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Datasheet for the decision of 20 May 2014

Case Number: T 2408/11 - 3.2.08

Application Number: 04735124.2

Publication Number: 1642991

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Language of the proceedings: EN

Title of invention:
METHOD FOR HOT FORMING AND HOT FORMED MEMBER

Patent Proprietors:
Nippon Steel & Sumitomo Metal Corporation
TOYOTA JIDOSHA KABUSHIKI KAISHA
Toyoda Iron Works Co., Ltd.

Opponents:
Benteler Automobiltechnik GmbH
ThyssenKrupp Steel Europe AG

Headword:

Relevant legal provisions:
EPC Art. 114(2), 100(a), 54
RPBA Art. 12(2), 12(4)

Keyword:
Late-filed evidence - admitted (no)
Novelty - (yes)

Decisions cited:

Catchword:

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Case Number: T 2408/11 - 3.2.08

D E C I S I O N
of Technical Board of Appeal 3.2.08
of 20 May 2014

Appellant: (Patent Proprietor 1)	Nippon Steel & Sumitomo Metal Corporation 6-1, Marunouchi 2-chome Chiyoda-ku Tokyo 100-8071 (JP)
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Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted on 21 September 2011 revoking European patent No. 1642991 pursuant to Article 101(3)(b) EPC.**

Composition of the Board:

Chairman T. Kriner
Members: M. Alvazzi Delfrate
D. T. Keeling

Summary of Facts and Submissions

I. By its decision posted on 21 September 2011 the opposition division revoked European patent No. 1 642 991.

The opposition division found that, for all the requests on file at the time, the claimed subject-matter lacked novelty in view of

K6: L. Vaissiere et al. "Development of Pre-Coated Boron Steel fro Applications on PSA Peugeot Citroën and RENAULT Bodies in White".

II. The appellants (patent proprietors) lodged an appeal against that decision in the prescribed form and within the prescribed time limit.

III. Oral proceedings before the Board of Appeal were held on 20 May 2014.

IV. The appellants requested that the decision under appeal be set aside and that the patent be maintained as granted (main request) or, in the alternative, in accordance with either of the auxiliary requests 1 or 2 filed with letter of 23 January 2012.

The respondents (opponents 1 and 2) requested that the appeal be dismissed.

V. Claims 1 and 4 of the **main request** read as follows:

"1. A hot forming method comprising heating a steel sheet having a steel composition consisting of, in mass percent, C: 0.15 - 0.45%; Mn: 0.5 - 3.0%; Cr: 0.1 - 0.5%; Ti: 0.01 - 0.1%; B: 0.0002 - 0.004%; Si: at most

0.5%; P: at most 0.05%; S: at most 0.05%; Al: at most 1%; N: at most 0.01%; one or more of Ni: at most 2%, Cu: at most 1%, Mo: at most 1%, V: at most 1%, and Nb: at most 1%; and a remainder of Fe and unavoidable impurities to a temperature of the Ac3 point or higher, holding it at that temperature, and then forming the heated steel sheet to the shape of a finished member, wherein the formed member is quenched by cooling from the forming temperature during forming or after forming in such a manner that the cooling rate to the Ms point is at least the critical cooling rate and characterized in that the average cooling rate of the formed member from the Ms point to 200 °C is in the range of 25 - 150 °C/s thereby to obtain an auto-tempered martensite structure."

"4. A hot formed member made from a steel sheet having a steel composition consisting of, in mass percent, C: 0.15 - 0.45%; Mn: 0.5 - 3.0%; Cr: 0.1 - 0.5%; Ti: 0.01 - 0.1%; B: 0.0002 - 0.004%; Si: at most 0.5%; P: at most 0.05%; S: at most 0.05%; Al: at most 1 %; N: at most 0.01 %; one or more ofNi: at most 2%, Cu: at most 1 %, Mo: at most 1 %, V: at most 1 %, and Nb: at most 1 %; and a remainder of Fe and unavoidable impurities, characterized in that the hardness after hot forming expressed in Vickers hardness is less than the value of (maximum quenching hardness - 10) and at least the value of (maximum quenching hardness - 100) and in that the member has an auto-tempered martensite structure, wherein the maximum quenching hardness is the hardness obtained when a material is held for 10 minutes in a salt bath heated to 900°C and is then water cooled."

The auxiliary requests are not relevant for the present decision.

