BESCHWERDEKAMMERN DES EUROPÄISCHEN PATENTAMTS

BOARDS OF APPEAL OF THE EUROPEAN PATENT OFFICE

CHAMBRES DE RECOURS DE L'OFFICE EUROPEEN DES BREVETS

Internal distribution code:
(A) [ ] Publication in OJ
(B) [ ] To Chairmen and Members
(C) [X] To Chairmen

D E C I S I O N
of 28 March 2001

Case Number: T 0089/98 - 3.2.2

Application Number: 90311661.4

Publication Number: 0426367

IPC: C22C 38/22

Language of the proceedings: EN

Title of invention:
Steel composition

Patentee:
UNITED ENGINEERING FORGINGS LIMITED

Opponent:
Mannesmann Aktiengesellschaft
ASCOMETAL
THYSSEN STAHL AG

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (no)"

Decisions cited:
-

Catchword:
-

Europäisches Patentamt | European Patent Office | Office européen des brevets

Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0089/98 - 3.2.2

D E C I S I O N
of the Technical Board of Appeal 3.2.2
of 28 March 2001

Appellant: (Proprietor of the patent)
UNITED ENGINEERING FORGINGS LIMITED
PO Box 4
Bromsgrove, Worcestershire B60 3DZ (GB)

Representative:
Moffat, John Andrew
Lewis & Taylor
5 The Quadrant
Coventry CV1 2EL (GB)

Respondent: (Opponent 01)
Mannesmann Aktiengesellschaft
Mannesmannufer 2
D-40213 Düsselforf (DE)

Representative:
Meissner, Peter T., Dipl.-Ing.
Meissner & Meissner
Patentanwaltsbüro
Postfach 33 01 30
D-14171 Berlin (DE)

Opponent:
ASCOMETAL
Immeuble La Pacific, 11-13 Cours Valmy
La Défense 7
92800 Puteaux (FR)

Representative:
Bouget, Lucien
Cabinet Lavoix
2, Place d'Estienne d'Orves
75441 Paris Cédex 09 (FR)

Opponent:
THYSSEN STAHL AG
Postfach 110561
D-47161 Duisburg (DE)

Representative:
Simons, Johannes Dipl.-Ing.
Cohausz & Florack
Patentanwälte
Postfach 33 02 29
D-40435 Düsseldorf (DE)

Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted 24 November 1997 revoking European patent No. 0 426 367 pursuant to Article 102(1) EPC.**

Composition of the Board:

Chairman: W. D. Weiß
Members: R. Ries
R. Menapace

Summary of Facts and Submissions

I. European patent No. 0 426 367 was granted on 8 February 1995 on the basis of European patent application No. 90 311 661.4.

II. The granted patent was opposed by the present respondents (opponents I to III) on the grounds that its subject matter lacked novelty and did not involve an inventive step with respect to the state of the art (Article 100 (a) EPC).

III. With its decision posted on 24 November 1997, the opposition division held that the claimed subject matter according to the main request and the auxiliary request lacked an inventive step and revoked the patent.

IV. An appeal against this decision was filed by the patentee (the appellant) on 26 January 1998. The fee for appeal was paid and the written statement setting out the grounds of appeal was filed within the time limit given in Article 108 EPC.

Of the pre-published documents relied upon in the opposition proceedings, only the following have still been relied upon on appeal:

D3.4: Composition Certificate of Mannesmann Röhrenwerke heat No. 325496; order No. 892/5486

D4: Analysis sheet of melt No. 325496

D5: Mannesmann Certificate for order No. 892/5662, heat No. 310980S

D6: Analysis sheet with analysis of melt No. 310980S

D11: US-A-4 461 657

D14: US-A-4 394 189

V. In order to meet the request of all parties, oral proceedings before the Board were held on 28 March 2001.

- The appellant (patentee) requested that the decision under appeal be set aside and that the patent be maintained on the basis of the set of claims 1 to 4 filed during the oral proceedings.

- The respondents (opponents) requested that the appeal be dismissed.

