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Datasheet for the decision of 3 August 2007

Case Number: T 0333/05 - 3.2.02

Application Number: 98400688.2

Publication Number: 0867520

IPC: C22C 38/04

Language of the proceedings: EN

Title of invention:
Welded high-strength steel structures and methods of manufacturing the same

Patentee:
SUMITOMO METAL INDUSTRIES, LTD.

Opponent:
L'AIR LIQUIDE, S.A.

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (yes)"

Decisions cited:
T 0012/81, T 0562/90, T 0373/95, T 0012/90, T 0658/91, T 0247/91

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0333/05 **-** 3.2.02

D E C I S I O N
of the Technical Board of Appeal 3.2.02
of 3 August 2007

Appellant: (Opponent)
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Decision under appeal:
Decision of the Opposition Division of the European Patent Office posted 20 January 2005 rejecting the opposition filed against European patent No. 0867520 pursuant to Article 102(2) EPC.

Composition of the Board:

Chairman: T. Kriner
Members: R. Ries
E. Dufrasne

Summary of Facts and Submissions

I. An opposition was filed by the appellant (opponent) against European patent No. 0 867 520. The opposition division held that the grounds for opposition pursuant to Article 100(a) EPC cited by the appellant did not prejudice the maintenance of the patent and therefore decided on 8 December 2004, posted on 20 January 2005, to reject the opposition.

II. The appellant lodged an appeal by notice received at the EPO on 14 March 2005 and paid the prescribed fee on the same day. A statement setting out the grounds of appeal was filed on 25 March 2005.

In support of its arguments the appellant referred to the documents

D1: EP-A-0 753 596 and

D2: Official Gazette for Kokai Patent Applications (A) Japanese Patent Application Kokai Publication Hei 8-252690 (in English language)

III. In the annex for the summons to oral proceedings requested on an auxiliary basis by the appellant, the board gave its provisional view on the case and referred to document

D7: GB-A-2 247 246 & Japanese Unexamined Patent Application Publication Hei 3-211230 cited in D2.

IV. The appellant requested that the decision under appeal be set aside and the European patent No. 0 867 520 be revoked.

The appellant's auxiliary request for oral proceedings was withdrawn with its letter dated and received at the European Patent Office on 1 June 2007. In consequence thereof, the oral proceedings were cancelled.

The respondent (patentee) requested that the appeal be dismissed.

V. Independent claims 1, 5 and 7 read as follows:

"1. A welded high-strength steel structure comprising a base metal and a weld metal, wherein the base metal is a steel whose microstructure is substantially formed of a mixed structure of martensite and lower bainite and which has a tensile strength of not less than 900 MPa; and the weld metal is a steel which has a tensile strength of not less than 900 MPa and comprises the following alloy elements based on % by weight:

C: 0.01% to 0.15%;
Si: 0.02% to 0.6%;
Mn: 0.6% to 3%;
Al: 0.004% to 0.08%;
Ti: 0.003% to 0.03%;
O(oxygen): not greater than 0.06%
B: 0.0002% to 0.005%;
Cu: 0% to 1.2%;
Ni: 0% to 3%;
Cr: 0% to 1.2%;
Mo: 0% to 1%;

V: 0% to 0.05%; and
Nb: 0% to 0.05%,

and which satisfies the equations 1) and 2) below:

1) $0.25 \leq Pcm \leq 0.32$

$$Pcm = C+(Si/30)+(Mn/20)+(Ni/60)+(Cu/20)+(Cr/20)+(Mo/15)+(V/10)+5B$$

2) $0.6 \leq Al/O(oxygen) \leq 1.4$

wherein each atomic symbol in equations 1) and 2) represents its content (wt.%) within the steel."

"5. A method of manufacturing a welded steel pipe as one of the welded high-strength steel structures according to anyone of claims 1 to 4, the method comprising the steps of bending a steel plate into a tubular shape, and seam-welding butted ends of the steel plate through submerged arc welding."

