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D E C I S I O N
of 24 October 2001

Case Number: T 0375/97 - 3.3.7

Application Number: 90910891.2

Publication Number: 0437626

IPC: B32B 3/12

Language of the proceedings: EN

Title of invention:

Heat resistant structure and method of manufacture thereof

Patentee:

SHOWA AIRCRAFT INDUSTRY CO., LTD

Opponent:

Emitec Gesellschaft für Emissionstechnologie mbH

Headword:

-

Relevant legal provisions:

EPC Art. 56

Keyword:

"Inventive step - (yes) - closest prior art, problem and solution"

Decisions cited:

T 0759/91, T 0952/92, G 0001/92

Catchword:

-



Case Number: T 0375/97 - 3.3.7

D E C I S I O N
of the Technical Board of Appeal 3.3.7
of 24 October 2001

Appellant:
(Opponent)

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Decision under appeal:

**Decision of the Opposition Division of the
European Patent Office posted 28 February 1997
rejecting the opposition filed against European
patent No. 0 437 626 pursuant to Article 102(2)
EPC.**

Composition of the Board:

Chairman: R. E. Teschemacher
Members: G. Santavicca
B. L. ter Laan

Summary of Facts and Submissions

- I. The mention of the grant of European patent 0 437 626, in respect of European patent application 90 910 891.2 (International application number PCT/JP90/00969), filed on 30 July 1990 and claiming the priorities of JP 202317/89 of 4 August 1989, JP 224273/89 of 29 August 1989 and JP 72638/90 of 22 March 1990, was published on 28 December 1994 (Bulletin 94/52). Claim 1 as granted read as follows:

"A heat resisting structure (1) of a honeycomb-like structure formed by alternately joining a corrugated stainless steel sheet, (2) having alternating ridges and grooves formed by folding the sheet continuously, and a flat or corrugated stainless steel sheet (4) by brazing material (3); characterised in that the brazing material is a nickel-based material substantially free of C and Cr and containing 4.0 to 8.0% by weight of Si and 2.0 to 4.5% by weight of B."

Dependent claims 2 to 3 were directed to preferred embodiments of the structure according to claim 1.

- II. Notice of opposition was filed on 25 September 1995 on the ground of Article 100(a) EPC that the subject-matter claimed in the patent lacked an inventive step. The opposition was supported, *inter alia*, by the following documents:

E8: DE-A-2 924 592

E9: Lurgi Schnellinformation "Hochtemperatur-Hartlote Nicrobraz", Got.3107/2.77

E10: Lamb, S. und F.M. Miller: The effects of Aggression by Nickel-Base Brazing Filler Metals, Welding Journal Research Supplement 48 (1969) 7, pages 283 to 289

E12: Produktinformation Nicrobraz Gotek 3142d/6.87

E13: Nicrobraz Engineering Data Sheet Number 2.1.10 Rev. C

E14: Nicrobraz Technical Data Sheet Number 2.1.1 Rev. P of the Wall Colmonoy Corporation.

III. By a decision announced on 19 February 1997, issued in writing on 28 February 1997, the Opposition Division rejected the opposition.

According to the impugned decision, the expression "substantially free of C", in opposed claim 1, was to be interpreted so as to mean that the carbon content was far below 0.1%, ie far below the usual carbon content of the known brazing filler metals mentioned in the opposed patent, and also far below the carbon content of "0.06% max" disclosed in information documents for Nicrobraz materials E9 and E12 to E14. Also, these documents did not suggest reducing the carbon content.

Hence, the invention as claimed was novel and involved an inventive step, irrespective of whether documents E9 and E12 to E14 had been made available to the public at the priority date of the opposed patent.

IV. On 7 April 1997, the opponent (appellant) lodged an appeal against the decision and paid the prescribed fee

on the same day. In the statement of grounds of appeal, received on 9 July 1997, the appellant mentioned all of the references cited on the first sheet of the patent specification, inter alia E6 (FR-A-2 577 616), as well as those filed during the opposition proceedings. With further submissions, he filed document E20 (Dubbel-Taschenbuch für den Maschinenbau", 16. Auflage, Springer, 1987) and a further declaration of the firm Gotek ("Erklärung über die Veröffentlichung von Produktinformationen", dated 26 March 1999).

