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D E C I S I O N
of 26 June 2003

Case Number: T 1067/00 - 3.2.2

Application Number: 96200060.0

Publication Number: 0723033

IPC: C22F 1/04

Language of the proceedings: EN

Title of invention:
Process for manufacturing thick aluminium alloy plate

Applicant:
Corus Aluminium Walzprodukte GmbH

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (no)"

Decisions cited:
T 0026/85, T 0751/94

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 1067/00 - 3.2.2

DECISION
of the Technical Board of Appeal 3.2.2
of 26 June 2003

Appellant: Corus Aluminium Walzprodukte GmbH
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Representative: Müller Hans-Jürgen, Dipl.-Ing.
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 16 May 2000 refusing European application No. 96200060.0 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: W. D. Weiß
Members: R. Ries
E. Dufrasne

Summary of Facts and Submissions

I. This appeal is against the decision of the examining division dated 16 May 2000 to refuse European patent application No. 96 200 060.0.

The ground of refusal was that the subject matter of claim 3 of the main and auxiliary requests lacked novelty and that the subject matter of claim 8 of the main request did not involve an inventive step having regard to the technical teaching given in document

D1: US-A-5 277 719

II. On 9 June 2000 the appellant (applicant) lodged an appeal against the decision and paid the prescribed fee on the same day. Enclosed with the statement of grounds of appeal which were filed on 26 September 2000, the appellant referred to the documents

D2: "Ultra Thick Aluminium Aircraft Plate from Koblenz" by HOOGOVENS Aluminium Walzprodukte, published 1997, pages 1 to 7 and

D3: "Aluminium Aircraft Products - Technical Data", CORUS Aluminium Walzprodukte, published July 2000, pages 1 to 15.

III. At the end of the oral proceeding which took place on 26 June 2003 the appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of the following documents:

- set of claims A, B or C filed at the oral proceedings or set of claims D filed on 29 September 2000 with the proviso that the same amendments are applied as to claim 3 of set A.

IV. Independent claims 1, 3 and 8 of set A (main request) read as follows:

"1. Process for manufacturing thick aluminium alloy plate by hot deformation of an ingot, said ingot having a length direction, a width direction and a thickness direction, and wherein the hot deformation comprises

(a) the step of hot rolling in the width direction, followed by
(b) the step of forging in the thickness direction,

and wherein the manufactured plate has a thickness in the range of 2 to 12 inches (5 to 30 cm) and a log-average fatigue life at 35 ksi of at least 150 kcycles."

"3. Process for manufacturing thick aluminium alloy plate by hot deformation of an ingot, said ingot having a length direction, a width direction, and a thickness direction, wherein the hot deformation comprises the combination of

(a) the step of forging in width direction, which results in a final thickness dimension which is larger than the final width direction, thereby forming a new width direction being the former thickness direction and a new thickness direction and a new thickness direction being the former width direction, said step (a) being followed by

(b) the step of hot rolling, and wherein the manufactured plate has a thickness in the range of 2 to 12 inches (5 to 30 cm) and a log-average fatigue life at 35 ksi of at least 150 kcycles."

"8. Process for manufacturing thick aluminium alloy plate by hot deformation of an ingot, said ingot having a length direction, a width direction, and a thickness direction, wherein the hot deformation comprises

(a) the step of forging in the thickness direction with a thickness reduction in the range of 10 to 30%, followed by

(b) the step of hot rolling in the width direction, and wherein step (b) is followed by

(c) hot rolling in the length direction, and wherein the manufactured plate has a thickness in the range 2 to 12 inches (5 to 30 cm) and a log-average fatigue life at 35 ksi of at least 150 kcycles."

Compared to the main request, claim 3 of set B (first auxiliary request) further includes the wording (in bold letters):

"3. ...at least 150 kycycles **and a fracture toughness relative to its thickness as given by the formula:**

$$K_{IC}(T-L) \geq -1.2 \times G + 31.2$$

in which $K_{IC}(T-L)$ is the fracture toughness in the long transverse direction expressed in Ksi· √inch and G is the thickness of the plate expressed in inches."

Compared to the main request, claim 3 of set C (second auxiliary request) includes the additional wording (in bold letters):

"3. Process for ... followed by

(b) the step of hot rolling, **comprising the step of (b1) hot rolling in said new width direction, and following step (b1), the step of (b2) hot rolling in the length direction,**

and wherein the manufactured plate has a thickness in the range of 2 to 12 inches (5 to 30 cm) and a log-average fatigue life at 35 ksi of at least 150 kcycles **and a fracture toughness relative to its thickness as given by the formula:**

$$K_{IC}(T-L) \geq -1.2 \times G + 31.2$$

in which $K_{IC}(T-L)$ is the fracture toughness in the long transverse direction expressed in Ksi· √inch and G is the thickness of the plate expressed in inches."

