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D E C I S I O N
of 4 July 1995

Case Number: T 0277/93 - 3.2.2

Application Number: 84302975.2

Publication Number: 0127343

IPC: C23C 22/04

Language of the proceedings: EN

Title of invention:
Structures fabricated from aluminium components and processes involved in making these structures

Patentee:
Gaydon Technology Limited, ET AL

Opponent:
Julius & August Erbslöh GmbH & Co
Vereinigte Aluminium-Werke AG, Berlin und Bonn

Headword:
Structures fabricated from aluminium/GAYDON

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step confirmed in the light of extensive prior art"

Decisions cited:
-

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0277/93 - 3.2.2

D E C I S I O N
of the Technical Board of Appeal 3.2.2
of 4 July 1995

Appellant: (Proprietor of the patent)
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Decision under appeal: **Decision of the Opposition Division of the European Patent Office dated 2 February 1993 revoking European patent No. 0 127 343 pursuant to Article 102(1) EPC.**

Composition of the Board:

Chairman: H. J. Seidenschwarz
Members: R. A. Lunzer
J. Van Moer

Summary of Facts and Submissions

I. European patent No. 127 343 was granted on 18 July 1990 on the basis of application No. 84 302 975.2 filed on 3 May 1984, claiming a priority date of 7 May 1983 derived from UK application No. 8 312 626.

II. Two oppositions were filed on the ground of Article 100(a) EPC, alleging lack of novelty (Article 54 EPC), and lack of any inventive step (Article 56 EPC).

III. By its decision given orally on 2 December 1992, and issued in writing on 2 February 1993, the Opposition Division revoked the patent. Of the 11 cited documents mentioned in its decision, the Opposition Division directed particular attention to the following:

(5) DE-A-1 717 434
(8) Aluminium, Vol. 28 (1952), pages 346-349
(9) Technische Information 604, G. Collardin GmbH, Köln, (1969), pages 1-46, and
(10) Aluminium Association Leaflet T 14 (1975).

It regarded document (10) as the closest prior art, and against that background regarded the problem underlying the alleged invention as providing a more economical method of producing adhesively bonded automotive aluminium structures using the existing production lines in which the forming step was neither detrimental to the chromate layer nor to the adhesive bonding. As it was normal for forming to precede bonding, it followed that the main issue to be decided was whether it was obvious to pretreat an aluminium sheet, such as by chromating, prior to shaping it. Documents (5) and (8) showed that chromated aluminium strip could be stored for long periods, while documents (5), (8) and (9) all

confirmed the excellent adherence of the chromate coatings there disclosed. Document (8) also indicated that chromate treated sheet aluminium could be subjected to working without the protective properties of the chromate layer being damaged. Hence it was held that the subject-matter of Claim 1 of the patent as granted lacked any inventive step, while the subject-matter of Claims 18 and 19 of the patent as granted also lacked any inventive step having regard to the disclosure of document (10).

Regarding main claims in accordance with the auxiliary requests, it was held that as the Appellant had acknowledged that the necessary bonding strength was attained through the chromate pretreatment, the reasoning applicable to Claim 1 in accordance with the main request applied equally to the validity of the Claims 1 and 19 according to the auxiliary requests.

IV. An appeal against that decision was filed on 22 March 1993, the appeal fee was paid on the same day, and the Statement of Grounds of Appeal was filed on 8 June 1993. In support of the appeal the Appellant referred by way of background information to a series of documents identified as A to W (inclusive apart from letter I). It also introduced on 18 June 1993 a signed statement dated 9 June 1993 by Dr Antony Clementson, MSc, FRAeS, FRSA, C. Eng.

Together with its Statement of Grounds of Appeal, the Appellant filed as a main request amended Claims 1 and 19. Following a communication from the Board dated 27 July 1994, the Appellant filed with its letter of 2 September 1994 a revised (Set A) of Claims 1 and 19 as its main request, and a second (Set B) as an auxiliary request. With its letter of 15 May 1995 the numbering the the Claims following Claim 13 was corrected so as to

take into account the deletion of Claims 14 and 15, with the result that Claim 19 was renumbered 17, the request of 2 September 1994 being otherwise unaltered.

