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Aktenzeichen / Case Number / N<sup>o</sup> du recours : T 392/88 - 3.3.1

Anmeldenummer / Filing No / N<sup>o</sup> de la demande : 81 902 728.5

Veröffentlichungs-Nr. / Publication No / N<sup>o</sup> de la publication : 0 084 569

Bezeichnung der Erfindung: **Process for manufacturing isotropic electro-**  
Title of invention: **magnetic steel plate having excellent magnetic**  
Titre de l'invention : **characteristics**

Klassifikation / Classification / Classement : C21D 8/12

**ENTSCHEIDUNG / DECISION**

vom / of / du 6 March 1990

Anmelder / Applicant / Demandeur :

Patentinhaber / Proprietor of the patent /  
Titulaire du brevet :

Nippon Steel Corporation

Einsprechender / Opponent / Opposant :

Stahlwerke Bochum AG

Stichwort / Headword / Référence : Electrical sheet steel/NIPPON

EPÜ / EPC / CBE

Schlagwort / Keyword / Mot clé :

"Inventive step (confirmed) - clear warning,  
but no prejudice"

Leitsatz / Headnote / Sommaire



## Summary of Facts and Submissions

I. The mention of the grant of European patent No. 0 084 569 in respect of European patent application No. 81 902 728.5 which was filed under the Patent Cooperation Treaty on 28 August 1981 with international application number PCT/JP81/00202 and claimed priority of 5 August 1981 from a prior Japanese application, was announced on 21 November 1985 (cf. Bulletin 85/47) on the basis of eight claims. The independent Claims 1 and 5, after correction of obvious errors, read as follows:

- "1. A process for producing a non-oriented electromagnetic steel sheet having excellent magnetic properties, wherein a steel slab for producing a non-oriented electromagnetic steel sheet containing not more than 0.005% carbon, not less than 2.5% silicon, not less than 1.0% aluminium, the total content of silicon and aluminium being from 3.5% to 5.0%, 0.1 to 1.0% manganese, not more than 0.005% sulfur, not more than 0.0040% nitrogen, and balance iron and incidental impurities other than sulfur and nitrogen is hot rolled, followed by hot-coil annealing, is cold-rolled once so as to obtain a final thickness, and is finish-annealed, characterised in that cold-rolling before finishing-annealing is carried out at a reduction ratio of from 55% to 87% and finishing-annealing is carried out by realizing a holding temperature of 1050°C or more for a period of from 3 to less than 60 seconds.
  
5. A process for producing a non-oriented electromagnetic steel sheet having excellent magnetic properties, wherein a steel slab for producing a non-oriented electromagnetic steel sheet or strip containing not more than 0.005% carbon, not less than 2.5% silicon,

not less than 1.0% aluminium, the total content of silicon and aluminium being from 3.5% to 5.0%, 0.1 to 1.0% manganese, not more than 0.005% sulfur, not more than 0.0040% nitrogen, and balance iron and incidental impurities other than sulphur and nitrogen is hot-rolled and then cold-rolled twice or more, with intermediate annealing being carried out between the cold-rolling steps, so as to obtain each time a final thickness, and the cold-rolled sheet or strip is finish-annealed, characterised in that cold-rolling before finishing-annealing is carried out at a reduction ratio of from 55% to 87% and finishing-annealing is carried out by realizing a holding temperature of 1050°C or more for a period of from .3 to less than 60 seconds".

II. A Notice of Opposition was filed on 20 August 1986 requesting the revocation of the patent on the ground that its subject-matter was not patentable within the terms of Articles 52 to 57 EPC. The Opponent also alleged that the process claimed in Claim 3 could not be carried out by the skilled person. The opposition was supported, inter alia, by the following documents:

- (1) Berg- und Hüttenmännische Monatshefte, 1968, pages 217 to 224 and
- (6) DE-A-2 747 660.

III. By a decision delivered orally on 28 April 1988, with written reasons posted on 29 June 1988, the Opposition Division rejected the opposition. The Opposition Division considered that the relatively long periods of time required for the final annealing stage of the process disclosed in document (6) induced internal oxidation of the steel sheet, which resulted in its non-stable magnetic properties.

Although it may be of benefit to carry out the final annealing at higher temperatures and shorter holding times than those disclosed in document (6), this document created a clear prejudice against heating the steel sheet above 1000°C or against annealing for longer than 15 minutes. Therefore, in the Opposition Division's opinion, document (6) led away from the solution proposed in the disputed patent.

Moreover, since the skilled person would not apply the same annealing treatment to steel sheets of significantly different compositions, he would not be guided by the disclosure of document (1) to disregard the prejudice created by document (6) against performing the final annealing of the steel sheet at temperatures of 1050°C or more.

- IV. An appeal was lodged against this decision on 17 August 1988 with payment of the prescribed fee. A Statement of Grounds of Appeal was filed on 29 October 1988. In their Statement and during the oral proceedings held on 6 March 1990, the Appellants alleged that five features of Claim 1 of the patent in suit are known from document (6) or rendered obvious by the combined teaching of documents (6) and (1).

