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D E C I S I O N
of 3 May 1994

Case Number: T 0404/92 - 3.2.2

Application Number: 80201130.4

Publication Number: 0031605

IPC: C22C 21/16, C22F 1/04

Language of the proceedings: EN

Title of invention:
Method of manufacturing products from a copper containing aluminium alloy

Patentee:
The Boeing Company

Opponent:
OI) Alusuisse-Lonza Holding AG
OII) Pechiney, S.A.

Headword:
-

Relevant legal norms:
EPC Art. 56, 123

Keyword:
"Original disclosure and inventive step (yes, after amendment)"

Decisions cited:
T 0200/89

Catchword:
-

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Case Number: T 0404/92 - 3.2.2

D E C I S I O N
of the Technical Board of Appeal 3.2.2
of 3 May 1994

Appellant: (Proprietor of the patent)
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Decision under appeal: **Decision of the Opposition Division of the European Patent Office delivered on 22 October 1991 and mailed on 3 March 1992 revoking European patent No. 0 031 605 pursuant to Article 102(1) EPC.**

Composition of the Board:

Chairman: H.J. Seidenschwarz
Members: W.D. Weiß
M.K.S. Aúz Castro

Summary of Facts and Submissions

I. European patent No. 0 031 605 was granted with effect from 3 October 1984 on the basis of European patent application 80 201 130.4, filed on 27 November 1980.

II. Two oppositions were filed against the patent on the grounds of lack of novelty and inventive step (Article 100a EPC).

III. In the course of the opposition proceedings, it was detected that Claim 1 as granted contained an error, which was requested to be corrected under Rule 88 EPC.

In a first decision orally announced at the end of oral proceedings on 8 November 1988, the written grounds of which were posted on 11 January 1989, the Opposition Division revoked the patent, because Claim 1 as proposed to be corrected did not comply with the requirements of Article 123(3) EPC.

IV. At the end of a first appeal proceeding following this first decision of the Opposition Division, the Board of Appeal found in its decision T 200/89 of 7 December 1989 (OJ EPO 1992, 46 followed) that the following version of Claim 1 met the requirements of Article 123 EPC:

"A method of manufacturing a product from an aluminium alloy of the 200 series, said alloy having copper, magnesium and manganese as main alloying elements, characterised by providing an alloy of the following composition:

Weight percent	Element
4.2 to 4.7	Cu
1.3 to 1.8	Mg
0.8 to 1.3	Mn
0.08 to 0.15	Zr
a maximum of 0.25	Zn
a maximum of 0.15	Ti
a maximum of 0.15	Fe
a maximum of 0.12	Si
a maximum of 0.05	Each other trace element
a maximum of 0.15	Total of said other trace elements
the balance being	Al

and by subjecting a body formed from said alloy to a treatment comprising the following steps:

homogenizing said body to provide a substantially uniform distribution of alloying elements, hot working said body to form a wrought product, said hot working being conducted at temperatures effective to yield a product having a highly elongated and substantially unrecrystallized grain microstructure after solution treating and quenching said body."

On the basis of this claim, the Board remitted the case to the Opposition Division to continue prosecution and to examine the grounds of opposition (lack of novelty and inventive step) which had been specifically alleged by the Respondents and which had not yet been examined.

V. At the end of second oral proceedings held on 22 October 1991 the Opposition Division again decided to revoke the patent. The written grounds for this decision were mailed on 3 March 1992.

In its second decision the Opposition Division found that, starting from document

OII(1) J.C. Morris ed., D.S. Thompson, Thermomechanical Processing of Al-alloys, Proceedings of a symposium sponsored by TMS-AIME- St. Louis, Missouri, 18 October 1979, pages 74 to 85,

as the closest state of the art, the subject-matter of the patent as then claimed lacked an inventive step in the light of documents

OII(5) M.V. Hyatt, Aluminium Alloys in the Aircraft Industries, Proceedings of a Symposium held in Turin, 1 to 2 October 1976, pages 31 to 43,

and, *inter alia*,

OII(6) J.T. Staley, Microstructure and Toughness of High Strength Aluminium Alloys, ASTM Special Technical Publication, ASTM (1976), pages 71 to 103.

