition that the heating of the slab is effected at low temperature (see page 4, lines 8 to 12). D2 further mentions the grains obtaining a sharp $\{110\}\langle 001 \rangle$ texture in the secondary grain growth (see page 4, lines 17 and 18). Thus D2 aims to solve the same problem as the patent in suit. D2 also suggests increasing the Si-content in its AlN inhibitor system to realize a high magnetic flux density (see page 4, lines 36 to 41). The person skilled in the art would consider the whole concentration range of 0.05-0.8% Mn claimed in D2 to be suitable for obtaining electrical steel sheet having good magnetic properties, since only values exceeding 0.8% Mn are stated to be unfavourable for the magnetic flux density. Therefore the upper limit for the person skilled in the art starting from D2 is 0.8% Mn (see D2, page 8, lines 19 to 23) and there is nothing withholding him from carrying out D2's invention in the overlapping range of 0.5-0.8% Mn. Furthermore, the examples V, W and X made in accordance with D4, which is cited as comparative prior art in the

patent in suit (see page 10, Table 4), show that it was already known to use higher Mn-contents. In this context it should be considered that it is very difficult and expensive to produce experimental alloys in preparation of patent applications, which may be the reason for the limited Mn-contents according to the examples of D2. Furthermore, it is known that Mn is effective at causing α - γ -transformation and that is the reason for adding it (see D4, column 5, lines 19 to 21). This fact belongs also to the common general knowledge of the person skilled in the art (see D3, pages 473 and 474) so that there exists the clear teaching for the skilled person to work in the whole range of D2. Compared with the electrical steel sheets of the examples of D2 no further or surprising technical effect can be seen. Therefore claim 11 lacks an inventive step in view of D2. It is admitted that D4 concerns a different steel system than the one disclosed in D2.

The amendments of claims 1, 4 and 7 of auxiliary request I contravene Article 123(2) EPC since the concentrations of the elements of example AE which define the essential features such as Mn_{eq} , the $[(\%Si) - 0.45(\%Mn_{eq})]$ -value, the amount of austenite, the volume resistivity, etc. are actually closely related to each other so that the amendments are contrary to the principles set out in T 201/83 (*supra*). Furthermore, the values for the elements Cr, Cu and Ni are not defined for example AE since only an upper limit is indicated (" ≤ 0.01 ") (see patent, page 11, Table 7). However, these three elements have been present in the steel composition of example AE since otherwise the value "0" would have been mentioned. Paragraph [0035]

of the impugned patent specifies that elements such as N, Sn, P, Mo, Sb and the like will also affect the amount of austenite and must be considered (see page 5, lines 29 to 31), so cannot be neglected. These elements, insofar as present in the example AE, were lacking in these claims of the patent in suit.

Example AC on which the further amendments of claim 1 of auxiliary request II are based specifies 0.035% Mo which amount is about 3-times as high as that of Sn. However, the minimum amount of Sn, which together with Mo and further elements is mentioned in paragraph [0035] of the patent as non-neglectable, is specified in claim 1 as purposive choice, whereas the content of Mo is merely specified as an "unavoidable impurity". This is contradictory as said amount of 0.035% Mo cannot represent an impurity level. Consequently there exists no support to this amendment in the application as originally filed. Therefore claim 1 of auxiliary request II contravenes Article 123(2) EPC.

Reasons for the Decision

Main request

1. *Admissibility of new objections under Article 123(2) EPC with respect to claim 11 of the main request*

The respondent's response to the grounds of appeal dated 26 September 2005 is silent with respect to an objection under Article 123(2) EPC to the main request and its claims 1, 7 and 11 maintained on appeal, which

already contained the amended concentration range of 0.5-4.5% Mn as in the present main request.