Claim 1 reads as follows:

"1. A steel composition for use in pressure vessels which comprises by weight:

carbon	0.32 - 0.37 %
silicon	0.15 - 0.35 %
manganese	0.60 - 0.90 %
chromium	0.80 - 1.10 %
phosphorus	a maximum of 0.02%
aluminium	0.01 - 0.05 %
nickel	a maximum of 0.25 %
molybdenum	0.40 to 0.50 %

and the sulphur is a maximum of 0.005% and the balance being iron and unavoidable impurities wherein the steel is heat treated by austenitising at a temperature in the range 870-920°C, immediately quenched and tempering is carried out in the range 570°-630°C such that the tensile strength is in the range 1069-1260 N/mm^2 and the yield strength exceeds 960 N/mm^2."

VI. The appellant argued as follows:

Document D11 which is also directed to a steel composition for producing pressure vessels is regarded as representing the closest prior art. The alloy composition proposed by document D11, however, comprises lower amounts of molybdenum and additionally includes vanadium as an essential constituent. In contrast thereto, document D14 is concerned with steel grades for deep oil and gas well tubulars which is a use different to that claimed. These oil well tubulars are subjected to lower pressures than the pressure vessels for which the steel according to the patent is intended to be used. Moreover, the aluminium contents specified in the exemplifying heats of D14 are much lower than those claimed in the patent, and there are intermediate fabrication steps to which the claimed steel is not subjected. Having regard to the different use, the teaching given in documents D11 and D14 is not an obvious combination to be considered by a skilled person.

Starting from the alloy composition disclosed in document D11 as closest prior art, the problem addressed by the patent is to improve the toughness or impact strength of the steel alloys so that the high pressure cylinders can be used at very low temperatures down - 50°C. The alloy composition according to the patent fulfils the acceptance values for the Charpy impact strength set out in Tables 1 and 4 of the technical norm ISO 9809-2:2000E which was proposed as a reference in March 1983 for refillable seamless steel gas cylinders for worldwide use. Due to the increased amounts of Mo and the reduction in the quantity of sulphur (i.e a specific Mo/S ratio) and by an appropriate heat treatment, the claimed steel achieves the desired combination of properties such as tensile strength (TS), yield strength (YS) and toughness. The

alloy compositions according to the prior art, in particular the steel grades given in document D11, however, do not exhibit the impact strength still required at minus 50°C. Hence the steel composition according to claim 1 of the patent is novel and involves an inventive step.

VII. The arguments put forward by the respondents are summarized as follows:

Claim 1 of the opposed patent is directed to a MnCrMo steel composition which, after quenching and tempering, exhibits a specific tensile strength and yield strength and which is provided for the production of pressure vessels such as gas storage cylinders. A high performance carbon steel alloy for producing pressure cylinders which exhibit after tempering at 1000°F (538°C) or 1100°F (593°C) a yield strength in the range of 150-175 ksi (1034 to 1204 N/mm^2) is disclosed in document D11, column 1, last line to column 2, line 26; column 5, lines 21 to 34). A similar steel composition for producing deep sour well seamless tubes is referred to in document D14. These tubulars are to be used in a highly corrosive atmosphere at pressures exceeding 15000 psi and 250°C (cf. D14, abstract; column 1, lines 26 to 29). The mechanical properties required of this steel material are, therefore, comparable to those of pressure cylinders according to document D11. More specifically, document D14 discloses in Table 1 and also in claim 1 a vanadium-free steel grade comprising (by weight) 0.20-0.35% C, up to 0.35% Si, 0.35-0.90%Mn, 0.75-1.50%Cr, 0.15-0.75%Mo, up to 0.25% Ni, up to 0.04% each of P and S, the balance being Fe. A more detailed explanation for the meaning of the term "fully killed" that is mentioned in column 2, line 66, is found in Table IV which specifies two heats comprising 0.004% Al or 0.005% Al, respectively. A broader interpretation of the term "killed steel" is also derivable from

document D11, column 6, lines 39 to 54, which advocates adding aluminium in amounts ranging from 0.005 to 0.05% to the melt for deoxidation and for preventing the formation of silicate type oxide inclusions. As set out in document D14, column 6, lines 53 to 68, the steels are austenitized at 1650-1700°F (898-926°C), water quenched to assure complete transformation of the austenite to martensite and tempered at 1100-1350°F (593-734°C). These temperatures which are typical in the art for the type of steel under consideration overlap the ranges claimed in the patent. It is apparent from D14, Table 4, that a tempering treatment at 1165°F (628°C) brings about a yield strength of 140000 psi (corresponding to 965 N/mm^2). This value falls within the YS limit given in claim 1 of the patent. Thus, the claimed steel composition neither represents a novel selection from the steel grades given in D14 nor does it involve an inventive step to achieve the desired mechanical properties by appropriately heat-treating the alloy. The low temperature impact strength the claimed steel composition is supposed to exhibit according to the appellant represents a mere conjecture which is irrelevant, since the patent neither addresses the problem of low temperature toughness nor gives any detailed information about the impact strength at all to support these allegations.

