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**Datasheet for the decision
of 9 November 2016**

Case Number: T 0721/13 - 3.2.03

Application Number: 04009965.7

Publication Number: 1475598

IPC: F28F19/06, F28F21/08

Language of the proceedings: EN

Title of invention:

Heat exchange tube

Patent Proprietor:

MITSUBISHI ALUMINUM CO., LTD.

Opponents:

Erbslöh Aluminium GmbH
VALEO THERMIQUE MOTEUR

Headword:

Relevant legal provisions:

EPC Art. 123(2), 123(3)

Keyword:

Added subject-matter in granted claim (yes)

Decisions cited:

Catchword:



Beschwerdekammern
Boards of Appeal
Chambres de recours

European Patent Office
D-80298 MUNICH
GERMANY
Tel. +49 (0) 89 2399-0
Fax +49 (0) 89 2399-4465

Case Number: T 0721/13 - 3.2.03

D E C I S I O N
of Technical Board of Appeal 3.2.03
of 9 November 2016

Appellant: MITSUBISHI ALUMINUM CO., LTD.
(Patent Proprietor) 3-3 Shiba 2-chome
Minato-ku
Tokyo (JP)

Representative: Hoffmann Eitle
Patent- und Rechtsanwälte PartmbB
Arabellastraße 30
81925 München (DE)

Respondent: Erbslöh Aluminium GmbH
(Opponent 1) Siebeneicker Strasse 235
42553 Velbert (DE)

Representative: Buse, Mentzel, Ludewig
Patentanwaltskanzlei
Kleiner Werth 34
42275 Wuppertal (DE)

Respondent: VALEO THERMIQUE MOTEUR
(Opponent 2) 8 rue Louis Lormand
La Verrière
78320 Le Mesnil Saint-Denis (FR)

Representative: Gevers & Orès
41 avenue de Friedland
75008 Paris (FR)

Decision under appeal: **Decision of the Opposition Division of the
European Patent Office posted on 30 January 2013
revoking European patent No. 1475598 pursuant to
Article 101(3) (b) EPC.**

Composition of the Board:

Chairman	G. Ashley
Members:	C. Donnelly
	E. Kossonakou

Summary of Facts and Submissions

- I. The appeal lies from the decision of the opposition division revoking European patent no. EP-B-1 475 598.

In its decision the opposition division held that the subject-matter of claim 1 according to the main request and auxiliary requests 1 to 4 did not meet the requirements of Article 123(2) EPC since the feature of the tube having a "uniformly distributed" flux layer was not originally disclosed.

- II. The patent proprietor (hereinafter: the "appellant") filed an appeal against this decision in due time and form. It submitted, amongst others, the following documents and experimental evidence in support of its case:

D13: M. Hanson, "Constitution of Binary Alloys", McGraw-Hill Book Company Inc., New York, pages 132 to 134, 1958.

D14: "Experimental data";

D14a: Y. HYOGO, "Experimental Report", concerning a description of the experimental procedure used in D14;

D15a: Modified Fig. 1 of D15 (an experimental report submitted by Opponent II);

D16: Short explanation of Si, Zn, Al diffusion in a molten fillet;

D17: "New experimental report";

D18: Photographic image of Si grains;

D19: Photographic image of flux coating applied by various means.

It also referred to:

D20: Excerpt from the Oxford English Dictionary regarding the definition of the word "distribute".

- III. Opponent I withdrew its opposition by letter of 21 August 2013.

Opponent II (hereinafter: the "respondent") replied to the appeal by letter of 15 October 2013 and submitted its own experimental evidence in document D15 to support its case.

- IV. In a communication pursuant to Article 15(1) RPBA, annexed to the summons to oral proceedings, the Board informed the parties of its provisional opinion. In particular, the Board indicated that the ground of opposition under Article 100(c) EPC appeared to prejudice the validity of the patent.

Oral proceedings before the Board were held on 9 November 2016. At the end of the debate the parties confirmed their requests as follows:

The appellant requested that the decision under appeal be set aside and the patent be maintained on the basis of one of the requests 1A, 2A, 3A, 1B, 2B, 3B, 1C, 2C, 3C, filed with the statement setting out the grounds of appeal dated 31 May 2013.

The respondent requested that the appeal be dismissed.

- V. Claim 1 of request set 1A (granted claim 1) reads:

"A heat exchanger tube comprising an Al alloy extruded tube having a uniformly distributed flux layer containing a Si powder and a Zn-containing flux on an external surface thereof, wherein

the maximum particle size of the Si powder is 30 μ m or smaller,
the amount of the Si powder applied to the Al alloy extruded tube is not less than 1g/m² and not more than 5g/m²,
the Zn containing flux contains at least one Zn compound selected from ZnF₂, ZnCl₂ and KZnF₃, and
the amount of the Zn-containing flux applied to the Al alloy extruded tube is not less than 5g/m² and not more than 20g/m²."