"7. A method of manufacturing a pipeline comprising the steps of butting together the end portions of adjacent two steel pipes having a tensile strength of not less than 900 MPa, and welding the circumference of the butted portion through gas metal arc welding, wherein the weld metal of the welded circumference portion is a steel which has a tensile strength of not less than 900 MPa and comprises the following alloy elements based on % by weight:

C: 0.01% to 0.15%;
Si: 0.02% to 0.6%;

Mn: 0.6% to 3%;
Al: 0.004% to 0.08%;
Ti: 0.003% to 0.03%;
O(oxygen): not greater than 0.06%
B: 0.0002% to 0.005%;
Cu: 0% to 1.2%;
Ni: 0% to 3%;
Cr: 0% to 1.2%;
Mo: 0% to 1%;
V: 0% to 0.05%; and
Nb: 0% to 0.05%,

and satisfies the equations 1) and 2) below:

1) $0.25 \leq Pcm \leq 0.32$

$$Pcm = C+(Si/30)+(Mn/20)+(Ni/60)+(Cu/20)+(Cr/20)+(Mo/15)+(V/10)+5B$$

2) $0.6 \leq Al/O(oxygen) \leq 1.4$

wherein each atomic symbol in equations 1) and 2) represents its content (wt.%) within the steel."

The dependent claims 2 to 4, 6 and 8 relate to preferred embodiments of the welded steel structure according to claim 1 or the method of manufacturing the steel structure set out in claims 5 or 7, respectively.

VI. The arguments of the appellant are summarized as follows:

Document D1 as the closest prior art related to an ultra-high strength steel excellent in toughness and

weldability. The steel exhibits a tensile strength (TS) of at least 950 MPa as well as a martensite - lower bainite structure. In coincidence with the patent, this steel was typically formed as the "base metal" into welded steel pipes for transporting crude oil and gas. However, document D1 failed to disclose the composition of the "weld metal" in the welded zone. Starting from D1, the problem underlying the patent at issue therefore resided in providing a "weld metal" which - after the welding with the base metal - achieved a high toughness at low temperatures and a high TS in the welded zone. In his search for an appropriate "weld metal" satisfying these properties in line pipes conveying oil or natural gas, the skilled person would be prompted to resort to the weld metal disclosed in document D2 given that this material was designed for the same purpose and provided the desired strength and toughness. As it was evident from the comparative table given on page 4 of the grounds of appeal, an overlap existed between the elements making up the claimed "weld metal" and that given in D2, including the range of $0.15 \leq Pcm \leq 0.28$ and also the ratio of $0 \leq Al/O \leq 0.75$ to 6. The opposition division's reliance on document D2 was misplaced in that it focused its attention mainly on the examples rather than on the teaching of document D2 as a whole, contrary to the precepts given in the decisions T 12/81, T 562/90, T 373/95, T 12/90, T 658/91 and T 247/91. Considering D2 as a whole, the relevant passages [0012], [0020] and [0022] would have led a skilled person to note that the proportions of Al, O, Ti and N should be controlled in the welded zone, in particular in that the amount of Al did not exceed 0.06% and oxygen was kept within a range from 0.01 to 0.08%. From these data, the ratio of Al/O

could be calculated to be 0.06/0.08 = 0.75 which fell in the middle of the range of 0.6 to 1.4 claimed for the Al/O ratio in the patent. Therefore, the teaching of D1 and D2 in combination with the results of a few routine welding tests around the known values would have evaluated the optimum welding results and would have led the skilled person in an obvious way to the claimed welded high-strength steel structure. The subject matter of product claim 1 and method claims 5 and 7 therefore lacked an inventive step.

VII. The arguments of the respondent are summarized as follows:

Document D1 related exclusively to the "base metal" having a mixed martensite/bainite structure, a TS of at least 950 MPa and an excellent low-temperature toughness. The known steel composition focused on the combination of high amounts of Mn with Ni-Mo-Nb which was, however, less important in the claimed alloy. More importantly, it was noted that the formula expressing the P value in D1 was entirely different from the Pcm value claimed in the patent in suit.