VI. In addition to K6 the following documents also played a role for the present decision:

K4: Stahlschlüssel-Taschenbuch 18. Auflage 1998, page 146;
K6-1: Declaration of DJ Podnar Jr.;
K6-2: print-out from the site papers.sae.org;
K13-2: graph temperature vs. time;
K14: M. Tisza "Physical Metallurgy for Engineers" (2001), pages 272-279;
K15: graph Vicker's Hardness vs C content;
K16: L.E. Samuels "Light Microscopy of Carbon Steels" ASM International, 1999, pages 276-280;
K17: E.Arnold "Steels Microstructure and Properties" (1992), chapter 8;
K18: M. Naderi et al. "Analysis of Microstructure and Mechanical Properties of Different High Strength Carbon Steels after Hot Stamping", Journal of Materials Processing Technology, Vol. 211(2011), pages 1117-1125;
K19: C.R. Brooks "Principles of the Heat Treatment of Plain Carbon and Low Alloy Steels", (1996) pages 45 to 53;
K20: D.R. Askeland et al."The Science and Engineering of Materials" (2011), pages 511-512; and
K21: “Shin-pan “Shiritai Netsu-shori” (New edition “Heat-treatment we want to learn”) by Fujikoshi Netsushori Kenkyu Grop (Fujikoshi (Nachi-Fujikoshi Corp.) Heat-treatment Research Group) Published on 10/ Oct/1994 (7th Edition) by Japan Machinist Co. Ltd and a translation of the text.

VII. The arguments of the appellants can be summarised as follows:

Introduction of K18 and K20 into the proceedings

K18 and K20 were submitted with the statement of grounds of appeal as a reaction to the arguments set out in the appealed decision.

These documents provided experimental evidence on the cooling behaviour of a steel part and explained the meaning of a Jominy curve. Hence, they were relevant to the present case despite the fact that they were not prior art.

Accordingly, K18 and K20 should be admitted into the procedure.

K6 as prior art

The publication date of K6 indicated by K6-1 and K6-2 was actually the date on which this article was said to have been presented at a conference. There was no guarantee that what was presented at the conference was the same as reported by K6. Therefore, it was not proven that the content of K6 belonged to the prior art.

Novelty

In any event, K6 did not disclose the claimed subject-matter.

K6 did not explicitly disclose the cooling rate of the part formed by the hot stamping process described in this document. Nor was it inevitable to use a cooling rate in accordance with claim 1 when performing this process. Although the average cooling rate to 80°C calculated from the conditions disclosed in K6 fell within the range stipulated by claim 1, in reality the

cooling rate varied during cooling, in particular by slowing down below 100°C, as shown for instance in K13-2 or K18 . Hence, it could not be assumed that in the hot stamping process of K6 a cooling in the interval Ms-200°C in accordance with claim 1 was performed. Rather, for water-cooled moulds a higher cooling rate was to be expected, as shown in K18. A higher cooling rate was also consistent with the fact that K6 aimed at a fully martensitic structure and not at an auto-tempered martensite. The fact that pure martensite and auto-tempered martensite were two different structures was evidenced by K4, K16 and K17.

As to Figure 8, it did not depict cooling rates actually used in the hot stamping process but merely showed the different structures achieved by different cooling rates.

Therefore, K6 did not disclose the features of claim 1 in combination. Accordingly, the subject-matter of this claim was novel.

Nor did K6 disclose the features of the characterising part of claim 4. Neither the hardness of the hot formed member nor its maximum quenching hardness were explicitly disclosed. Moreover, while the former could be estimated from the tensile strength of the hot formed part there was no way of calculating the latter from the information given in K6. In particular, a maximum quenching strength and, as a consequence the maximum quenching hardness could not be derived from the maximum strength shown in Figure 9 because it was not clear which parts were measured in the experiments from which this Figure was obtained. Since, as disclosed in K15 and K19, the hardness of a steel part depends also on its composition and on its grain size,

experiments performed on potentially different parts could not be compared with each other. This was also clear from Figure 7, which would indicate a maximum quenching hardness below the value calculated from the tensile strength.

Additionally, also the fact that the structure is an auto-tempered martensite was not disclosed in K6, which merely related to full martensitic structures.

Therefore, also the subject-matter of claim 4 was novel.

VIII. The arguments of the respondents can be summarised as follows:

Introduction of K18 and K20 into the proceedings

Neither K18 nor K20 belonged to the prior art, since they were published after the priority date of the patent in suit. Moreover, they did not make any reference to K6. Hence, they were not relevant and there was no reason to introduce these late-filed documents into the proceedings.

K6 as prior art

K6-1 and K6-2 provided clear evidence that K6 was published before the priority date of the patent in suit. Therefore, K6 was prior art.