Compared to claim 3 of the main request, claim 1 of set D (third auxiliary request) additionally includes the wording:

"1. Process for ... followed by

(b) the step of hot rolling **comprising the step of (b1) hot rolling in said new width direction, and following step (b1), the step of (b2) hot rolling in the length direction.**"

V. The appellant argued as follows:

Following the technical teaching given in document D1 and acting accordingly, the person skilled in the art would reduce the thickness of Al-ingot by (a) pre-forging the ingot and (b) hot rolling the billet in the (same) thickness direction alone (cf. also D1, column 3, lines 21 to 29). The process step of reducing the ingot in the (same) thickness direction features in all 166 claims and is described in D1 as being preferred. As to the alternative pre-forging operations, document D1 does not provide any example showing the pre-forging of the ingot in the width direction (B-direction). The skilled reader would, therefore, conclude that pre-forging in the width direction alone or after deforming in the thickness direction are less effective operations. Thus a skilled person would not seriously contemplate to turn to these alternatives. Having regard to decisions T 26/85 and T 751/94, the claimed process, therefore, involves an inventive step.

Compared with the properties of the plate disclosed in the Table in column 6 of document D1, the thick Al-plates obtained by the claimed process exhibit - in addition to an improved resistance to fatigue - a far better fracture toughness both in the long-transverse and short-transverse direction thus showing very low anisotropy. This is apparent from Figure 5 of the application. Based on the data obtained by the supplementary tests, the improvement to the isotropy of the fracture toughness is essentially attributed to the double hot rolling of the billet in the "new" width and length direction. Such double hot rolling is neither disclosed nor suggested anywhere in document D1. Hence, the process claimed in any of sets A to D comprises technical features which are not only new but also involve an inventive step.

Reasons for the Decision

1. The appeal is admissible.

2. Given that essentially claim 3 was objected to in the appealed decision, the following arguments pertain to claim 3 in particular of set C (second auxiliary request). The reason for this is that this claim represents the most preferred embodiment of the claimed process and, therefore, the same arguments apply equally to claim 3 of the main and first auxiliary request and to claim 1 of the third auxiliary request which are all broader in scope.

3. *Novelty*

Although the novelty of the claimed process was questioned by the examining division, the Board holds the view that document D1 does not disclose clearly and unambiguously the technical feature which is stipulated in all independent claims of the present application that, after forging the ingot in its (original) width direction, a new width direction and a new thickness direction is necessarily formed.

4. *Inventive step*

4.1 Technical background; the closest prior art

Like the present application, document D1 relates to "thick" plates from AA 7000 series Al alloys ranging from 3 to 10 inches in thickness (cf. D1, column 2, lines 45 to 53; column 5, lines 11 to 16). Such plates are used for the manufacture of aircraft structural members and, therefore, their fatigue properties and other long time mechanical properties have to be eminent. As compared to the fatigue properties of "thin" Al plates, document D1 observes in column 1, lines 13 to 16 that owing to porosity the logarithmic average fatigue life of "thick" Al-plates decreases the more thickness increases. Such porosity is due to micropores which develop during solidification of the molten metal either when gaseous components, in particular hydrogen, dissolved in the melt are released thus generating microvoids and holes in the cast ingot, or when the ingot "shrinks". (cf. D3, column 2, line 53 to column 3, line 3).

To cope with the problem of microporosity and, in consequence thereof, to maximize the fatigue properties of "thick" (i.e. 3 to 10 inches) Al plate products without adversely affecting other mechanical properties such as tensile strength, toughness and ductility, document D1, therefore, advocates a method comprising, in addition to a degassing of the melt, a pre-working operation which is effective to reduce the microporosity prior to rolling or working (cf. D1, column 1, lines 19 to 22; column 2, line 65 to column 4, line 49). The fatigue lifetime of the Al-plate is determined under cyclic loading pursuant to the ASTM test method E-466 (cf. D1, column 1, lines 65 to column 2, line 2; column 5, lines 61 to 64). The object and the test method described in document D1 and the present application being the same, this document is considered to represent the closest prior art.

However, document D1 does not disclose a double rolling operation and is silent about a minimum fracture toughness K_{IC}(T-L) as does claim 3 of set C (second auxiliary request).

4.2 Technical problem and solution

The object of the present application, therefore, resides in providing a process which results in "thick" Al alloy plate products exhibiting fatigue properties and mechanical properties superior to those obtained in products produced by the prior art process proposed in document D1.