By letter dated 6 September 2001 the respondent additionally filed three alternative sets of claims as first to third auxiliary requests.

V. During the proceedings before the Board the appellant argued essentially as follows:

- (a) Regarding the wording of the claims, the term "substantially free of C" was not clear and needed interpretation. However, the patent specification did not contain any limit for the tolerable carbon content.

The impugned decision was based on the assumption that "substantially free" meant a carbon content far below 0.1 percent. However, in line with established board of appeal case law, the term in dispute should be interpreted to mean that carbon could indeed be present, but in such an amount that the essential characteristics of the structure were not detrimentally affected thereby.

The essential characteristics of the structure mentioned in the patent did not contain any limit

for the tolerable carbon content, and it was not derivable in how far the effect of improved corrosion resistance was linked to the substantial absence of chromium and in how far to the substantial absence of carbon. Therefore, the assumed limit was not based upon any disclosure in the patent in suit.

Since no clear meaning for the term "substantially free of carbon" had been given, one could freely interpret this term.

- (b) As to novelty, according to E14, honeycombs made of stainless material, such as Inconel which contained 24% chromium, and brazed with Nicrobraz 130 had been made available to the public before the priority date of the patent in dispute.

Although Nicrobraz 130 contained a maximum carbon content of 0.06 percent, which could result in carbide precipitation, according to the information in E14 the essential characteristics of the honeycomb structure had not been altered by an amount of carbon of 0.06 percent by weight. Consequently, that carbon content fell within the term "substantially free" in claim 1.

Since the constructional features of the sheets used in the honeycomb, as defined in the preamble of claim 1, were common to all honeycombs, E14 prejudiced the novelty of the claimed subject-matter.

- (c) As regards inventive step, E14 represented the closest prior art because it related to the same

technical field, namely honeycombs for catalysts. It disclosed all of the essential features of the claimed structure and also mentioned stainless sheets, joint strength and fatigue resistance of honeycombs. Using E8 or E6 as the closest prior art, more changes were required to arrive at the solution as claimed. Therefore, E14 was the proper starting point.

The problem to be solved was to improve the strength of joints and the oxidation resistance in honeycomb structures for catalysts.

The solution as defined in claim 1 in dispute was obvious.

Starting from E14, the skilled person had to make no or only minimal structural changes, in order to provide a structure with the desired properties.

In this respect, although the respondent had argued that the properties of honeycombs brazed with Nicrobraz 130 were not satisfactory, the brazing filler metal as defined in the claims also encompassed Nicrobraz 130. Therefore, the properties of Nicrobraz 130 were apparently suitable for the structure as claimed.

Although E14 taught that Nicrobraz 130 was not the best choice for brazing honeycomb structures, it actually mentioned a honeycomb structure brazed with Nicrobraz 130, so that the structure could have been reproduced and tested for the relevant properties, as had been established in decisions G 1/92 and T 952/92. Therefore, a honeycomb brazed

with Microbraz 130 had been made available as such to the public at the priority date of the patent.

VI. The arguments of the respondent (proprietor) during the proceedings before the Board can be summarised as follows:

- (a) The definition "substantially free" given in claim 1, according to the patent specification, meant that carbide precipitation should be prevented. The public availability of the data sheets for Microbraz had not been proven. Even if they were to be considered as part of the prior art, a carbon content of about 0.06%, as disclosed in any of E9 and E12 to E14 for Microbraz 130, did not mean "substantially free of C", because carbide precipitation would occur to a degree which was detrimental.

There had never been any intention to protect structures brazed with fillers having a carbon content as high as "about 0.06 percent", which corresponded more or less to the carbon content of the prior art braze filler metals mentioned in the patent. Levels of 0.002 percent might be considered as maximum tolerable carbon content for the purpose of the opposed patent.