The respondent argued for the first time at the oral proceedings before the Board that the concentration range in question had no basis in the application as originally filed. Consequently, this argument of the respondent is to be considered a late change to the respondent's case. In accordance with Article 13(1) RPBA, it lies within the discretion of the Board whether or not it considers such a belated objection. In exercising their discretion the Boards of Appeal consistently require the objection to be "*prima facie*" (highly) relevant.

The description of the application as originally filed allows to derive the said concentration range of "0.5-4.5% Mn" by a combination of the lower limit of "0.5%" as mentioned for the preferred ranges "less than 0.5-11% Mn" and "about 0.5-3% Mn" with the preferred upper limit of "4.5% Mn" (see page 10, lines 7 to 12 of the application as originally filed). Further, the functional definition "to provide a volume resistivity of at least 50 micro-ohm-cm" as present since grant in independent claims 1, 7 and 11 of the main request, already excludes compositions of simple Fe-Mn-Si-alloys in the non-hatched low Mn region of $0.5\% \leq \text{Mn} \leq 1.5\%$ and $\text{Si} \leq 3.1\%$ as derivable from Figure 1. Thus, the argument that 0.5% Mn was only originally disclosed in relation with a Si-content higher than about 3.1%, cannot hold. For other Fe-Mn-Si-X-alloys as shown in Figure 2 a low Mn content such as 0.5% can be compensated for by the Mn_{eq} -elements Cr, Cu and/or Ni, so there is no need for a further limitation in respect of the Si-content

either. The Board therefore came to the conclusion that the belated Article 123(2) EPC objection raised with respect to the main request was not *prima facie* relevant. Consequently, the Board did not admit this objection at this late stage of the proceedings.

There is no need, in view of the reasons hereafter, to discuss the issue concerning extended subject-matter (Article 123(2) EPC).

Novelty of the subject-matter of claim 11 (Article 54 EPC) has no longer been disputed by the respondent.

2. *Inventive step (Article 56 EPC)*

2.1 *Closest prior art*

D2 is undisputedly the closest prior art for discussing inventive step of the steel melt of claim 11, disclosing a process for the production of grain oriented electrical steel sheet having excellent magnetic properties using a steel composition having broadly overlapping concentration ranges for the elements Si, C, Al, S, N and a partly overlapping range of the Mn-content: between 0.5 and 0.8%. The steel slab disclosed in D2 generally comprises (all % in weight.%) 0.025-0.075% C, 2.5-5.0% Si (preferred range 3.4-5.0, see claim 2), 0.05-0.8% Mn, $\leq 0.014\%$ (S+0.405 Se), 0.015-0.080% acid-soluble Al, 0.0030-0.013% N, with the balance consisting of Fe with inevitable impurities, and the steel has a ratio of acid soluble Al to Si of $\text{Al\%/Si\%} \geq 0.0080$ (see claims 1 and 2). The slab preferably comprises at least one member selected from

the group consisting of 0.01-0.15% of Sn and 0.03-0.20% of Cr (see claim 3).

- 2.1.1 The subject-matter of claim 11 of the main request is distinguished from D2 by a minimum Mn_{eq} value of at least 0.5%, a minimum volume resistivity of at least $50 \mu\Omega\text{cm}$, a certain range for the value of $[\%Si-0.45(\%Mn_{eq})]$ of from 2.0-4.4 and a volume fraction of the austenite of at least 5% up to 40%.
- 2.1.2 The different steel compositions of all the examples of the patent in suit and the "comparative" examples therein, which correspond to different pieces of prior art such as D4, but not D2 (see patent, Tables 1-8), do not allow to derive which effects can be attributed to the feature Mn_{eq} , the $[\%Si-0.45(\%Mn_{eq})]$ -value, the austenite volume fraction, and the varying contents of Si, Mn, Cr, Ni, Cu, P, etc., as mentioned in claim 11.