This object is achieved (i) by a forging step in the width direction of the ingot so that a "new" width is formed and (ii) by hot rolling the billet in the new width and length direction. These steps, however, are obvious to a person skilled in the art as is shown in the following.

4.2.1 Although the application does not specifically address the phenomenon of microporosity and the problems associated therewith, the skilled person is completely aware of the fact that a low degree of microporosity is the key prerequisite for a high fatigue resistance in the final Al alloy plate. This is evident from document D1 alone. This background knowledge has also been corroborated by the applicant during the oral proceedings and by the post-published documents D2 and 3 enclosed with the applicant's grounds of appeal. In this context reference is made for instance to document D2, page 2, column 3. To decrease the microvoid fraction or close the micropores, D1 proposes - prior to hot rolling - an effective forging operation wherein the ingots are preferably deformed (forged or squeezed) in the thickness direction (C-direction) by 5 to 80% reduction of their original thickness. However, document D1 further teaches as an alternative that the ingot may also be deformed either in the width direction (B-direction) after a C-direction deformation, or in the width direction alone so that a billet forged to an intermediate thickness and/or width dimension is obtained (cf. D1, column 3, lines 55 to 62; column 4, lines 47 to 49). The latter operation essentially corresponds to the forging step stipulated in the claimed process. Although document D1 does not expressly mention that after heavy forging a "new" width and a "new" thickness direction of the ingot needs to be formed and further hot rolling in this new width and length direction has to be performed, such operations are carried out without inventive efforts by a skilled metallurgist who is familiar with forging and rolling. When executing the basic teaching given in document D1, the skilled metallurgist will choose the reduction rate sufficiently high to minimize or even eliminate the microporosity of the plate.

4.2.2 As regards the double hot rolling step in the width and length direction, it is evident from the application (see example 4) that already hot rolling in the length direction alone suffices to achieve the desired fatigue strength and level of the mechanical properties. The appellant referred to the supplementary test results showing that by rolling in the width and length direction the L-T and T-L fracture toughness are almost equal so that the Al-plate product shows almost isotropy in the mechanical properties.

It is, however, basic metallurgical knowledge that the grain growth orientation is influenced by the rolling direction, thus resulting in an anisotropy of the mechanical properties which can be avoided by rolling in different directions. Therefore, the claimed hot rolling the ingot in the "new" width **and** the length direction, is only this usual measure to avoid anisotropy of the properties in the final product.

4.2.3 At the oral proceedings, the applicant conceded that an overlap exists between the process described by D1 and that claimed as regards the pre-forging steps to deform the ingot. Referring to decisions T 26/85 and T 751/94, the applicant argued that the skilled person would, in the light of the technical facts disclosed in D1, not have seriously contemplated applying the technical teaching of the prior art in the range of overlap.

This argument is, however, not convincing for the following reasons. Although all the claims in document D1 relate to a pre-forging in the thickness direction (C-direction) which is specified as being the most preferred direction, document D1 nevertheless recommends alternative pre-forging steps either in the width and thickness direction or in the width direction alone. Document D1 does not provide any prejudice or warning prompting the reader skilled in the art to exclude a pre-forging step in the width direction alone and at a reduction rate of more than 50% in this direction so that a "new" width and thickness direction is obtained. Hence there is no reason to disregard this part of technical information included in document D1.

4.2.4 Process claim 3 further stipulates that, dependent upon the plate thickness, a minimum value for the fracture toughness is to be obtained by the claimed method.

The Board acknowledges that - in addition to an increased resistance to fatigue - an improvement in fracture toughness of the Al-plates could be obtained by the claimed process. It is, however, considered that the desired toughness properties stipulated by the formula in claim 3 are nearly achieved also by the Al-plate given in document D1. For the 5.7-inch thick plate (example given in D1), the K_{IC}(L-T) minimum value according to the claimed formula is calculated to be 24.36 Ksi· $\sqrt{}$inch. This value is rather close to the fracture toughness of 24.0 Ksi· $\sqrt{}$inch which is obtained by the process disclosed in document D1 (cf. D1, column 6, line 17).

4.2.5 In summary the claimed process therefore represents a mere optimisation of the pre-forging and rolling operations already known from document D1 so that in particular the fatigue strength and - as a bonus effect - the fracture toughness of the resulting "thick" Al-plate are further improved. The mere optimisation of an existing technology does, however, not involve an inventive step.

4.3 Since the same reasoning is valid for the process claimed in claim 3 either of the main and the first auxiliary request or that claimed in claim 1 of the third auxiliary request, the claims of these requests are equally not allowable for lack of inventive step of the claimed subject matter.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

V. Commare W. D. Weiß

R. R. 21/8/03