Therefore, the term "substantially free" excluded the filler metals with 0.06 weight percent of carbon.

- (b) The novelty of claim 1 in suit had never been objected to at any point in the proceedings and the respondent did not agree with the introduction

of any such belated ground of opposition without adjournment of the oral proceedings and payment of the resulting extra costs by the appellant. Any new ground should have been notified in advance, so that it could be countered properly. However, preliminary comments were given as follows:

Nicrobraz did not fall under the definition for a brazing filler metal given in claim 1 in suit, nor had it been proven that it was suitable for use in the structures as claimed, in particular that their essential characteristics were maintained in use. E14 did not disclose Nicrobraz 130 in combination with a honeycomb structure. The latter was mentioned, but the material it was made of was not. Mention was made of stainless material, which was not stainless steel, however.

Therefore, in E14 there was no direct and unambiguous disclosure of the structure as defined in claim 1 in dispute, which was, consequently, novel.

- (c) Regarding inventive step, the patent addressed the problem that arises in heat-resistant stainless steel honeycomb-like structures, particularly in thin structures, of finding a brazing filler metal which avoided stress corrosion cracking. The problem was closely linked to the presence of chromium in stainless steel and applied particularly to ferritic stainless steel.

E14 was not related to heat-resistant stainless steel honeycomb-like structures. Hence, having regard to the problem mentioned in the patent in

dispute, it could not serve as the closest prior art.

On the contrary, E8 or its English version E16 could be considered as closest prior art. As a starting point, E6 was equally appropriate as E8, since both concerned the improvement of heat-resistant honeycomb structures, as did the patent.

Even starting from E14, the skilled person who was interested in heat-resistant, stainless steel honeycombs, would not have come to the selection of Nicrobraz 130 for brazing the structure - apart from the fact that the latter did not fall under the definition of claim 1. According to E14, other brazing filler metals were more suitable for that use, such as Nicrobraz 30, which was also mentioned in E6. Also the other documents on file did not steer the skilled person in the direction of a brazing filler metal as defined in claim 1 in suit. In particular, the choice of a brazing filler metal without chromium to braze a stainless steel structure was far away from all of the suggestions in the cited documents. On the contrary, the patent went in the opposite direction with respect to chromium content and oxidation resistance, so that the solution was not obvious.

Starting from E6 or E8, the arguments would be similar. To improve the structure, or to make an alternative structure, many choices were available. E14 showed six alternatives, which were all suited for replacing the brazing filler metal, but which did not comply with the present

requirements. Based on that information, the skilled person would not necessarily use Nicrobraz 130. Therefore, to use a brazing filler metal as defined in claim 1 in suit for brazing stainless steel honeycombs was not obvious.

In response to the argument that a honeycomb brazed with Nicrobraz 130 had been made available to the public by E14, and that the skilled person could have reproduced it to gather the relevant properties thereof, the respondent stressed that the argument did not apply to the behaviour of the brazing filler metal with stainless steel in particular environments.

Hence, the claimed subject-matter was also inventive.

VII. The appellant requested that the decision under appeal be set aside and that the patent be revoked.

The respondent requested that the appeal be dismissed and that the patent be maintained as granted, or, alternatively, on the basis of a set of claims with an amended claim 1 according to one of the three auxiliary requests filed with letter dated 6 September 2001.

Reasons for the Decision

1. The appeal is admissible.
2. *The wording of the claims (Main request)*
 - 2.1 The term "substantially free of C and Cr" has a

relative meaning that does not make clear what amounts of C and Cr are actually tolerable for the purposes of the invention. Therefore, the patent specification as a whole has to be used for an assessment of the meaning of the claims.

The description of the patent in dispute does not indicate any specific value for the tolerable maximum amounts of C and Cr in order not to lose the desired effect. It illustrates however what purposes should be served by the substantial absence of C and Cr.

The precipitation of chromium carbides at grain boundaries consumes chromium that is needed for effective passivation and resistance, which leads to the formation of a chromium depleted region along the grain boundaries (column 2, lines 34 to 43).