Claims 1 and 17 in accordance with the main request were in the following form, words added by way of amendment of the Claims in the patent as granted being shown in italics:

"1. A process for forming a structure of aluminium components, *said structure being the load-bearing structure of a vehicle*, wich process comprises pretreating aluminium sheet to produce a non-metallic surface coating thereon containing at least 10% by weight of chromium, forming the pretreated sheet to produce components of desired shapes, applying adhesive to the components and securing the somponents together by means of the adhesive, *wherein the forming step is performed in the presence of an adhesive-compatible press lubricant and the step of securing the components together by means of the adhesive is performed in the presence of residual press lubricant*.

17. Aluminium sheet suitable for forming a structure of formed aluminium components secured together by adhesive, *said structure being the load-bearing structure of a vehicle*, which sheet carries a non-metallic surface coating of between 0.01 and 1.5 g/m^2 thereon containing at least 10% by weight of chromium, and an adhesive-compatible press lubricant on the surface coating."

In its Statement of Grounds of Appeal, and in further statements in writing, the Appellant argued that there was a prejudice in the industry against attempting to bond aluminium alloy sheets by adhesive bonding in the presence of residual amounts of lubricants, that there

was a long felt want for the alleged invention as reflected by later literature, and that the alleged invention needed to be assessed in the light of the much more extensive literature provided for the purposes of the appeal. In particular, document (10), which had been relied on as the closest prior art by the Opposition Division, needed to be read in the light of document -

(L) SAE Paper 740078 "Adhesive Bonding of Aluminium Automotive Body Sheet" by Minford et al (1974),

which was to a large extent the basis of document (10) published a year later, and equally document -

(P) SAE Paper 810816, "Weldbonding Aluminium in the Presence of Forming Lubricants" by Minford (1981),

which reflected the state of the art closer to the priority date of the patent in suit.

When seen in its proper context, the very idea of using adhesive bonding to join the parts of a load bearing structure of a vehicle was inventive over document (10) and the other cited documents.

The newly introduced literature reflected the fact that the alleged invention had created great interest throughout the motor industry.

V. Only the opponent O2 filed any written submissions in response to the appeal. In its counterstatement filed on 15 October 1993, and in its letter of 29 July 1994, which dealt with the proposal in its communication of 27 July 1994, suggesting that the substance of Claims 14 and 15 ought to be brought into Claim 1, the Respondent argued that the proposed amendments to Claim 1 were not admissible. In particular it was objected that the

limitation to the load bearing structure of a vehicle did not impose any limit on the process steps, there being no clear distinction between the "skin panels" and "body structure" of a motor vehicle, as amplified below. Additionally, the term "adhesive-compatible press lubricant" was unclear when neither the adhesive nor the lubricant were defined, while the term "residual" left it uncertain as to what amounts of lubricant could be regarded as tolerable.

An additional document was introduced by the Respondent and identified as -

(X) Aluminium-Taschenbuch, 14th Edn. pages 879 - 881.

It showed at page 881 that since 1979 Daimler-Benz had used aluminium alloy panels in load carrying parts of vehicle bodies in mass production, while on the same page reference was made to the series production by Panhard in France of cars made wholly of aluminium alloys joined by spot welding. In fact no valid distinction could be drawn between load bearing panels, and the skin panels of an automobile, because the skin panels and other panels frequently contributed to the strength and rigidity of the automobile body as a whole. The literature relating to chromating, i.e. documents (5), (8) and (9) made it clear that there was no problem with the storage of chromated coatings, which were very adherent, and were not destroyed by working or drawing the underlying metal.

In the Respondent's final written submission of 29 July 1994 reference was made to a still further document:

(Y) Aluminium, 51, 1975, pages 534 to 537,

which at page 535 discussed the influence of the surface tension of the adhesive, and surface pre-treatment of the aluminium, from the point of view of the quality of the bond. It was contended that this showed that there was no prejudice against the use of an adhesive in the presence of a lubricant on the surface to be bonded, and that satisfactory bonding could be obtained so long as the effects of surface tension were taken into account.

VI. The Appellant requested that the patent should be maintained on the basis of the Claims 1 and 17 as set out above, the description to be amended. The Respondent requested that the appeal be dismissed.

Reasons for the Decision

1. The appeal is admissible.

2. *Admissibility of amendments*

2.1 Three further limitations have been introduced into Claim 1. The first is that the claimed structure is now required to be a load bearing structure. The second is that the forming step is performed in the presence of an adhesive-compatible press lubricant, and the third is that the components are secured together in the presence of residual press lubricant. These features were disclosed in the application as filed, at page 6 line 4, page 18 lines 12 to 23, and Claim 27, corresponding essentially to page 3 line 53, page 6 lines 14 to 19, and Claims 14 and 15 of the patent as granted. The introduction into Claim 17 of the same limitation as that introduced into Claim 1 is permissible for the same reasons as have been given above. Accordingly the Board

is satisfied that these limitations to Claims 1 and 17 meet the requirements of Article 123(2) and 123(3) EPC, and are therefore admissible.