V. On 13 April 1992 the Appellant (Proprietor) filed an appeal and paid the appeal fee simultaneously. The Statement of Grounds was filed on 3 July 1992.

VI. During the oral proceedings of 3 May 1994 before the Board, the Appellant submitted new Claims 1 to 4, Claim 1 of which reads as follows:

"A method of producing an aluminium alloy plate product for a lower wing skin for an aircraft, comprising the steps of:

a) providing an alloy body composed of an aluminium alloy of the 2000-series, said aluminium alloy having

copper, magnesium, manganese and zirconium as main alloying elements, and having following composition:

Weight percent	Element
4.2 to 4.7	Cu
1.3 to 1.8	Mg
0.8 to 1.3	Mn
0.08 to 0.15	Zr
a maximum of 0.25	Zn
a maximum of 0.15	Ti
a maximum of 0.15	Fe
a maximum of 0.12	Si
a maximum of 0.05	Each other trace element
a maximum of 0.15	Total of said other trace elements, inclusive chromium
the balance being	Al

b) homogenizing said alloy body to provide a substantially uniform distribution of alloying elements;

c) hot working said body by hot rolling to produce said alloy plate product, said hot rolling being positively controlled by intentionally maintaining the temperature of said alloy body at a temperature effective to yield said alloy plate product having a substantially unrecrystallized grain microstructure of elongated platelet-like grains the length-to-thickness ration of which exceeds at least about 10:1 and less than about 20 volume percent of the grain microstructure is recrystallized;

d) subjecting said hot rolled alloy plate product to solution heat treatment;

e) quenching said solution heat treated alloy plate product; and

f) subjecting said alloy plate product to an aging treatment."

VII. The Appellant, during the oral proceedings of 3 May 1994, essentially presented the following arguments:

The basic technical problem of the patent in suit, depicted in the paragraph bridging columns 1 and 2, had been a well known goal for all the experts doing research in this field. The congress papers OII(5) (1976) and OII(1) (1978) represented successive review articles about the progress achieved during the ongoing research. It was the gist of both documents that the copper content had to be chosen such that the alloy was still in the single-phase region at homogenising and solution annealing temperatures, which according to the phase diagrams acknowledged at those days (OII(5), Figure 15, and patent in suit, Figure 2A)) could not be warranted at copper contents exceeding about 4%. The patent in suit, however, was based on the finding that, contrary to those generally accepted phase diagrams, the effective single-phase boundary had been shifted to higher copper contents due to the formation of secondary phases withdrawing part of the copper content. Therefore, for alloys with a composition chosen according to the rules of the patent in suit, the copper content could be increased to beyond 4% without losing the capability of developing a fine grain microstructure. Table V of document OII(1) had also to be interpreted as referring to alloys having a copper content of about 3.8% which is at the upper limit of the 2048 type corresponding to the lower limit of the 2124 type (see document OII(2), Aluminium Association Registration Record of Intern. Alloy Designations and

Chemical Limits for Wrought Al and Wrought Al-Alloys, 1 September 1976, pages 4 and 8).

It might be that the ranges of the homogenising and rolling temperatures used in the production of a conventional 2024 plate according to document OII(5), Table 1, overlapped to a certain extent with those mentioned in the patent in suit; but the fact that the rolling temperatures were allowed to drop to lower temperatures than those admissible according to the patent in suit and that the homogenising annealing there was consistently performed at temperatures above 490°C pointed to the fact that no special care was taken to obtain a certain degree and form of recrystallisation.

VIII. The Respondents asserted that the subject-matter of Claim 1 lacked an inventive step based on the documents OII(1), OII(5), OII(6), and

OII(7) V.I. Elagin and N.N. Averkina, Metallovedenie: term obrab. metallov., 1963, No. 12, pages 21 to 26, including a translation into French,

cited in the course of the opposition proceedings, as well as on the documents

OI(5) M. Hyatt et al., Metal Progress, March 1977, pages 56 to 59,

OII(8) V.P. Kozlovskaja et al., Tekhnol. Legkikh Splavov, No. 2, 1968, pages 9 to 13, including a translation into French,

which were first cited during the appeal proceedings.