Since the brazing filler metal according to claim 1 in dispute contains almost no chrome, when the structure is used at high environmental temperature, segregation of chromium in the vicinity of the brazing joint boundary of the stainless steel sheets constituting the base metal does not occur. Thus, the possibility is eliminated that the low chromium portion becomes prone to oxidation, resulting in a low oxidation rate of the heat resisting structure (patent, line 43 of column 6 to line 16 of column 7).

In Figure 3 the oxidation rate (mg) is plotted as a function of the number of heating/cooling cycles, whereby each cycle has a period of 30 minutes, the structure is heated at a temperature of 1000 °C, then air cooled for 10 minutes, and then the cycle is repeated. The heat resisting structure brazed with a

filler metal containing no chromium has a lower oxidation rate than a prior art heat resisting structure brazed with a filler metal with chromium (page 6, column 7, lines 13 to 14).

Furthermore, since the brazing filler metal contains almost no carbon, when the heat resisting structure is used at high environmental temperature, precipitation of carbide and, accordingly, adverse effects due to precipitation like stress corrosion cracking, intergranular corrosion cracking, intergranular separation do not occur (column 7, lines 17 to 30).

Therefore, the description of the patent makes clear what adverse effects on the structure are prevented by the substantial absence of both C and Cr in the brazing filler metal used.

Hence, the term "substantially free of C and Cr" in claim 1 in dispute has to be interpreted as meaning that the amounts of Cr and C are to be kept so low that no segregation of chromium and precipitation of carbides and, consequently, no corrosion cracking, intergranular corrosion cracking, intergranular separation occur when the heat resistant structure is used.

- 2.2 With regard to the argument of the appellant, that the amount of 0.06 percent by weight of carbon was within the definition "substantially free of C" as given in claim 1 in suit, no proof was presented that such an amount would not lead to the above mentioned negative effects. As regards decision T 759/91 (cited in Case Law of the Boards of Appeal of the EPO, 3rd edition, 1998, II.B.1.1.3), mentioned by the appellant,

it concerns a different expression, ie "comprising substantially", which is not applicable to the present case.

3. *Novelty (Main request)*

The ground of lack of novelty was mentioned in the notice of opposition only in connection with claim 2. During opposition proceedings and written appeal proceedings the ground had not been pursued any longer, nor has it been extended to the subject-matter of claim 1.

However, during the oral proceedings before the Board, the appellant drew new conclusions from a document cited against inventive step and the relevant arguments brought forward until then, namely that the subject-matter of claim 1 in dispute would not be novel over a honeycomb structure resulting from the disclosure of E14.

In the present case, it can be left undecided whether this ground of opposition had been duly substantiated and whether it should be admitted into the proceedings, since the Board has no doubt that novelty is present. E14 does not directly and unambiguously disclose a heat-resistant honeycomb-like structure, made of stainless steel and formed as outlined in the preamble of claim 1, and brazed with a nickel-based filler metal having the composition as given in the characterizing portion of claim 1 in suit.

4. *The documents*

4.1 Document E14, a technical data sheet of the Wall

Colmonoy Corporation, bearing the date 1987, concerns the brazing filler metals registered under the trademark Microbraz.

The data sheet consists of three parts:

- (a) A selector chart for Microbraz filler metals, including footnotes;
- (b) A table for special purpose Microbraz filler metals, which are distinct over those mentioned in the selector chart, with accompanying footnote;
- (c) A further table titled "composition, properties and applications for the Microbraz brazing filler metals", also provided with footnotes.

The selector chart discloses which Microbraz filler metal is recommended for which application, whereby the suitability of the filler metals is ranked as "best", "satisfactory" or "least satisfactory", as well as which comparative physical and metallurgical properties can be expected from the respective Microbraz filler metals in a comparative scale from "1" (highest) to "6" (lowest).

The application "For honeycomb and other thin materials" is mentioned as one of the specific applications for the filler metals given in the selector chart of E14. The construction of the honeycomb and the relevant materials of construction cannot be gathered from E14, however.