Novelty

K6 disclosed all the features of claim 1. In particular, a cooling rate from the Ms point to 200°C in accordance with claim 1 was clearly disclosed in

Figure 8, which showed cooling rates of at least 27°C/s, some of which fell in the range according to claim 1. When these cooling rates were adopted the structure which was indicated as "completely martensitic" in K6 would actually be an auto-tempered martensite; accordingly, the term "completely martensitic" in K6 comprised also auto-tempered martensite. Therefore, K6 disclosed an average cooling rate from the Ms point to 200 °C in the range of 25 to 150 °C/s, to obtain an auto-tempered martensite structure.

Moreover, a cooling rate in accordance with claim 1 was disclosed also in the section of K6 describing the hot stamping process, because the overall average cooling speed calculated from the time of residence in the cooled tool and the temperature of extraction from the tool was about 53 °C/s.

Therefore, the subject-matter of claim 1 lacked novelty.

K6 also disclosed all the features of claim 4. It was true that it did not explicitly indicate the hardness of the hot formed member. However, it disclosed that its tensile strength was 1500 Mpa, which could be converted to a hardness value on the basis of the table of K4. When the same conversion was applied to the maximum achievable strength derived from Figure 9, it was clear that the hardness of the hot formed member satisfied the requirements of claim 4. Accordingly, also the subject-matter of this claim lacked novelty.

Reasons for the Decision

1. The appeal is admissible.

2. Introduction of K18 and K20 into the proceedings

Documents K18 and K20 have been submitted with the statement of grounds of appeal. Accordingly, it lies within the power of the Board to admit or not these documents into the proceedings (Article 12(4) RPBA and Article 114(2) EPC).

In the present case both K18 and K20 have been submitted at the earliest possible stage during the appeal proceedings, namely together with the statement of grounds of appeal, in accordance with Article 12(2) RPBA.

Moreover, their submission is considered as a reaction to the arguments expounded in the appealed decision, because K18 and K20 concern the cooling rate of a steel part quenched in a water cooled mould and the significance of the Jominy curve, two crucial points of the decision under appeal (see pages 6 and 7).

Finally, it is true that they do not refer to K6 and that neither K18 nor K20 belongs to the prior art. However, this is immaterial for the purposes which they are intended to serve, namely to provide experimental evidence on the cooling behaviour of a steel part and to explain the meaning of a Jominy curve.

Under these circumstances, the Board decided to admit K18 and K20 into the proceedings.

3. K6 as prior art

According to the appellants it has not been proven that the content of K6 belongs to the prior art. However, K6-2 clearly indicates that K6 was published on 9 July 2002. This evidence is confirmed by K6-1. Hence, there is no reason to doubt that K6 was published on 9 July 2002. Whether or not its content was also presented at a conference on the same day is thus immaterial. Accordingly, the content of K6 belongs to the prior art.

4. Novelty

4.1 According to established case law, it is a prerequisite for the acceptance of lack of novelty that the claimed subject-matter is "directly and unambiguously" derivable from the prior art. In other words, it has to be beyond doubt - not merely probable - that the claimed subject-matter was directly and unambiguously disclosed in a prior art document (see Case Law of the Boards of Appeal of the European Patent Office, 7h edition 2013, I.C.3.1).

4.2 Claim 1

4.2.1 K6 undisputedly discloses a hot forming method (see page 6, "HOT STAMPING PROCESS") comprising heating a steel sheet having a steel composition falling in the range in mass percent, C: 0.15 - 0.45%; Mn: 0.5 - 3.0%; Cr: 0.1 - 0.5%; Ti: 0.01 - 0.1%; B: 0.0002 - 0.004%; Si: at most 0.5%; P: at most 0.05%; S: at most 0.05%; Al: at most 1%; N: at most 0.01%; one or more of Ni: at most 2%, Cu: at most 1%, Mo: at most 1%, V: at most 1%, and Nb: at most 1%; and a remainder of Fe and unavoidable impurities (see page 2, "Chemical analysis and coating"; note: wherein the indication "a%" should be read as wt% in view of the generally known

composition of USIBOR 1500). The sheet is heated to a temperature of the Ac3 point or higher (see on page 6 Figure 18 and "THE FURNACE", in combination with page 3, "Austenitisation") and held at this temperature for several minutes, and then the heated steel sheet is formed to the shape of a finished member (see page 7, "THE PRESS AND TOOL"). Since martensite is obtained, the formed member is quenched by cooling from the forming temperature during forming or after forming in such a manner that the cooling rate to the Ms point is at least the critical cooling rate (see page 7, "THE PRESS AND TOOL").