In this respect the Respondents presented essentially the following arguments:

In the light of the conclusion "that a 2124 alloy with a high Mn content plus Zr can produce the desired properties", the disclosure of document OII(1) (page 82, last paragraph) went beyond what was taught by document OII(5). In particular Table V of this document clearly referred to alloys of the 2124 type which were characterised by a copper content of between 3.8 and 4.9%. Since the grain refining elements were the same as and the homogenising and the rolling temperatures were similar to those used according to the patent in suit, the structure of the test samples mentioned in Table V must have been necessarily similar to the structure defined in Claim 1. Document OII(6) proved that a fine grain unrecrystallised structure was a prerequisite for the combination of both high strength and notch toughness. The documents OII(7) and OII(8) served as a proof that there existed no prejudice against producing such a fine grain structure also in Al alloys with higher copper contents by the addition of zirconium. Document OI(5) served to prove that it was common general knowledge to maintain low iron and silicon contents to warrant a single phase structure to be present in alloys of 2XXX type at homogenising temperatures.

IX. The Appellant requested that the decision under appeal be set aside and that the patent be maintained on the basis of Claims 1 to 4 filed together with an adapted description during oral proceedings of 3 May 1994 and all the figures of the patent as granted.

The Respondents requested that the appeal be dismissed.

Reasons for the Decision

1. *Admissibility of Amendments (Article 123 EPC)*

Claim 1 differs from the claim which had been allowed by the previous decision T 200/89 (see point IV of Facts and Submissions), by the following features:-

(i) The method is now directed to producing an aluminium alloy plate product for a lower wing skin for an aircraft which involves that the hot working is done by hot rolling.

(ii) Zirconium is now particularly mentioned as a main alloying element.

(iii) It is particularly mentioned that the total of the trace elements includes chromium.

(iv) The functional feature referring to the hot working resulting in a product "having a highly elongated and substantially unrecrystallised grain microstructure after solution treating and quenching" has been replaced by that the "hot rolling is positively controlled by intentionally maintaining the temperature of said alloy body at a temperature to yield a substantially unrecrystallised grain microstructure of elongated platelet-like grains the length-to-thickness ratio of which exceeds at least about 10:1 and less than about 20 volume percent of the grain microstructure is recrystallised".

(v) An aging treatment is now particularly mentioned as a final step.

Ad (i): The original (see page 1, paragraph 3) as well as the granted version of the description state that the product of the method according to the patent in suit is particularly aimed at replacing conventional plate products hitherto used on the lower wing skins of commercial aircraft.

Ad (ii): Zirconium has from the beginning been one of the four obligatory components.

Ad (iii): Decision T 200/89 states in its point 3.3 that the granted version of Claim 1 has to be interpreted such that the composition of the alloy "requires a maximum of 0.05% chromium" being within the term "trace element".

Ad (iv): This functional feature has been disclosed in the paragraph bridging pages 8 and 9 of the original and in column 9, lines 5 to 24, of the granted version of the description. There is also stated that this well defined version of a "highly elongated" and "substantially unrecrystallised" grain microstructure persists through the final heat treatment.

Ad (v): This feature is based on paragraph 4 on page 10 of the original and on column 10, lines 57 to 61, of the granted version of the description.

Claim 1 is, therefore, not objectionable in view of Article 123 EPC.

2. *Novelty*

2.1 Document OII(1) represents the closest prior art. This review article originates from a paper which was presented at a symposium in October 1978.

It discloses, that for the 2000 series aluminium alloys, there had been set, *inter alia*, the following generally acknowledged goals:

- An 8% increase in longitudinal tensile strength over 2024-T351 plate.

- Fracture toughness (K_c or K_{ic}) to be increased in proportion to the increase in strength (8% increase).

- Fatigue crack growth rate (da/dN)) must be decreased in proportion to the increase in strength.

- Exfoliation corrosion and stress corrosion properties to be equal or better than 2024-T351.