As far as suitability and nominal composition of the nickel-based filler metals for brazing honeycombs are

concerned, the following picture results from the selector chart in E14:

The most recommended (rank A) filler metals are:

Nicrobraz 30, containing (wt.%) no B, Cr 19.0, Si 10.2, C 0.06 max.

Nicrobraz 35, containing (wt.%) no B and no C, Cr 19.5, Si 9.8 and Mn 9.5.

Nicrobraz 10, containing (wt.%) no Cr, no B and no Si, P 11.0 and C 0.06 max.

Nicrobraz 50, containing (wt.%) no Si and no B, Cr 14.0, P 10.0 and C 0.06 max.

Nicrobraz 51, containing (wt.%) no C, no Si and no B, Cr 25.0 and P 10.0.

Nicrobraz 210, the sixth most recommended filler metal, is cobalt-based and shows the best joint strength and the best oxidation resistance of joints, followed by Nicrobraz 30 and Nicrobraz 35. The solution and diffusion of all the braze filler metals into the base metal is low. As can be seen from the above, all braze filler metals ranked as "best" do not contain B.

The satisfactory (rank B) filler metals are:

Nicrobraz L.M., containing (wt.%) Cr 7.0, Si 4.5, B 3.1, Fe 3.0 and C 0.06 max.

Nicrobraz 130, containing (wt.%) no Cr, Si 4.5, B 3.1 and C 0.06 max.

Nicrobraz 135, containing (wt.%) no Cr, Si 3.5, B 1.9 and C 0.06 max.

Nicrobraz 150, containing (wt.%) no Si, Cr 15.0, B 3.5 and C 0.06 max.

Nicrobraz 200, containing (wt.%) Cr 7.0, Si 4.5, B 3.2, W 6.0, Fe 3.0 and C 0.06 max.

L.M. means Low Melt.

Nicrobraz 150 shows the best joint strength and oxidation resistance, followed by Nicrobraz 200, then by Nicrobraz 130 and finally by Nicrobraz 135. These filler metals all show a higher solution and diffusion into the base metal, compared with the most recommended (Rank A) filler metals.

The least satisfactory (rank C) metal fillers are:

Nicrobraz 125, containing (wt.%) Cr 14.0, Si 4.5, B 3.0, Fe 4.5 and C 0.7.

Nicrobraz L.C. containing (wt.%) Cr 14.0, Si 4.5, B 3.0, Fe 4.5 and C 0.06 max.

Nicrobraz 160, containing (wt.%) Cr 11.0, Si 3.5, B 2.25, Fe 3.5 and C 0.5.

Nicrobraz 170, containing Cr 12.0, Si 3.5, B 2.5, Fe 3.5, W 16.0 and C 0.50.

Nicrobraz 171, containing Cr 10.0, Si 3.5, B 2.5, Fe 3.5, W 12.0 and C 0.4.

L.C. means Low Carbon. From the table of the composition of E14, in the description of filler Nicrobraz L.C., under the heading "*Filler Metal Designations and Descriptions*", it can be gathered that a further filler metal, designated as E.L.C., is available, the carbon content of which is reduced to 0.03 percent maximum. No further information is however given for that material.

Structures made of thin-gauge honeycombs are mentioned in the table for special purpose Nicrobraz filler metals. There, Nicrobraz 3002, containing 15 weight percent chromium, 8 weight percent silicium, no carbon and no boron, balance nickel, is recommended for brazing thin-gauge honeycombs.

As can be seen from the above, most of the materials recommended for use in honeycomb structures are nickel base brazing filler metals with a high chromium content and no boron, whereas materials containing both silicium and boron and no chromium, ie which have a composition close to the present one, in particular Nicrobraz 130, are ranked as "satisfactory" only. Satisfactory braze filler metals like Nicrobraz 130 show a higher solution and diffusion into the base metal than filler metals of rank A. Hence, it is not recommended to use materials such as now claimed for the brazing of honeycomb structures.