Particularly, all the examples of the patent in suit do not allow to establish any improvement over the electrical steel sheets according to D2. Thus the impugned patent does not contain a comparison with the closest prior art as required by the EPC in accordance with the long standing jurisprudence of the Boards of Appeal (see Case Law of the Boards of Appeal of the European Patent Office, 5th edition 2006, chapter I.D.9.8). Such a comparison has also not been submitted during the appeal procedure, as admitted by the appellant, although this deficiency has been remarked in the communication of the Board (see point III.2 above).

2.1.3 Taking account of point 2.1.2 above and of the overlap of the concentration ranges of the relevant elements of the steel composition according to D2 with those claimed in claim 11 the Board notes that - using equations (1), (4) and (5) of the patent in suit for calculation of the corresponding values - the compositions based on the Si-content of 3.4% Si (specifically claimed in claim 2 of D2), a C-content of 0.025% C and the maximum Mn-content of 0.8% Mn (both as claimed in claim 1 of D2) and optionally in addition comprising 0.03-0.2% Cr (as in claim 3 of D2) meet all the four requirements of claim 11 mentioned in point 2.1.1 above even though these requirements are not specifically mentioned in D2.

2.1.4 Furthermore, the 57 examples of D2 are based on 8 different steel compositions having slightly varying Mn contents in the range of from 0.10-0.15% Mn in combination with Mn_{eq} values in the range of from 0.11-0.15% Mn_{eq} . Although the aforementioned Mn_{eq} values of these 8 steel compositions are outside the range of "Mneq of at least 0.5%" according to claim 11 of the main request, 5 steel compositions thereof (i.e. those of examples 1, 2, 4, 6 and 7) - using equations (1), (4) and (5) of the patent in suit for calculation of the corresponding values - nevertheless meet the remaining three claimed requirements of a volume resistivity of at least 50 $\mu\Omega\text{cm}$, an austenite volume fraction in the range of at least 5% up to 40% and a $[\%Si-0.45(\%Mn_{eq})]$ value in the range from 2.0 to 4.4. The steel composition of example 8 of D2 allows calculating a volume resistivity of 49.9 $\mu\Omega\text{cm}$, which is only slightly below the required value of at least 50 $\mu\Omega\text{cm}$, but the remaining two requirements are likewise met. The steel

compositions of examples 3 and 5 of D2 have austenite volume fractions below 5% but meet the remaining two requirements of volume resistivity and $[\%Si-0.45(\%Mn_{eq})]$ value.

The above means that the object of the invention, as claimed by means of the conditions to be fulfilled (volume resistivity, austenite volume fraction, $[\%Si-0.45(\%Mn_{eq})]$ value) is also achieved in D2 with Mn and Mn_{eq} values outside of the ranges presently claimed in claim 11. The conclusion can thus only be that these values are not critical, contrary to what the appellant argues.

2.2 *Problem to be solved*

Thus taking account of points 2.1.2 to 2.1.4 above it is reasonable to define a less ambitious objective technical problem of simply providing an alternative steel composition for stably producing grain oriented electrical steel sheet having excellent magnetic properties and including an aluminium nitride inhibitor system (see Case Law of the Boards of Appeal of the European Patent Office, 5th edition 2006, chapter I.D.4.5).

The technical problem as defined by the appellant, i.e. to provide a composition which has similar magnetic properties as D2 and which provides a stable system for secondary grain growth resulting in a sharper texture, cannot be accepted by the Board since no evidence has been submitted to prove that a sharper texture than that obtained with the process of D2 can be actually obtained according to the patent in suit.

2.3 *Solution to the problem*

The problem as defined in point 2.2 above is solved by the steel composition according to claim 11 of the main request.

2.4 The Board considers, however, that the subject-matter of claim 11 of the main request is obvious to the person skilled in the art for the following reasons:

The Board holds the view that the person skilled in the art by simply carrying out the preferred teaching of D2, as represented by the subject-matter of its claims 1 and 2 (compare point 2.1 above), would arrive at steel compositions including 3.4-5.0% Si, and 0.5-0.8% Mn and 0.5 %Mn_{eq}.