The "weld metal" disclosed in document D2, on the other hand, was designed in the first place for improving the corrosion resistance of oil and gas pipelines. The alloy composition was particularly resistant to corrosion by CO_2 and also possessed sufficient strength and toughness in the circular weld metal sections. Although not specifically mentioned, it seemed evident from Japanese unexamined patent application Hei 3-211230 referred to in D2, paragraph [0003] that the "base metal" the pipes were made of exhibited a TS of

less than 667 MPa which was far below the TS ≥ 900 MPa claimed in the patent. Already for this reason, a skilled person would not combine D1 with D2 in an obvious manner, as alleged by the opponent.

In addition, D2 neither explicitly nor implicitly taught the ratio Al/O and failed to mention the requirement of adhering to the Al/O ratio in combination with the Pcm value. As shown in the patent in suit, a TS of not less than 900 MPa, an upper shelf energy ≥ 80J and a transition temperature of fracture appearance vTs ≤ -50°C was not obtained unless both conditions are met simultaneously. Specifically, none of the examples given in D2 satisfied both conditions for Pcm and Al/0, and there was no teaching whatsoever in D2 linking these values with the specific microstructure and the TS associated therewith.

As to its general disclosure referred to by the opponent, document D2 required to regulate the balance between hardenability and Ti, Al, N and O so that the inequality

(2): $-50 \leq \alpha' = \{1,5(0-0.89Al) + 3.4N - Ti\}x10^3 \leq 50$

was satisfied to prevent a deterioration in toughness and cleanliness. Hence, the general disclosure of document D2 pointed to a different direction and taught away from the present invention. The claimed subject matter therefore involved an inventive step.

Reasons for the Decision

1. The appeal is admissible.

2. *Novelty*

In the grounds of appeal, novelty has not been disputed.

3. *Inventive step*

3.1 Document D1 which is amply acknowledged in paragraph [0005] of the patent specification relates to a weldable high-tensile steel for producing line pipes transporting natural gas and oils. The known "base metal" exhibits a mixed martensite - bainite structure, a TS of at least 950 MPa and an excellent balance between strength and low-temperature toughness (cf. D1, claim 1; Table 2). The board concurs with the assessment of the parties that document D1 qualifies as the closest prior art. However, D1 neither discloses the alloy of the weld filler wire (i.e. the welding rod) nor the composition of the "weld metal" that is formed in the welded zone by the welding process.

The problem underlying the invention and addressed in paragraphs [0007] and [0008] of the patent specification, therefore, resides in providing a welded steel structure (in particular welded steel pipes, pipelines, marine structures etc.) wherein the base metal and also the welded joints (= the weld metal) exhibit an excellent low temperature toughness, an upper shelf energy of ≥ 80 J, a transition temperature of fracture appearance vTs $\leq -50^{\circ}$C and a TS $\geq$ 900 MPa even when welded at an heat input up to 10 KJ/mm.

As set out in claim 1 of the patent, the solution to this problem consists in specifying the composition of the "weld metal" which meets the correlation rule for the Pcm-value and the Al/O ratio expressed in equations 1) and 2), respectively, and which exhibits a mixed martensite + lower bainite microstructure as a consequence thereof. The crucial influence of the ranges claimed for the Pcm-value and the Al/O ratio on the mechanical properties is established by the numerous examples, the results of which are summarized in Figure 1 and show that the claimed object is successfully achieved by the claimed solution.

3.2 In the appellant's view, the skilled person would immediately be prompted to turn to the "weld metal disclosed in D2 to solve this problem. The board cannot, however, agree with the appellant's position for the following reasons.