2.2 Regarding the inclusion of those features in Claim 1, the Board does not accept the Respondent's arguments that its scope is not curtailed by the limitation to a load bearing structure, or that the other limitations introduce a lack of clarity contrary to Article 84 EPC. The limitation of the structure to a load bearing structure means that non-load-bearing components, such as those disclosed in document (10), which is discussed in detail below, are excluded from the scope of Claim 1.

2.3 As to the requirement that forming is carried out in the presence of an adhesive-compatible lubricant, and that residual amounts of lubricant may be present when adhesive bonding, the Board regards these as relative terms, the use of which is permissible in claims if their meaning would be sufficiently clear to the reader (cf. T 860/93, OJ EPO 1995, 47). In the present circumstances it would be unreasonable to limit the Claim to a specified adhesive, and lubricants compatible therewith, because in the life of the patent newer and better adhesives might become available, the use of which would then be outside the protection conferred by the patent. It is clear that the lubricants mentioned at page 6 lines 13 to 26 are given by way of exemplification, and are not intended to limit the scope of the alleged invention.

3. *Novelty*

Having reviewed the cited documents, the Board is satisfied that none of them discloses a process, or an aluminium sheet, having all the features defined in Claims 1 and 17. Therefore the subject-matter of the

patent is considered to be novel within the meaning of Article 54 EPC. Novelty being uncontested at the appeal stage, more detailed reasons are unnecessary.

4. *Inventive step*

4.1 The prior art

4.1.1 The Board agrees with the Opposition Division in regarding document (10) as the closest prior art. However, as the Board has before it substantially more background material than was available to the Opposition Division, its interpretation of this document is influenced by that further information.

4.1.2 Document (10) was published in 1975, and is acknowledged in the patent in suit at page 3 lines 31 to 34. It is a review article, which according to its title, is concerned with "Adhesive bonding of aluminium automotive **body sheet** alloys." (Emphasis has been added above and in some of the later quoted passages.) What is meant by "body sheet" is reflected by the passage at page 8 (left hand column last paragraph) which states:

"Adhesive bonding is presently employed in the joining of automotive **steel** body sheet components, primarily in bonding hood and deck inner and outer panels or load deck areas."

The terminology there used is of distinctly American origin in an area where there are differences between British and American usage. What is there referred to as the "hood" would be called the "bonnet" in England, while the "deck" is presumed to be the floor of the boot (US trunk). There is nothing else in this article about

where it is contemplated that bonded sheet might be used, and certainly no suggestion of its possible use in the load bearing frame of the vehicle.

4.1.3 As is to be expected in a review article, numerous possibilities are considered. In particular, some of the wrought aluminium alloys contemplated are listed in Table 1 on page 5. The various types of adhesives which may be used are discussed in the lower part of page 5, where direct reference is made to document (L), and a selected list is given at page 6. The suitability of various aluminium alloys is discussed further at page 7, and the topic of surface preparation appears on page 10.

4.1.4 Chromate treatment of the surfaces of aluminium sheets to be bonded receives a somewhat qualified commendation with the words - "and a second step **might** be a chemical conversion processing of the surface as in Alodine 401-45 solution." (Page 10, right hand column, 4th full paragraph.) There follows in Table 8 on page 10 a comparison of the strength under corrosive conditions of sheet in three forms: (A) mill finish, (B) vapour degreased, and (C) treated with Alodine 401-45. It is a matter of no surprise that the bonding of the chromate treated sheet (C) is much superior in these tests, given that the comparison is being made between unprotected aluminium surfaces in (A) and (B), and a surface with a conversion coating of known resistance to corrosion in (C).

4.1.5 The performance of different adhesives is discussed from page 11 onwards, attention being directed to epoxy, and vinyl plastisol, adhesives, of which it is noted that their ability to absorb and strike through oil on the metal surface so as to form a firm bond with the metal has dictated their use (i.e. for steels). In Table 9 on

page 12 there is a comparison of the performance of certain adhesives based on experience both with aluminium alloys and with steels.