E14 also contains information on the oxidation resistance properties of the joints brazed with the filler metals, whereby the joints are made of Inconel, apart from the test of Nicrobraz 170 which was conducted on Hastelloy X. However, Inconel and Hastelloy X materials are not iron-based but nickel-

based alloys (E10, table 1, Inconel Alloy 625), which cannot, consequently, fall in the category of stainless **steel**.

Stainless steel is mentioned in two instances in E14: in connection with brazing temperatures (footnote to the table relating to special purpose Nicrobraz filler metals) and in connection with recommended atmospheres for brazing (footnotes 4 and 6 in the table for the compositions, properties and applications for Nicrobraz brazing filler metals).

In summary, E14 does not recommend using brazing filler metals as defined in the patent in suit for the brazing of stainless steel heat-resisting structures as claimed.

- 4.2 E8 concerns a process of manufacture of a catalytic reactor matrix for cleaning the exhaust gases of an internal combustion engine, wherein the matrix comprises alternate flat and corrugated sheets of heat resistant steel, the sheets being disposed one above the other in layers, the individual layers being soldered spotwise or overall together and the sheets being coated with a catalytically active material (preamble of claim 1).

The problem underlying E8 is to provide soldering methods for producing the support matrix which are simple, versatile and applicable to various forms of matrices (last paragraph on renumbered page 6).

The problem is solved by a method of manufacture of the matrix comprising degreasing and/or pickling the metal sheets and, before alternately arranging the sheets in

layers, applying a coating of solder to at least one of the smooth and the corrugated steel plates respectively, disposing the smooth and corrugated plates in alternate layers and heating up the matrix to effect a simultaneous soldering together of all layers (renumbered page 7, first full paragraph and characterizing portion of claim 1).

The solder may be in powder or foil form (claims 9 and 13).

In a preferred embodiment, a binder is preliminarily applied to the places which are later to be coated by the solder. In this connection "Nicobraz" cement is exemplified (claims 7 and 8).

The sheets can be wound spirally together to form a cylindrical honeycomb body, which can be inserted in a casing (Figure 7).

- 4.3 E6 discloses a process for the manufacture of a metal support body for an exhaust gas purification converter, and a metal support body manufactured by this process (page 1, first paragraph).

E6 aims at an improvement in the process disclosed by E8 (page 1, line 7, to page 2, line 22). According to E6, the method of E8 has the following drawbacks:

- (a) a relatively high quantity of braze filler metal is necessary for brazing the honeycomb (page 1, lines 25 to 29);
- (b) a good brazed joint cannot be achieved in all of the contact zones between the sheets. Moreover,

stress might be exercised on the sheets, which might lead to deformation or destruction, because they are very thin (page 1 line 30 to page 2 line 11).

- (c) the necessity of pickling the metal sheets, which requires difficult and complicated removal of the aggressive pickling solution (page 2, line 12 to 22).

Hence, the problem in E6 is to overcome the above drawbacks while using only the quantity of braze metal which is necessary for the secure, mutual junction of the base metal sheets.

The solution thereto comprises the following process steps: a support body is first of all formed by stacking individual layers of sheet steel. A mixture of powdered brazing solder and plastic-based binder is then sprinkled over at least one front face of this support body. The support body thus treated is then subjected to high-temperature brazing under vacuum (claim 1).

According to E6, to obtain an impeccable joint with the least possible deterioration of the base metal, it is necessary to use compatible materials for both the base and the braze filler metal (page 8, lines 4 to 6). The base metal of the individual metal sheets may be ferritic stainless steel (page 4, lines 15 to 18; page 8, lines 13 to 19; claim 9). The braze filler metal described may contain about 20 percent of chromium (page 4, lines 18 to 19) and Nicrobraz 30 is actually exemplified as being very appropriate for the combination with ferritic stainless steels (page 8,

lines 29 to 33).

The metal support for the exhaust gas converter is especially suitable for internal combustion engines (page 5, lines 5 to 8, and page 8, lines 7 to 13).

5. *Closest state of the art (Main request)*

5.1 The appellant considered document E14 as the closest prior art, whereas the respondent started from document E8. In the Board's view document E6 might also be considered as a proper starting point. In selecting the closest prior art, the first consideration is that it should be directed to the same purpose or effect as the invention (Case law, *supra*, I.D.3.1).