Reasons for the Decision

1. The appeal complies with the formal requirements of Articles 106 to 108 and Rules 1(1) and 64 EPC. It is therefore admissible.

2. *The closest prior art*

In the Board's view and as agreed by the parties, the closest prior art is represented by document D11 which is referred to in the description of the disputed patent. A comparison of the steel grade disclosed in document D11 with the claimed steel composition is given in the following Table (in wt%):

Element	EP-A-0 426 367	US-A-4 461 657 (document D11)
carbon	0.32-0.37	0.32-0.36 (cf. claim 3)
manganese	0.60-0.90	0.6 - 0.9
silicon	0.15-0.35	0.15-0.35
chromium	0.80-1.10	0.8 - 1.1
molybdenum	0.40-0.50	0.15-0.25
aluminium	0.01-0.05	0.005-0.05 pref.: 0.01-0.03
sulphur	≤ 0.005	≤ 0.010 (cf. claim 11)
phosphorus	≤ 0.02	≤ 0.025 (cf. claim 6)
vanadium		0.04 -0.10
nickel	≤0.25	
Zr, Ca,Rare earth elem.		optionally for sulphide and oxide shape control
iron	balance + impur.	bal.+ unavoidable impurities.
austenit.°C	870-920 °C (880*)	
tempering°C	570-630 °C (580*)	> 598°C (preferred)
TS (N/mm^2)	1069-1260 (1100*)	> 1034-1204 (150-175 ksi)
fracture toughness		>70 ksi√in (cf. claim 10
YS (N/mm^2)	> 960 (1000*)	

* (example)

The steel alloy according to document D11 is particularly suited in the tempered state to the manufacture of gas storage cylinders. Since it exhibits a remarkably improved performance over the standard steel grades used for this purpose, less material than with prior art steels is required to fabricate the cylinders (cf. D11, column 4, lines 16 to 28). According to document D11, page 5, lines 21 to 29, a tensile strength of 150 to 175 ksi = 1034-1204 N/mm^2 is obtained after tempering which is preferably carried out at a temperature of least 1100°F (598°C) and which falls within the range claimed in the patent (580-630°C; TS 1069-1260 N/mm^2). In addition to molybdenum which promotes an increase in hardenability, temper resistance and high temperature strength, the steel according to D11 comprises 0.04 to 0.10% vanadium as a strong carbide and nitride former which, like molybdenum, helps to increase the temper resistance (cf. D11, column 6, lines 29 to 33; column 6, line 55 to column 7, line 4). Moreover, calcium and or zirconium or rare earth elements can be optionally added for sulphide shape control to improve the fracture toughness (cf. D11, column 2, lines 11 to 26; column 7, lines 27 to 50).

It is apparent from the comparative table above that the known alloy contains aluminium in amounts of 0.005 to 0.05, most preferably 0.01 to 0.03%. This typical range, however, merely represents conventional steelmaking practice to provide a fully killed steel and to prevent the formation of detrimental silicate type oxides which would reduce the fracture toughness in the transverse direction (cf. D11, column 6, lines 39 to 54). This rating of the aluminium range set out in D11 which fully complies with the range given in the patent was not disputed by the patentee in the opposition proceedings (cf. the appealed decision, point 5.1).

The appellant developed arguments that the TS and YS of the claimed steel composition result from a specific Mo/S ratio and that the claimed alloy exhibits a high impact strength at minus 50°C as evidenced by the documents submitted at the oral proceedings.