Claim 1 of request set 1B reads:

"A heat exchanger tube comprising an Al alloy extruded tube having a uniformly distributed flux layer containing a mixture of Si powder and a Zn-containing flux on an external surface thereof so that a molten brazing material layer is formed over the entire surface of the tube after brazing, wherein the maximum particle size of the Si powder is 30 μ m or smaller, the amount of the Si powder applied to the Al alloy extruded tube is not less than 1g/m² and not more than 5g/m², the Zn containing flux contains at least one Zn compound selected from ZnF₂, ZnCl₂ and KZnF₃, and the amount of the Zn-containing flux applied to the Al alloy extruded tube is not less than 5g/m² and not more than 20g/m²."

Claim 1 of request set 1C reads:

"A heat exchanger tube comprising an Al alloy extruded tube having a flux layer containing a mixture of Si powder and a Zn-containing flux on an external surface thereof so that a molten brazing material layer is formed over the entire surface of the tube after brazing, wherein

the maximum particle size of the Si powder is 30µm or smaller,
the amount of the Si powder applied to the Al alloy extruded tube is not less than 1g/m² and not more than 5g/m²,
the Zn containing flux contains at least one Zn compound selected from ZnF₂, ZnCl₂ and KZnF₃, and
the amount of the Zn-containing flux applied to the Al alloy extruded tube is not less than 5g/m² and not more than 20g/m²."

VI. The arguments of the parties relevant to the decision can be summarised as follows:

(a) Appellant's case,

(i) Claim 1 of request set 1A (granted claim 1)

The decision of the opposition division was wrong since it did not consider the original disclosure through the eyes of the skilled person. The decision makes no attempt to establish who the skilled person is for this technical field and what subject-matter is implicitly known to that person.

The skilled person is someone who designs and/or manufactures heat exchangers, particularly heat exchangers using aluminium alloy extruded tubes. In particular, the skilled person is familiar with the role of flux and the formation of a brazing liquid.

Flux is used to ensure wetting of the brazing liquid with the aluminium alloy. Flux applied in combination with the brazing material decomposes the oxide films formed on the surfaces of the silicon powder and aluminium alloy. During the brazing a component of the

flux such as F or Cl reacts with the oxide films to decompose them.

Since the eutectic temperature of the Al-Si system is 577 °C, which is lower than the melting point of Al (660 °C - see D13), a brazing liquid is formed by the eutectic melting of Al and Si. To form the brazing liquid by the eutectic melting the Si powder must be directly in contact with aluminium, hence it is necessary to decompose any oxide layers using a flux. The skilled person knows that the surface oxide in any area not coated with the flux will not be decomposed, and that the brazing liquid will not spread to the area due to the inferior wetting conditions in that area.

In paragraph [0012] of the published application it is explained that a flux layer, containing Si powder and Zn-containing flux, is formed on the external surface of the Al alloy extruded tube. In paragraph [0024] of the published application it is further explained that the flux layer is formed on the tube surface so that a molten brazing material layer is formed over the entire surface of the tube after brazing.

The skilled person would implicitly understand that a molten brazing liquid can only be formed over the entire surface of the tube after brazing if the flux layer is uniformly distributed prior to the brazing step, since a brazing liquid will not form on an area where no flux layer has been applied. It therefore follows that the skilled person would understand from paragraph [0024] that the flux layer should be distributed over the entire surface.

The term "uniformly distributed flux layer" clearly refers to the distribution of the flux layer on the

external surface of the tube and not to the distribution of components within the flux layer since this is the ordinary meaning of the words and is the only reasonable technical interpretation.

The skilled person understands "distributed" to mean the two-dimensional application of the flux layer on the tube. According to D20 the meaning of "distribute" is "Spread or disperse throughout a region; put at different points over an area; spread generally; scatter".

Also the units of the amounts of Si powder and Zn-containing flux applied to the Al alloy are "g/m²". This means that the flux layer is applied on the surface of the tube to satisfy the criterion of a given weight per surface area, and to satisfy this criterion, the flux layer has to be uniformly distributed.

It has been argued that spots or patterns of flux can lead to a molten brazing material layer over the entire surface of the tube after brazing. However, the skilled person knows that the brazing liquid will not spread to areas not covered by the flux. Reference is made to figures 1, 2 and 3 of D14 which show this effect.