5.2 According to the description, the heat resisting structure has a small oxidation rate, a high oxidation resistance and excellent strength and durability (column 7 line 31 to column 8 line 16). Such a heat resisting structure is made of a honeycomb-like structure made of stainless steel sheets joined by a brazing material as defined in claim 1.

5.3 E14 mentions the use of brazing filler metal Nicrobraz 130 for application in honeycombs and other thin parts. Although that combination shows structural and compositional similarity with the claimed subject-matter, E14 does not address a technical problem comparable to that of the patent in dispute.

5.4 E8 does not mention the problems of oxidation resistance, stress corrosion cracking and durability of the structure. It neither explicitly mentions stainless steel as a base material nor to braze with any specific

filler metal. Hence, E8 does not concern the same purpose as the patent in suit.

5.5 E6, however, not only addresses the problem of improving stress resistance and durability of the structure in use. It also discloses a heat-resistant, stainless steel honeycomb-like structure with all of the structural features as defined in the preamble of claim 1 in dispute. Furthermore, it hints at using compatible materials, ie at properly matching sheets and braze filler metals, and it mentions that the sheets are thin and made of ferritic stainless steel.

5.6 The Board considers E6 as the closest prior art, because it pertains to the same technical field, addresses a similar technical problem, describes a similar use of the same particular materials as claimed and shows the closest structural similarity with the claimed structure.

6. *The technical problem (main request)*

6.1 The heat-resisting honeycomb-like structure of E6, employing ferritic stainless steel and brazed with a nickel-base filler metal containing a large amount of chromium and low carbon content, has a satisfactory performance. However, when used at high environmental temperature, its oxidation resistance and durability leave room for improvement (patent in suit, column 3, line 11 to 21).

6.2 Hence, the technical problem to be solved may be seen in the improvement of oxidation resistance and durability of stainless steel honeycomb-like structures used at high environmental temperature, in line with

the patent in suit, column 4, lines 39 to 42.

7. *The solution (main request)*

7.1 According to the patent in suit, that problem is solved by brazing the structure with a very specific filler metal, which is substantially free of chromium and carbon and contains silicium and boron in the given range as defined in claim 1.

7.2 Figure 3 in the patent in dispute shows a comparison of the oxidation rates of a heat resistant structure from the prior art and of a structure as claimed. According to the results, it is apparent that the structure as claimed is lower in oxidation rate than that of the prior art. However, although the oxidation rate of the claimed structure is shown to be low and is said to be reduced over that of the prior art, it is not clear which prior art is meant in Figure 3, let alone if it represents E6. Therefore, the problem to be solved has to be reformulated on a less ambitious basis so as to provide a heat resistant structure having good oxidation resistance and durability at high temperatures.

7.3 In view of Figure 3, the Board is satisfied that the problem thus defined is effectively solved by the claimed solution.

8. *Inventive step (main request)*

It remains to be decided whether the claimed subject-matter is obvious having regard to the documents on file.

- 8.1 The general teaching of E6, in order to form a good joint, is to avoid high quantities of braze filler metals, to thereby reduce joint clearances and to prevent deterioration of the base metal by avoiding pickling solutions and by using compatible materials for both the base and the braze filler metals.

The practical implementation of the method requires that the braze filler metal be sprinkled over at least one front face of the stacked individual layers of sheet stainless steel, not over the entire surface.

The most appropriate braze filler metal (Nicrobraz 30) mentioned in E6 contains a large amount of chromium and a low carbon content and does not contain any boron. There is no suggestion in E6 to use a braze filler metal with substantially no chromium, substantially no carbon but containing boron. Consequently, E6 by itself cannot render the claimed subject-matter obvious.

- 8.2 The same conclusion is valid for the other documents as cited: none of them refer to the desirability of using a braze material as now defined.