Document D2 is essentially concerned with providing a weld metal composition exhibiting sufficient resistance to selective corrosion by CO_2 of the circular weld metal sections and possessing sufficient strength and toughness (cf. D2, paragraph [0007]. This object is achieved by confining the Pcm-values to 0.15 to 0.28 and by controlling the balance between hardenability and Ti, Al N and O in the weld metal section (expressed by the parameter α') to improve the low temperature toughness (cf. D2, paragraph [0012], [0024], [0025]).

The appellant's assessment of the general teaching of document D2 is correct in that the amounts of Al and O are restricted to max. 0.06% Al and 0.01 to 0.08% O,

respectively (cf. D2, paragraphs [0020], [0022]). However, as correctly analysed by the opposition division under point 4.5 of the impugned decision, the general teaching of document D2 fails to give any information about the significance of the Al/O ratio at all, contrary to the patent in suit in which the Al/O ratio represents one of the key features of the claimed weld metal composition. Nor does D2 teach the combination of the upper limits for Al (0.6%) and oxygen (0.08%) to calculate a Al/O ratio of 0.75 as suggested by the appellant in the grounds of appeal. Doing so would mean to construct - on the basis of hindsight - a "new" example which has not been originally disclosed in D2. The examples featuring in Table 1 clearly show that such an exemplifying "new" composition was neither intended nor tested in D2.

It is further undisputed that an overlap exists between the Pcm-range of the claimed weld metal (0.25-0.32) and that given in D2 (0.15-0.28). The range of overlap is, however, small and the majority of the examples in D2 exhibits a Pcm-value around 0.20 ± 0.04 which is clearly outside the claimed range (cf. D2, Table 1, examples 1 to 10). One example only (example 1) having a Pcm of 0.27 actually falls within the range of overlap, and 4 examples (5, 6, 8, 10) satisfy the claimed Al/O ratio of 0.6 to 1.4 which is, as mentioned above, neither a critical parameter nor addressed anywhere in document D2. But more importantly it is noted in coincidence with the analysis of the opposition division, that none of the examples given in Table 1 of D2 actually satisfies both conditions claimed for (i) the Pcm value of 0.25 to 0.32 **and** (ii) the ratio Al/O of 0.6 to 1.4. The patent specification emphasizes in paragraph [0009]

that both parameters are essential and only in combination promote the desired martensite/lower bainite microstructure which results in a TS of ≥ 900 MPa and provides the excellent match of properties of the welded high-strength steel structure claimed in the patent at issue. Contrary thereto, document D2 does not even remotely pay any attention to the microstructure and its effect on the mechanical properties. Moreover, the skilled person is left short of the TS that is actually achieved by the weld metal set out in D2 since apart from the hardness HV, the vE-30 value and the corrosion rate, D2 is silent on that point. Therefore, the teaching of this document cannot induce the skilled person to select in an obvious way the alloy composition of the "weld metal" claimed in the patent.

The above considerations lead to the conclusion that the opposition division's evaluation of the contents of document D2 (i) as a whole and (ii) as regards the preferred embodiments in the form of the examples vis-à-vis the opposed patent is unimpeachable. Hence, the impugned decision does not contravene the considerations set out in the decisions T 12/81, T 562/90, T 373/95, T 12/90, T 658/91, and T 247/91, contrary to the appellant's allegations.

As to the "base metal" used in document D2, it could only be deduced from paragraph [0003] that the steel pipes consist of the CO_2 - corrosion resistant steel composition disclosed in Japanese Unexamined Patent Application Publication Hei-3-211230 (cf. D2, [0003]). This document corresponds to D7: GB-A-2 247 246. It is however apparent from D7, Table 1, and page 14 that the

TS of more than 900 MPa is not obtained with this base metal. The appellant has not submitted any comments on that point.

In conclusion, there is no reason to pick features from document D2 to associate with the teaching of document D1 and even if this were done, the subject matter of claim 1 would not be reached in an obvious way. The subject matter of claim 1 therefore involves an inventive step. The same statement is true for the independent claims 5 and 7 and the claims dependent thereupon, respectively.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

V. Commare T. Kriner