The opposition division also stated at paragraph 2.1.4 of the decision that "The distribution of a non-uniform layer, for example a layer with a non-uniform thickness, can lead to such a result", and that "The ranges of the amounts of Si powder and Zn-containing flux claimed and defined with the unit "g/m²" can be achieved either by a uniform or by a non-uniform distribution".

However, the skilled person would never consider applying a flux layer in a non-uniform way such that it would lead to a defective flux-coated tube. As for possible variations in the thickness of the flux layer, the skilled person understands that a powder layer will never be completely flat as shown for example in D18. Further, as shown in D19, the cross-sectional images of flux coatings applied by various methods reveal a variation in thickness. Thus, the skilled person would interpret the feature "having a uniform distributed flux layer" as meaning the distribution of the flux layer over the two dimensional surface of the tube - i.e. that all parts of the tube that should have a flux coating after brazing are covered by the flux layer before brazing.

(ii) Requests 1B, 2B, 3B

These requests were filed for the case that the board considered that a spot or similar pattern leaving bare tube surface fell within the scope of the claim. By requiring that "a molten brazing material layer is formed over the entire surface of the tube after brazing" this type of distribution of the flux layer is clearly excluded.

(iii) Requests 1C, 2C, 3C

Deleting the expression "uniformly distributed" does not infringe Article 123(3) EPC since it is effectively redundant in view of the fact that the skilled person knows that the flux layer is always uniformly distributed for the reasons given in connection with the A set of claims.

(b) **Respondent's case**

(i) **Claim 1A (granted claim 1), Article 100(c),
123(2) EPC**

At no point in the application as originally filed is the flux layer explicitly described as being "uniformly distributed". Nor is a uniformly distributed flux layer implicitly disclosed. The reasons given in the decision under appeal are correct.

It is impossible to verify the validity of the test results presented in D14 since the testing protocol is not provided. Furthermore, the results from D14 are not relevant since they apply to a simple flat tube rather than a tube fitted into a header or attached to a baffle, as would be the case in a heat exchanger.

D15 shows that when the tube is attached to a baffle there is more zinc at the brazing joint and that there is less zinc in the zones more distant from the contact point. Thus, there is no uniform distribution of zinc.

(ii) **Requests 1B, 2B, 3B, Article 123(2) EPC**

Since the feature of "a uniformly distributed flux layer" is also present in all the independent claims of this set of claims, the same objections apply.

(iii) **Requests 1C, 2C, 3C, Article 123(3)EPC**

Article 123(3) EPC is infringed since a uniformly distributed flux layer is a particular embodiment and

by deleting the expression "uniformly distributed" all types of flux layer, including those which are not uniformly distributed, are now covered by the claim. Hence, the scope of protection has been extended.

Reasons for the Decision

1. Claim 1 of request 1A (claim 1 as granted), Article 100(c), Article 123(2) EPC

1.1 The only issue in dispute is whether the skilled person would find a direct and unambiguous disclosure of the feature "having a uniformly distributed flux layer" in the application as originally filed. The appellant accepts that there is no explicit disclosure of this characteristic, but maintains that such a uniformly distributed flux layer is implicitly disclosed to the skilled person.

1.2 The Board agrees with the appellant that the skilled person is someone who designs and/or manufactures heat exchangers using aluminium alloy extruded tubes and is familiar with the role of flux and the formation of a brazing liquid.

1.3 The Board also agrees with the appellant's summary of the brazing process and its submission that the skilled person knows that the surface oxide in any area not coated with the flux will not be decomposed, with the result that the brazing liquid will not spread to that area due to the inferior wetting conditions. Further, the board concurs that the term "uniformly distributed

flux layer" refers to the distribution of the flux layer on the external surface of the tube and not to the distribution of components within the flux layer.

1.4 In view of this, the appellant's submission that in order for a molten brazing material layer to be formed over the entire surface of the tube after brazing, the flux layer must be distributed so as to cover all the tube surface, is accepted. However, whilst this means that flux layers consisting of spots or other patterns leaving parts of the tube surface uncovered, are excluded, it does not necessarily mean the thickness of a flux layer covering the entire surface is uniform.

1.5 The appellant has asserted that the skilled person would never consider applying a flux layer in a non-uniform way, since by so doing it would be impossible to avoid defective phenomena, such as residual Si particles after the brazing step, in those areas where excessive amount of the material is applied.

1.6 However, the disclosure of the patent itself suggests the opposite is the case. At paragraph [0009] of the patent, when defining the problem to be solved, it is stated that:

"In actuality, however, it is difficult to achieve a stable coating condition with ordinary coating methods, such as immersion coating and roll coating, and therefore it has been difficult to uniformly apply the Zn-containing flux. As a result, Zn distribution in the sacrificial anode layer becomes uneven thus leading to insufficient corrosion resistance of the tubes with preferential corrosion occurring in a portion that has higher concentration of Zn".