When looking for brazing metal fillers suitable for honeycomb structures, the skilled person, on the basis of E14, would select an alternative from the filler metals ranked as "best", suitable for thin gauge honeycombs, like Nicrobraz 3002 or 3003. However, these filler metals all have a large amount of chromium or phosphor, thus none of them have a composition falling under the definition in claim 1 in dispute.

Even knowing the composition of Nicrobraz 130, which does not contain chromium and has a low carbon content,

the skilled person would not select it for brazing stainless steel honeycomb structures, since more suitable materials are recommended by E14.

Contrary to the allegation of the appellant, the fact that the composition of Nicrobraz 130 was known for the application "honeycomb and other thin parts" does not mean that the resulting structure and all of the relevant properties thereof were known. According to G 1/92 (OJ EPO 1993, 277) - which dealt with the issue of novelty, not inventive step - characteristics which were only revealed when a product known *per se* was exposed to interaction with specifically chosen outside conditions in order to achieve a particular result, cannot be considered as having been made available to the public.

In the present case, the use of Nicrobraz 130, regardless of its carbon content, for brazing stainless steel sheets with a view to oxidation resistance and high temperature durability, was therefore not a selection obvious to the skilled person.

This conclusion is not changed by decision T 952/92 (OJ EPO 1995, 755), which relates to the prior use of a product, since it has not been shown that Nicrobraz 130 had in fact been used for brazing stainless steel honeycomb structures.

Thus, E14, like E9 and E12 to E13, cannot provide the features missing in E6 so as to arrive at the combination of features now being claimed.

Therefore, any combination of E6 with any of said E9 and E12 to E14 would not result in another conclusion,

since none of them would lead to the claimed subject-matter.

- 8.3 Also starting from E8 would not lead to any other result.

E8 does not mention stainless steel for the sheets of the honeycomb and does not specify any kind of braze filler metal therefor. Hence, if taken alone, it does not lead the skilled person to the subject-matter of claim 1 in dispute.

Starting from E8, the skilled person would have to take a considerable number of steps in order to arrive at the claimed combination: to choose stainless steel for the honeycomb material, to select a Nicrobraz filler metal, in particular Nicrobraz 130, and to reduce further the carbon content of the latter.

The same arguments as above (point 8.2) as to why that combination of selection steps is not obvious in view of E14, apply here: E14 does not provide the features which E8 lacks so as to arrive at the combination of features now being claimed. The same is valid regarding the other documents on file.

- 8.4 The same arguments are valid for E14 as the closest prior art document.

Starting from E14, where a number of filler metals are mentioned as being suitable for brazing honeycombs in general, the question to be answered would be whether the skilled person would have arrived at a heat resistant, stainless steel honeycomb-like structure brazed with a nickel-based filler metal containing 4 to

8 percent by weight of silicium, 2.0 to 4.5 percent by weight of boron and being substantially free of both chromium and carbon, as delineated in claim 1 in dispute.

In order to arrive at the claimed subject-matter, the skilled person would have to select the detailed structure of the honeycomb as well as its material and a specific braze filler metal against the recommendations of E14, with the substantial absence of carbon as well.

The skilled person could, however, not find the slightest suggestion in E14 towards a honeycomb-like structure with all of the features defined in claim 1 in dispute.

Therefore, the argument of the appellant, that little or no structural modification was necessary when starting from E14 to arrive at something falling under the terms of claim 1 in dispute, is not convincing.

8.5 None of the further documents on file point to any combination with E14, nor do they contain any information to point the skilled person in the direction of the combination of features of claim 1 in suit.

9. It follows from the above, that the claimed subject-matter was not obvious, therefore the subject-matter as defined in claim 1 of the main request is inventive.

Thus, the main request is allowable.

10. Since the main request is allowable, it is not

necessary to consider the auxiliary requests.

11. *Public availability of documents E9 and E12 to E14*

In view of the above, the question whether documents E9 and E12 to E14 were available to the public before the priority date of the patent in dispute can be left unanswered. It follows from the above conclusions, that these documents do not prejudice the maintenance of the patent as granted.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:

C. Eickhoff

R. Teschemacher