4.2.2 K6 states that the transfer of the blank from the furnace to the tool must be realised as quickly as possible because if the temperature falls below 780 °C, the microstructure would present bainitic or ferritic areas. In the hot forming process of K6 the blank is placed in the tool which is water cooled and remains closed for approximately 15 seconds. Then the part is extracted from the tool at a temperature of around 80°C (see pages 6 and 7, "THE BLANK TRANSFER" and "THE PRESS AND THE TOOL"). However, K6 does not explicitly mention the cooling rate of the formed member in the region from the Ms point to 200 °C. Hence, the question to be considered is whether K6 implicitly discloses an average cooling rate in the range 25-150°/s for this region of temperatures.

The respondent submitted that an overall average cooling speed of about 53 °C/s can be calculated from the cooling time (15 s) and cooling start and end temperatures disclosed in K6 (about 780°C and 80°C). However, this cooling rate is an average calculated on the whole interval 780 to 80°C, whereas, as shown for instance in K13-2 or K18 (Figure 5), the cooling rate

varies during cooling, in particular it markedly slows down below 100°C. Therefore, it cannot be excluded that the calculated cooling rate of K6 results from a cooling faster than what is defined in the claim in the interval Ms-200°C followed by a slow cooling down to about 80°C.

As to Figure 8, it merely shows which structures are obtained by different cooling speeds, in particular disclosing the conditions necessary to obtain the structure indicated as "completely martensitic" in K6. It is accepted that, as submitted by the respondents, in the context of K6 a "completely martensitic" structure refers not only to pure martensite but also to auto-tempered martensite, given that the critical quenching rate of 27°C/s, said to result in a completely martensitic structure, actually results in an auto-tempered martensite. Nonetheless, Figure 8 does not disclose the conditions adopted in the hot stamping process of K6 but rather the results of CCT (continuous cooling transformation) experiments. Hence, there is no clear and unambiguous disclosure in K6 that a cooling rate in accordance with claim 1, resulting in an auto-tempered martensite, is used for the hot stamping process of K6.

4.2.3 Therefore, the subject-matter of claim 1 is novel.

4.3 Claim 4

4.3.1 In respect of claim 4 the crucial point is whether K6 discloses a hardness after hot forming expressed in Vickers hardness which is less than the value of (maximum quenching hardness - 10) and at least the value of (maximum quenching hardness - 100), wherein the maximum quenching hardness is the hardness obtained

when a material is held for 10 minutes in a salt bath heated to 900°C and is then water cooled.

4.3.2 Although K6 does not explicitly disclose these hardnesses, it states that the hot formed parts exhibit a tensile strength of 1500 MPa. An approximate value of the hardness after hot forming can be calculated on the basis of this value, with the help of the table of K4.

The respondents submitted that the maximum quenching hardness can be calculated from the maximum strength shown in Figure 9. However, the test pieces for the measurements of Figure 9 are treated at 950°C for 5 minutes before water quenching, and then annealed at different temperatures for one hour, while the maximum quenching hardness is measured on parts held for 10 minutes in a salt bath heated to 900°C and then water cooled. Moreover, and most importantly, there is no indication that these test pieces and the hot formed parts have the same composition and grain size, two factors which strongly influence the hardness (see K15 and K19). Indeed, when considering also Figure 7, which shows a maximum obtainable hardness that is lower that the hardness calculated from the tensile strength of the parts formed by hot stamping, it is clear that the different values of hardness and/or strength disclosed in the different experiments of K6 cannot be assumed to represent the properties of the same material. Therefore, K6 does not disclose the maximum quenching hardness as defined by claim 4, i.e. the hardness obtained when a material is held for 10 minutes in a salt bath heated to 900°C and is then water cooled. Accordingly, this document does not disclose that the hardness of the hot formed parts falls in the range of claim 1.

4.3.3 In conclusion, the subject-matter of claim 4 is novel, too.

5. In the decision under appeal the patent was revoked solely on the grounds of lack of novelty. However, the patent in suit was opposed also on the grounds of lack of inventive step. Hence, the Board deems it appropriate, exercising its powers under Article 111(1) EPC, to remit the case to the opposition division for further prosecution in order to retain the possibility of examination by two instances in respect of this issue as well.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the opposition division for further prosecution.

The Registrar: The Chairman:

V. Commare T. Kriner

Decision electronically authenticated