The document reports about the progress achieved in current laboratory research work which was based on three different approaches (see page 76, second paragraph). The third of these three approaches consists of developing, essentially, "a new alloy by the addition of Zr and higher-than-normal levels of Mn to 2124". The results achieved in this third approach are reported in the chapter headed "Laboratory Trials of a Modified 2124" (pages 80 and 81).

This chapter describes a method of manufacturing an alloy plate product from "2048/2124 type alloys" in which a series of cast ingots with varying manganese (<0.01 to 1.15%) and zirconium (0.09 to 0.14%) contents (see in particular Table V) were prepared, homogenised at 495°C, hot rolled at between 288 and 426°C, solution treated at 495°C, and cold water quenched.

Document OII(1), in this particular chapter, is silent about which special basic composition, and more precisely, which copper content, was chosen for the test specimens in Table V. The copper content is defined as lying between 3.8 and 4.9% for the 2124 standard alloy and between 2.8 and 3.8% for the 2048 alloy (cf. document OII(2)). Consequently, there is no basis for the assumption why the denomination "2048/2124 type alloy" should stand for a test composition different from those called by this name in the other chapters of the same document, namely for a copper content at the upper margin of the 2048 range and at the lower margin of the 2124 alloy. According to Tables I and II on page 77, and Table IV on page 85, the copper content of a particular test composition is 3.98% or 3.94%, i.e. lower than required by Claim 1 of the patent in suit.

2.2 Consequently, the subject-matter of Claim 1 differs from this closest prior art in

- that the a higher copper content is chosen;
- that the conditions for the homogenising and the hot rolling treatment are chosen to yield in a plate product having substantially unrecrystallised grain microstructure of elongated platelet-like grains the length-to-thickness ratio of which exceeds at least about 10:1 and of which less than about 20 volume percent is recrystallised, and
- that the plate product is subjected to a final aging treatment.

The disclosure of the further documents cited by the Respondents against Claim 1 is even further away from its subject-matter, which has not been questioned.

2.3 The subject-matter of Claim 1 is, therefore, considered to be new.

3. *Technical Problem and Solution*

According to its description (EP-B-0 031 605, the paragraph bridging columns 1 and 2), the patent in suit aims at providing an aluminium alloy plate product that

- has a higher strength-to-density ratio than the currently available alloy 2024-T351,

- has improved fatigue and fracture toughness characteristics over alloy 2024-T351, and

- maintains stress-corrosion resistance and exfoliation - corrosion resistance at a level approximately equivalent to or better than that of the alloy 2024-T351.

The basic technical problem of the patent in suit, therefore, is the same as the one underlying the closest prior art according to document OII(1) (see point 2.1 above), and the still prior document OII(5), and represents a long-felt need which the experts in this field of technology were striving to meet.

Starting from the third approach disclosed in document OII(1) (see point 2.1 above), the subject-matter of Claim 1 solves this problem by the combination of features enumerated under point 2.2 above.

4. *Inventive Step*

4.1 Document OII(1), in its final chapter "Discussions and Conclusions", states "What may prove to be more the practical approach toward achieving the required goals is the use of alloy modification and a normal -T351 practice. It has been demonstrated that a 2124 alloy with a high Mn content plus Zr can produce the desired properties."

This statement, which obviously summarises the results of the tests reported in chapter "Laboratory Trials of a Modified 2124" forming the closest prior art, leads to the conclusion that an industrial scale solution for the problem under research had not yet been found, but that the approach of this chapter was a promising path to be followed in future development.

A study of the test results reported in Table V reveals that only the samples 40454 and 40455 meet the goal that the tensile strength as well as the fracture toughness are higher than the respective values of a standard 2024-T351 material. These two samples stand for manganese contents of 0.45% and 0.72%, respectively. At higher manganese contents of 0.95% and 1.15% the fracture toughness is dramatically reduced to values well below those of a standard 2024-T351 alloy. Consequently, researchers in this field of technology were still directed to follow the same track on which they had already been two years ago, when the preceding progress report on the same topic (document OII(5)) had recommended for the 2000-series alloys (page 43, left-hand column, third paragraph):

- Copper contents around 3.9%:
- Magnesium contents around 1.6%;
- Evaluate different levels of manganese (0.5-1.1)%;

- Evaluate different dispersoid-forming elements - Zr, Cr, Mn;
- Minimum commercially practical levels of iron (0.04-0.08%) and silicon (0.04-0.06%);
- Use of naturally aged tempers only with FTMT's of the T3XX type developed by Reynolds for 2048;
- Optimisation of homogenisation, rolling and final heat treatment practice.