2.4.1 First of all, this is due to the fact that the teaching of D2 is not confined to the detailed information given in its 57 examples, which are in the range of about 0.10-0.15% Mn, but includes any information in the claims and the description enabling the person skilled in the art to carry out the invention (compare Case Law of the Boards of Appeal of the European Patent Office, 5th edition 2006, chapter I.C.2.7). Secondly, the person skilled in the art is taught by D2 that Si-contents of 3.4% Si or more are particularly desirable to obtain lower iron loss (see page 7, lines 49 to 53; claim 2).

2.4.2 Furthermore, the person skilled in the art would seriously contemplate to work within the whole Mn-range up to 0.8% for the following reasons. Taking account of the description of D2 and its specific teaching with

respect to the Mn-content, the skilled person is only taught that a Mn-content of below 0.05% lowers unfavourably the yield of the rolled strip while a Mn-content exceeding 0.8% is unfavourable because the magnetic flux density of products is lowered (see page 8, lines 19 to 23). Otherwise there exists no prejudice in D2 which would hinder him from using a Mn-content within said range of 0.05-0.8% Mn, e.g. 0.75% Mn. The person skilled in the art is only taught by D2 that he should not use a Mn-content outside said entire claimed range.

2.4.3 In this context it needs also to be considered that it belongs to the common general knowledge of the person skilled in the art that Mn is effective at causing α - γ -transformation in steels (see D3, pages 473 and 474). This is one of the reasons why Mn is added in a certain amount to the steel composition.

2.4.4 The calculations based on the equations of the patent in suit and the values of the examples of D2 do not represent an ex-post facto analysis but are made only to prove that the resulting electrical steel sheets fulfil the claimed requirements, thus must have identical or similar electrical and magnetic properties as those brought forward by the appellant in support of claim 11 of the main request.

2.4.5 Consequently, all the corresponding arguments of the appellant cannot be accepted.

2.5 Furthermore, taking account of examples AA and AB of the patent in suit, which originally were presented as being in accordance with the invention, it is evident

that the minimum Mn-content of at least 0.5% Mn and the minimum Mn_{eq} of at least 0.5% Mn_{eq} are arbitrarily chosen. Both examples AA and AB disclose a Mn-content of 0.11%, which concentration is well below the range now required by claim 11. Additionally, the Mn_{eq} value of example AA is 0.46% Mn_{eq} , thus also outside the minimum value of at least 0.5% required by claim 11, while that of example AB is 0.55% Mn_{eq} (see patent, Tables 7 and 8). Nevertheless, their calculated values for [%Si-0.45(% Mn_{eq})] and the volume resistivity are in the ranges required by claim 11 and their peak permeability and the calculated saturation at 796 A/m are similar to those of the examples AC to AF falling under the definitions of claim 11. Consequently, it is obvious that both examples AA and AB likewise solve the objective technical problem as defined in point 2.2 above and it is evident that claim 11 provides a simple alternative to the compositions according to D2.

Auxiliary request I

3. *Admissibility of amendments (Article 123(2) EPC)*

3.1 The volume resistivity of the steel compositions according to the patent in suit is defined by the weight percentages of solute elements via equation (1):

$$(1) \text{ vol. resistivity} = 9.2 + 12.2 \% \text{ Si} + 4.6(\% \text{ Mn} + \% \text{ Cr}) + 2(\% \text{ Cu}) + \% \text{ Ni},$$

and the volume percent of austenite is defined by equation (4):

$$(4) \gamma_{1150^{\circ}\text{C}} = 15.1(\% \text{ Mn}_{eq}) + 784(\% \text{ C}) - 33.7(\% \text{ Si}) + 88.7$$

wherein an Mn equivalent is defined according to equation (5) as:

$$(5) \% Mn_{eq} = \%Mn + 1.5(\%Ni) + 0.5(\%Cu) + 0.1 (\%Cr),$$

and the amount of Si is balanced with the Mn-equivalent Mn_{eq} such that:

$$2.0 \leq [(\% Si) - 0.45 (\%Mn_{eq})] \leq 4.4$$

so that the alloy remains transcritical in the absence of carbon and lower secondary grain growth temperatures can be used which provide the desired degree of orientation, and so that sufficient austenite is formed and the steel is substantially ferritic after decarburization (see page 7, lines 24 to 29; page 8, lines 18 to 29; page 9, lines 17 to 25 of the application as originally filed).