The Appellants also argued that the temperature of 1000°C specified in document (6) only represents the upper temperature limit for finish annealing with respect to the holding times of 2 to 15 minutes and that the skilled person would combine higher annealing temperatures with shorter holding times. Thus, it would be clear to the skilled person that if the finishing annealing is carried out at temperatures greater than 1000°C, the holding times must be reduced. In the Appellant's opinion, this view is supported by the disclosure of document (1). Furthermore, the Appellant's contended that document (6) could not be used to

support the assertion that there was a prejudice against carrying out the finishing annealing at temperatures higher than 1000°C.

Additionally, the Appellants asserted that internal oxidation did not occur during the process of document (6), since the finishing annealing is carried out in a dry atmosphere consisting of nitrogen and hydrogen.

- V. In their reply to the Statement of Grounds of Appeal and during the oral proceedings, the Respondents maintained that, due to the finishing annealing conditions according to the claimed process, internal oxidation does not occur and the resulting electrical sheet steel has excellent magnetic properties.

The Respondents also contended that the considerable reduced finishing annealing times of the present process made it possible to increase the production of non-oriented electrical sheet steel having excellent magnetic properties. Moreover, due to the differences between the steel compositions disclosed in document (1) and those in the disputed patent, the Respondents argued that the transfer of the teaching of document (1) to document (6) was not allowable.

With regard to the disclosure of document (6), the Respondents considered that this document taught that the temperature of 1000°C for the finishing annealing should not be exceeded under any circumstances.

- VI. The Appellants requested that the decision under appeal be set aside and the patent revoked. The Respondents requested that the appeal be dismissed.

VII. At the conclusion of the oral proceedings, the Board's decision to dismiss the appeal was announced.

#### Reasons for the Decision

1. The appeal complies with Articles 106 to 108 and Rule 64 EPC and is, therefore, admissible.
2. The disputed patent relates to a process for the manufacture of non-oriented electrical sheet or strip steel having a magnetic flux density  $B_{50}$  of at least 1.67 telsa and maximum core losses  $W_{15/50}$  of 2.70 W/kg (thickness 0.50 mm) and 2.20 W/kg (thickness 0.35 mm). Electrical steels with these maximum core loss limits and minimum flux densities correspond to the Japanese grades designated S7 and S8 (cf. patent specification page 3, lines 2 to 10).
  - 2.1 Document (6), which may be considered to represent the closest prior art, discloses a process for the production of non-oriented electrical sheet steels, the magnetic properties of which correspond to those required by electrical steels of grade S7 or S8. However, a disadvantage of this known process was considered to lie in its low productivity.

In the light of this closest prior art, the technical problem underlying the patent in suit may be seen in providing a process for the manufacture of electrical sheet steel having magnetic properties complying with the above-mentioned Japanese standard grades designated S7 and S8, the productivity of which is greater than that of this known process.

- 2.2 According to the disputed patent, this technical problem is essentially solved by cold-rolling a steel sheet of a

specified composition at a reduction ratio of 55 to 87% before finishing annealing the cold-rolled product at a temperature of at least 1050°C and a holding time of from 3 to less than 60 seconds.

Since the holding time for the finishing annealing of the process in accordance with document (6) is from 2 to 15 minutes and in light of the comparison between the Examples of document (6) and the disputed patent, the Board is satisfied that the above-defined technical problem is plausibly solved.

- 2.3 According to the disputed patent, a disadvantage connected with the process of document (6) was the fact that, in order to produce non-oriented electrical sheet steel of grade S7 or S8, it was necessary to ensure that the crystal grains in the sheet resulting from cold-rolling a steel slab at a reduction rate of at least 20% and an intermediate annealing at a temperature of 900 to 1050°C and a holding time of 3 to 15 minutes had to have an average diameter of at least 0.07 mm. This allegedly makes it impossible to increase the production rate (cf. page 2, lines 47 to 51 of the disputed patent).

However, in the Board's judgement, the overcoming of this alleged disadvantage of the prior art process cannot be regarded as forming part of the technical problem underlying the disputed patent since, before commencing a production run, it is possible to experimentally determine the necessary conditions, viz. cold reduction ratio and the temperature and duration of the intermediate annealing, to ensure the desired crystal grain size for a particular steel. In this manner, the need to determine the crystal grain size during a production run can be eliminated and therefore this criterion has no effect on the production rate.