According to this optimised practice, the homogenisation is performed at temperatures of 495°C for 24 hours ((OII(1), page 81, second paragraph) or even higher (OII(5), page 38, second paragraph), and during the hot rolling step, which was started at temperatures of about 425°C, the slabs were allowed to cool down to about 290°C before they were reheated. The Board has been convinced that this practice inevitably leads to a final grain structure with a much higher degree of recrystallisation than is requested according to Claim 1.

Nothing in documents OII(1) and OII(5), which represent the knowledge of the experts in this field shortly before the priority date, points to the solution of the patent in suit. This solution is based on the finding that the deliberate formation of $Al_{20}Cu_2Mn_3$ precipitates allows the copper content to be increased up to 4.7% without leaving the single-phase region at homogenising and solution treatment temperatures and running the risk of embrittling the material by the formation of large intermetallic $CuAl_2$ and Al_2CuMg particles.

The solution offered by the subject-matter of Claim 1 (see point 2.2 above) results in a plate product comprising a combination of the addressed material characteristics the values of which are significantly superior to those hitherto achieved (see Figures 3 to 5

of the Annex to Appellant's letter of 2 July 1992). This superiority of the material produced by the claimed method has not been questioned by the Respondents.

Document OI(5) deals with the same research activities which are reported in documents OII(1) and OII(5). Its teaching is, however, more remote to the claimed solution because it suggests substantial amounts of cold work to be performed after the solution treatment (page 58, right-hand column, fifth paragraph).

Thus, the prior art, which represents the latest trend of the research work before the priority date of the patent in suit, does not point to the solution as claimed in Claim 1.

4.2 Document OII(6) discloses the teaching that the fracture toughness of wrought plates made from 7XXX and 2XXX alloys is higher when the material is unrecrystallised than when it is recrystallised, and refers to the yield strength in the short-transverse direction. The yield strength in this direction is, however, not of predominant importance to materials for the lower wing skin. Moreover, the tests reported there were performed on 4.5 cm thick plates which are not usable for this purpose and the document discloses no specific composition, a person skilled in the art could not extract any teaching from this document leading him to the solution of his problem.

Document OII(7) concerns cold rolled plates of an alloy D16 which is devoid of zirconium and contains less manganese than the alloy treated according to the claimed method.

Document OII(8) discloses the production of non-recrystallised plates from a zirconium containing AlCuMg alloy by extrusion. The alloy no. 5 referred to by the Respondents 2 has an iron content of 0.25% which is higher than is admissible according to Claim 1. Moreover, the plate is not subjected to any further treatment after the extrusion and the parameters of fracture toughness and stress corrosion resistance are not tested.

The Board cannot see any reason, why a skilled person should have consulted the more general documents OII(7) and OII(8) to solve a specific problem which ten years later, according to the documents OI(1), OII(5), OI(5) and OII(6), all the persons skilled in this field of technology were desperately trying to solve.

Therefore, the teachings of this documents could not, either alone or in combination with the teachings of the documents discussed in the foregoing paragraph, lead the person skilled in the art to a method according to Claim 1 of the patent in suit.

4.3 The subject-matter of Claim 1, therefore involves an inventive step.

5. Consequently Claim 1, together with the dependent Claims 2 to 4, the amended description and the Figures of the patent as granted, are not objectionable in the light of the EPC.

Order

For these reasons, it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the first instance with the order to maintain the patent on the basis of:

   Claims 1 to 4 and an amended description, both filed during oral proceedings of 3 May 1994, and

   the Figures of the patent as granted.

The Registrar:

S. Fabiani

The Chairman:

H. Seidenschwarz