- 3.2 In the description of the application as filed it is further stated that "the levels of Si, Mn, C and other elements must be controlled in order to provide the required amount of austenite ..." and "while Si, C and the constituents of the Mn_{eq} (for the Board: Ni, Cr, Cu, Mn) are the primary elements of concern, **other elements such as N, Sn, P, Mo, Sb** and the like (made as deliberate additions or present as impurities from the steelmaking process) will also effect the amount of austenite and **must be considered** (emphasis added by the Board; see page 8, lines 5 to 10 and lines 31 to 35; page 9, line 30 to page 10, line 6 and lines 13 to 33; page 11, lines 20 to 23 of the application as originally filed).

3.3 It is clear therefrom to the person skilled in the art that the individual amounts of C, Mn, S, Si, Cr, Al, N, Ni, Cu, Mo etc. specified in a specific example are closely associated with each other and with the other mentioned components like Fe, P, Sn, Sb etc. to promote the formation of the desired microstructure and to provide the mechanical and electrical/magnetic properties including volume resistivity and core loss properties.

3.4 Taking account of the teaching of the application as originally filed (see paragraphs 3.1 and 3.2 above) the appellant's arguments that the Mo concentration value is neglectable, that there exists no influence of the Mo content on the electrical steel properties thus cannot be accepted. The absence of the value of 0.001% for Mo of example AE in claims 1, 4 and 7 of auxiliary request I thus infringes Article 123(2) EPC.

3.5 Further, as there exists a substantial degree of interdependence of the quantitative values for these constituents (see 3.3) in the examples the isolation of one value from the rest of the conditions is not directly and unambiguously derivable for the skilled reader from the application as originally filed.

3.5.1 Given this situation, the individual amounts of the constituents of the example steel AE relied upon by the appellant cannot be regarded in isolation. In this context reference is made to the longstanding Case Law of the Boards of Appeal, see particularly decision T 201/83 (OJ EPO 1984, 481, point 12 of the reasons, last sentence): "an amendment of a concentration range

in a claim for a mixture, such as an alloy, is allowable on the basis of a particular value described in a specific example, provided the skilled man could have readily recognised this value as not so closely associated with the other features of the example as to determine the effect of that embodiment of the invention as a whole in a unique manner and to a significant degree".

Taking account of the considerations of this decision which was also referred to by the appellant, the conclusion must be that because of the effects of the interaction of the constituents making up the claimed electrical steel composition and its properties, it is not possible to make an arbitrary selection of individual features from an individual example. To disregard the specific context of that example would result in a new selection from the originally disclosed set of values. Hence the proposed combination of values, isolated from the original composition of the example, cannot be allowed.

3.5.2 More specifically, example AE specifies a content of 0.80 % Mn in combination with a Mn_{eq} value of 0.81 (see application as originally filed, pages 20 and 21, Tables 7 and 8).

It appears that the value for Mn_{eq} is incorrectly rounded off and should be 0.82%. This value is also present in claims 1, 4 and 7 of auxiliary request I.

Since said claimed Mn_{eq} value of 0.82 (or 0.81 for that matter) is greater than the Mn concentration of 0.80 it must be concluded - taking account of equation (5) -

that the steel composition of example AE comprised at least a small amount of Cr, Ni and/or Cu because otherwise the values of % Mn and % Mn_{eq} would have been identical. This is, however, at odds with the present wording of claims 1, 4 and 7 of this request, which allows for 0% of Cu, Cr and Ni: "up to 3% Cr, up to 1% Cu, up to 2% Ni." The only available information on these constituents in example AE is that Cr, Cu and Ni each should be < 0.01%. This is, however, not specific enough to be incorporated in these claims for overcoming the objection under Article 123(2) EPC.