- 2.4 A further alleged disadvantage of this prior art process was the possible adverse effect on the magnetic properties of the electric steel sheet due to the risk of internal oxidation of the steel occurring during rather long periods of time necessary for the intermediate and finishing annealing. Although it may be true that atmospheres consisting of hydrogen and nitrogen with dew points ranging from 5°C to -20°C may contain a certain amount of moisture, it is clear from the magnetic properties of the electric steel sheets obtained in the Examples of document (6) that, even if internal oxidation did occur, its affect on the magnetic properties was negligible.
3. After examination of the cited prior art, the Board is satisfied that the claimed subject-matter is novel. Since during the oral proceedings the Appellants acknowledged novelty, it is not necessary to consider this matter in detail.
4. It still remains to be examined whether the requirement of inventive step is met by the claimed subject-matter.
- 4.1 Document (6) discloses a process for the production of grade S7 or S8 non-oriented electrical sheet steel from a steel slab consisting of not more than 0.02% carbon, 1.6 to 3.5% silicon, 0.2 to 2.5% aluminium, 0.1 to 1.0% manganese, not more than 0.005% sulphur, not more than 0.0025% oxygen and the balance iron. The steel slab is hot-rolled, cold-rolled at a reduction ratio of at least 20% and the resulting sheet of intermediate thickness is annealed by holding it at a temperature of 900° to 1050°C for 3 to 15 minutes. After being cold-rolled to the finish thickness at a reduction ratio of 45 to 70%, the intermediately annealed sheet is finally annealed by being held at 930° to 1000°C for 2 to 15 minutes (cf. Claim 1 and Examples 2 and 3).

Thus, there is considerable overlap between the steel compositions of document (6) and those of the patent in suit. Moreover, in the third complete paragraph on page 6 (original numbering) of document (6) it is emphasised that, if the finished steel sheet contains more than 0.005% of carbon, its magnetic properties are adversely affected. Therefore, it was known at the priority date of the disputed patent to use low carbon steel containing silicon and aluminium to manufacture S7 and S8 grade electrical sheet steel.

With respect to the finishing annealing conditions, it is unequivocally stated in document (6) that if the annealing is performed at a temperature of more than 1000°C or for a period of time longer than 15 minutes, the magnetic properties will be adversely affected due to unfavourably oriented crystallites in the finished product (cf. last paragraph on page 15). In the Board's judgement, this statement represents a clear warning to the skilled person not to exceed a temperature of 1000°C, irrespective of the duration of the annealing treatment. Thus, the warning represents an obstacle which would actively discourage the skilled person from contemplating performing this annealing stage at temperatures higher than 1000°C. Therefore, the teaching of this document would not provide the skilled person with any indication that one of the essential features of the proposed solution to the technical problem underlying the disputed patent is to finally anneal the sheet at a temperature of at least 1050°C for a duration of 3 to less than 60 seconds.

- 4.2 However, the Board agrees with the Respondents that the above-mentioned statement in a single patent specification cannot be considered as creating a technical prejudice against the use of temperatures higher than 1000°C in the

final annealing of electrical sheet steel (cf. T 19/81, Röhm/Film coating, OJ 1982, 51, points 5.2 and 5.3). Thus, a technical prejudice may be considered to exist if it is related to an error or misapprehension relatively widespread among the skilled workers in the field in question which is supported, in principle, by statements in the relevant non-patent technical literature.

- 4.3 Document (1) reports the investigation of short duration annealing in lead baths of cold-rolled soft magnetic strips. Figure 3 on page 221 of this document shows the variation of coercive force values for steel strips comprising 0.023% carbon, 3.38% silicon and 0.050% aluminium or 0.017% carbon, 3.25% silicon and 0.004% aluminium with annealing times at temperatures of 910°C, 1000°C, 1107°C and 1200°C. These graphs clearly demonstrate that the coercive force values decrease with increasing annealing times for all annealing temperature and all reduction ratios. For an annealing temperature of 1200°C, the minimum coercive force is attained after annealing for approximately 30 seconds.

In the Board's judgement, it is highly unlikely that the skilled person, seeking a solution to the problem underlying the disputed patent, would have combined the disclosure of document (1) with that of document (6). Thus, the compositions of the steels of the two documents (cf. Table 2 on page 220 of document (1)) differ considerably with respect to their carbon and aluminium contents and, from his common general knowledge, the skilled person is aware that the annealing conditions, i.e. temperature, duration and atmosphere, necessary to obtain the desired properties of the final product vary considerably depending upon the steel composition.

Furthermore, document (1) is wholly silent with respect to the core loss and magnetic flux density of the soft magnetic

strips. Although it is known that one of the two components contributing to total core loss is hysteresis loss, which corresponds to the area under the hysteresis loop, and that the coercive force of a substance is the strength of the magnetic field to which a ferromagnetic substance undergoing an hysteresis cycle must be subjected in order to demagnetise the substance completely, there is no direct correlation between coercive force and core loss.

Furthermore, it must be borne in mind that to meet the requirements of the grades S7 and S8 with respect to magnetic properties depends not only on the core loss of the electrical sheet steel falling below a certain value, but also on its magnetic flux density exceeding a specified minimum figure.

Therefore, in the light of the technical problem underlying the patent in suit, document (1), which has to be considered by itself, is irrelevant.

5. In the Board's judgement, the proposed solution to the problem of providing a process for the manufacture of S7 and S8 grade electrical sheet steel with a higher production rate than that of the process disclosed in document (6) is inventive. Therefore, the subject-matter of Claims 1 and 5 involves an inventive step and these claims are allowable.
6. Claims 2 to 4 and 6 and 8, which relate to the preferred embodiments of the processes of Claims 1 and 5 respectively, are also acceptable in view of the allowability of Claims 1 and 5.

Order

For these reasons, it is decided that:

The appeal is dismissed.

The Registrar:



M. Beer

The Chairman:



K. Jahn

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