1.7 Thus, the patent explains to the skilled person that the problem of insufficient corrosion resistance is essentially caused by the fact that the Zn-containing flux cannot be distributed uniformly on the external surface of the tube. The patent does not propose any measures as to how the uniformity of the flux distribution can be improved, but rather suggests an alternative solution relying on the application of a flux layer which is a mixture of a Si powder and a Zn containing flux, as the patent explains in paragraph [0014]:

"since a mixture of the Si powder and the Zn-containing flux is applied, the Si powder melts and turns into a brazing liquid during a brazing process, and Zn contained in the flux is diffused uniformly in the brazing liquid and is distributed uniformly over the tube surface. Since the diffusion velocity of Zn in a liquid phase such as a brazing liquid is significantly higher than the diffusion velocity in the solid phase, Zn concentration in the tube surface becomes substantially uniform, thus making it possible to form a uniform sacrificial anode layer and improve the corrosion resistance of the heat exchanger tube."

1.8 Hence, the patent proposes solving the problem by exploiting the significantly increased diffusion velocity of Zn in the liquid phase to obtain a substantially uniform Zn concentration in the tube surface. In view of this, the patent teaches the skilled person that there is in fact no need to distribute the flux uniformly on the tube surface since the Zn concentration will become uniform during the liquid phase. Paragraphs [0039] and [0040] of the patent reiterate that this is the process by which Zn

(as opposed to the flux layer) is distributed uniformly over the tube surface.

- 1.9 The appellant has referred to D18 and D19 to show that the flux layer surface is never perfectly flat. It then argued that since a certain degree of non-uniformity in the flux layer thickness is inevitably present, the skilled person would interpret the feature "having a uniformly distributed flux layer" as simply meaning that all parts of the tube that should have a flux coating after brazing are covered by the flux layer before brazing.
- 1.10 However, the Board does not find this reasoning persuasive, not only since the photographs shown in D19 are limited to showing surface roughness over a small "observation area" and provide no information of overall thickness variations over the tube surface, but also because, if anything, these images confirm that there is non-uniformity of the flux layer as stated in the patent. Similarly, D18 shows a highly magnified image of Si grains over a small area together with a highly schematic representation of a cross-section through a flux layer.
- 1.11 Further, the Board does not accept this reasoning since the patent itself suggests non-uniformity of the flux coating is in fact the problem and the use of the term "uniformly distributed" in the claim language cannot simply be ignored as being redundant. Therefore, it can only be assumed that uniformly distributed flux layers prior to brazing might be achieved, but the ones of the patent do not meet this requirement.
- 1.12 The use of the unit "g/m²" to define the amounts of Si powder and Zn-containing flux applied to the Al alloy

does not imply any uniformity of the flux layer thickness. Indeed, since the unit of area chosen is very large (m^2 as opposed to cm^2) and the claim specifies a range of values, the implication is that local variations in the flux layer thickness would still fall within the specification. Consequently, the Board agrees with the opposition division that the ranges of the amounts of Si powder and Zn-containing flux claimed can be achieved either by a uniform or by a non-uniform distribution.

1.13 In conclusion, the subject-matter of claim 1 according to request 1A contains added subject-matter and the ground of opposition made under Article 100(c) EPC prejudices the maintenance of the patent in this form.

2. Requests 2A, 3A, Article 123(2) EPC

2.1 All of the independent claims of the remaining A requests specify an Al extruded tube having "a uniformly distributed flux layer". As a consequence the same objection applies to all of these claims.

3. Requests 1B, 2B, 3B, Article 123(2) EPC

All of the independent claims of the B requests also specify an Al extruded tube having "a uniformly distributed flux layer". The additional functional characteristic "so that a molten brazing material layer is formed over the entire surface of the tube after brazing" does not overcome the objection based on a non-uniform thickness of the flux layer.

Thus, all the requests of the B set fail to meet the requirements of Article 123(2) EPC

4. Requests 1C, 2C, 3C, Article 123(3) EPC

In the C set of claim requests the expression "uniformly distributed" has been deleted. However, as pointed out by the respondent, this amendment leads to a broadening of scope of the claims, since tubes with a non-uniformly distributed flux layer are now included in the scope of protection.

The appellant's argument that the expression deleted is in effect redundant since the skilled person would know that a flux layer is always uniformly distributed cannot be accepted, since this additional characteristic is not simply cosmetic and does describe a specific quality which not all flux layers as now claimed would meet.

Hence, the requirements of Article 123(3) EPC are not met.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:



G. Rauh

G. Ashley

Decision electronically authenticated