The non-incorporation of minimum concentration values for Cr, Cu, and Ni into claims 1, 4 and 7 according to auxiliary request I contravenes Article 123(2) EPC.

Example AE also requires specific amounts for P and Sn, thus the same conclusion is valid with respect to the non-incorporation of the concentrations of 0.014 % P and 0.001 % Sn into claims 4 and 7 of auxiliary request I.

Auxiliary request I is therefore not allowable under Article 123(2) EPC.

Auxiliary request II

4. *Admissibility of amendments (Article 123(2) EPC)*

Claim 1 of auxiliary request II differs from that of auxiliary request I in that all the concentration values for the elements specified in Table 7 of the application as filed for example AC are incorporated as the minimum values in the ranges of the respective

elements except for the element Mo, of which the concentration is specified in the claim by "and unavoidable impurities **including at least 0.035% Mo**".

This latter definition creates an open-end range of a Mo-content within said "unavoidable impurity" level.

- 4.1 The application as originally filed provides no explicit or implicit basis for this feature, as now claimed.

The Board believes that this wording was chosen by the appellant in order to avoid a conflict with Article 123(3) EPC since the closed definition of the steel composition of claim 1 as granted ("comprising ... balance iron and unavoidable impurities") did not specify any range for the Mo-content (as noted by the Board in its preliminary opinion, compare point III.1 above).

- 4.2 Example AC, on which the amendments of claim 1 of auxiliary request II are based, specifies said content of 0.035% Mo which is about 3-times as high as the amount of 0.013% Sn for this example. However, said minimum amount of Sn has been specified in claim 1 of auxiliary request II.

In the application as originally filed (page 8, lines 31 to 35 and page 11, lines 20 to 23) it is stated that Sn together with Mo and further elements are either non-neglectable ("must be considered") or may be comprised as impurities from the steelmaking process.

- 4.2.1 It is not apparent from the application as originally filed that said amount of 0.035% Mo according to example AC has to be considered to represent an impurity level since it is 35-times as high as the lowest amount of 0.001% Mo specified in the application according to examples AE, AF, or G, Q and R (see Tables 3 and 7). On the other hand the highest disclosed Mo-content (for example M) is 0.041% Mo (see Table 3). Thus it is apparent that an amount of 0.001% Mo is to be considered to represent said "unavoidable impurity" level, but that 0.035% Mo is a deliberate choice. Likewise the Board notes that the examples A to Y do not specify any Sn content while the examples AA to AF reveal concentrations of 0.013% Sn and 0.001% Sn, respectively (see Tables 1, 3, 5 and 7). It is clear that the lower content thereof represents the "unavoidable impurity" level, whereas the higher content represents a deliberate choice.
- 4.2.2 In this context the Board therefore considers that the application as originally filed embraces the **deliberate addition of** elements such as **Sb, As, Bi, Mo, P, Sn** and the like, when specific concentration values other than 0.001% are mentioned for these elements in the examples.
- 4.2.3 Claim 1 of auxiliary request II mentions 0.013% Sn and 0.022% P as deliberate choices for the lowest allowable level for these elements. In contrast thereto the lowest level of 0.035% Mo is presented as an "unavoidable impurity". This is in contradiction with what the Board considers to be the original disclosure of the application as originally filed (see points 4.2.1 and 4.2.2 above), thus not in agreement with the

requirements of Article 123(2) EPC. Auxiliary request II is thus not allowable under Article 123(2) EPC.

5. The Board therefore concludes that none of the appellant's requests is allowable.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:

G. Nachtigall

H. Meinders