According to the established case law of the Boards of Appeal, each party to the proceedings carries the burden of proof for the facts it alleges. In the present case, the patent specification points out on page 2, lines 42 to 46 that by increasing the amount of Mo and reducing the quantity of sulphur compared to the existing compositions, the desired strength, toughness and ductility required for gas storage cylinders is obtained. However, apart from the fact that the claimed alloy in the tempered state merely exhibits a tensile strength comparable to that of the alloy according to the prior art D11, neither the example nor the description of the patent as a whole deliver any evidence that there is any synergistic effect on the properties of the alloy resulting from the interaction of high Mo and low S contents. Hence, the statement given on page 2, lines 42 to 46 of the patent specification is devoid of any corroborating evidence. This assessment is also true for the appellant's further allegation that the claimed steel grade in the tempered state meets the minimum impact test acceptance values for very low temperatures (i.e. minus 50°C) required by ISO/DIS 9809.2 of March 1983 for refillable seamless steel gas cylinders for worldwide usage. There is not any evidence in the documents submitted at the oral proceedings or in the patent specification to support this allegation, the more so since the patent neither discloses any data at all for the impact strength at room temperature nor for a temperature of minus 50°C or lower. The patentee's allegations in this respect have therefore to be disregarded by the Board.

3. *The problem to be solved*

Starting from document D11, the problem underlying the disputed patent is, therefore, seen in designing a more economic steel alloy composition having the same specifications with respect to tensile strength and yield strength state of the art steel compositions which use V and Ca, Zr or RE elements to control the shape of the sulphide inclusions.

This problem is solved by shifting the molybdenum content to amounts in the range of 0.4-0.50%, by dispensing with vanadium and by reducing the sulphur to a maximum of 0.005%. Compared with the prior art D11, the annealing and tempering temperatures are essentially unchanged.

4. *Inventive Step*

Having regard to the sulphur content of "not more than 0.015% S" specified in document D11, it belongs to the basic knowledge of a metallurgist that high amounts of sulphur involve the risk of forming elongated sulphide inclusions which are detrimental to the fracture toughness. Consequently the metallurgist aims at reducing the concentration of sulphur in the steel to as low a level as possible. This position is corroborated by the chemical analysis of various heats of standard alloy 32CrMo4 for producing gas storage cylinders which typically comprise sulphur contents of about 0.005% or lower (cf. e.g. document D3.4, D4, D6).

Moreover, in his search for a more economic alloy composition which is to provide the required match in TS, YS and fracture toughness, the metallurgist would also turn to the technical information given in document D14 for the following reasons. Like the steel for pressure cylinders as claimed in the patent, the

deep sour oil well tubes produced from this steel must sustain high pressures and high temperatures and must be resistant to corrosion attack, in particular by hydrogen sulfide (cf. document D14, abstract; column 2, lines 11 to 21; column 10 to 18; Table I; claim 1). The basic teaching of document D14 discloses a vanadium-free carbon steel comprising 0.20 to 0.35% C, up to 0.35% silicium, 0.35 tp 0.90 % manganese, 0.75 to 1.5% chromium, 0.15 to 0.75% molybdenum, up to 0.25% nickel and up to 0.04% sulphur and phosphorus each (cf. D14, Table I). After austenitising at a temperature between 1650 to 1700°F (898-926°C) and quenching, the steel is tempered at 1100 to 1350°F (593-734°C) to provide a substantially tempered martensite microstructure and a closely controlled yield strength. The comparison reveals that the elemental ranges of the claimed steel composition fall completely within the ranges of the basis alloy specified in Table 1 of document D14. As set out in claim 1 of document D14, the yield strength after tempering the V-free steel can be as high as 140 000 psi (965 N/mm^2) which is above the limit of 960 N/mm^2 claimed in the patent (cf. also column 6, lines 54 to 68). Moreover, Table III makes it clear that tempering at increasing temperatures results in a lower yield strength, hardness or ultimate tensile strength, respectively, and in a higher fracture toughness. Bearing in mind this interdependency, it falls within the normal competence of a metallurgist to select the appropriate tempering temperature in order to provide a steel material which exhibits the desired match in the TS, YS and fracture toughness.

In a more preferred embodiment, vanadium is added to the basic composition (cf. D14, claim 2; Table II). However, the passages in column 6, lines 29 to 38 and lines 55 to 65 of document D11 reflect the basic metallurgical experience that either molybdenum and vanadium are extremely potent elements to increase hardenability and to enhance the temper resistance.

Hence, there is a basis for concluding that vanadium can be compensated for by increased amounts of molybdenum, as has been done in the patent under appeal.

5. In view of these considerations, the technical teaching according to document D11 in combination with that given in document D14 leads a person skilled in the field of metallurgy in an obvious way to the steel material claimed in patent. The subject matter of claim 1, therefore, does not involve an inventive step.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

V. Commare W. D. Weiß