4.1.6 The last part of document (10) is the most important for present purposes. It comprises Table 10 on page 12 and the section beginning on page 13 entitled "Effect of Forming Oil on Aluminium Surfaces on the Bond Strength and Durability of Several Adhesives". Table 10 is in fact Table 7, taken verbatim from document (L), published a year before document (10). Document (L) includes considerably more background detail concerning its Table 7, which shows the effect of varying the quantities of oil present on the surface of aluminium alloy sheets of different compositions bonded using different adhesives. It is notable that with the adhesive identified as Epoxy A, and the alloy 2036-T4, there was a total failure of the bond under the most severe test conditions, i.e. 5% salt spray at 95°F for 3 weeks with the thickest oil coatings. The thickness of these coating were respectively 3.0 and 2.24 mg/in^2, corresponding to 0.465 and 0.35 mg/cm^2. As explained in document (L) page 2 at the centre of the right hand column, this test reflects the most aggressive environment encountered by an automobile.

4.1.7 Although the author of document (L) stressed the positive degree of bonding achieved with lubricant bearing surfaces, (cf. page 5 right hand column and the conclusion at pages 6 and 7) the question which arises is how the amounts of lubricant on the aluminium alloy test pieces considered in Table 10 of document (10), or Table 7 of document (L) (hereinafter referred to as "Table 10/7") compare with the amounts normally present when aluminium sheet is formed by pressing. On that topic, the only information available to the Board is contained in document (P). At Figure 1 on page 3 it

identifies levels of dry lubricant of 0.5 and 1.0 mg/cm² as being the "Manufacturers' recommended levels for forming aluminium".

4.1.8 The amounts of lubricant which gave satisfactory bonding in Table 10/7 were 0.34 and 0.20 mg/in², corresponding to 0.052 and 0.031 mg/cm², i.e. of the order of one tenth of the amount suggested as the normal amounts when forming sheet according to document (P). That only small amounts of lubricant were present when satisfactory bonding was achieved in accordance with the test results reported in Table 10/7 is confirmed at page 13 of document (10), where it is stated that:

"The data in Table 10 show that available commercial epoxies and vinyl plastisols have the ability to develop bonded joints in spite of oil contamination on the surface. As anticipated, the bonding through quite **thick oil layers** is marginal or poor at best."

4.1.9 In fact the thickest oil layer disclosed in that Table, 0.465 mg/cm², is of the same order as those disclosed in document (P) as being recommended for forming aluminium sheet. To like effect is the conclusion expressed at page 3 of document (10), part of which is quoted below:

"Present commercial adhesives designed to tolerate oil contamination on metal surfaces may form bonds on deliberately oiled surfaces approximately equivalent to those obtained on vapour degreased surfaces. Obviously, there are practical limits to the amount of oil contamination that can be tolerated."

4.1.10 That heavily qualified commendation of the bonding of aluminum alloys by adhesives in the presence of lubricating oils is confirmed by the concluding remarks

of document (P), published closer to the 1983 priority date of the patent in suit, which is expressed in these words:

"The ability of the various adhesives to bond strongly in the presence of significant amounts of lubricant contamination on the surfaces seems to contradict some of the statements that have governed bond strength predictions made from the literature. In spite of these present results, the general rule that clean metal surfaces are to be preferred for most effective bonding remains **axiomatic**."

4.1.11 Document (Y), introduced by the Respondent at a late stage, does not take the matter significantly further than earlier cited art. It discusses the conditions necessary for maximising the strength of adhesive bonds between aluminium components, and in particular stresses the significance of surface tension. That does not go so far as to satisfy the Board that it was known in this art that a degree of adhesion could be attained which would be sufficient to make it feasible, in the presence of residual quantities of lubricant following forming by pressing, to produce bonds of sufficient strength for the purposes of making a load bearing structure. In fact it is noted that the only examples of bonding illustrated are for lightly stressed bonds, such as hot water pipes and packaging.

4.1.12 Summarising the effect of the extensive prior art literature available in this appeal, it may be concluded that although it was known that suitably chosen adhesives could tolerate the presence of small amounts of lubricant, and still produce a reasonable bond, nevertheless it was to be expected that no more than a modest bond could be expected in the presence of the amounts of lubricant encountered when pressing aluminium

alloy sheets, and that when seeking a very strong bond, such as would be needed in a load bearing structure, surface cleanliness was regarded as axiomatic.

4.2 The statement by Dr Clementson

4.2.1 The above summary finds confirmation in the statement by Dr Clementson mentioned in paragraph IV above. He identifies himself as a person who has had extensive experience in the field of design and development of structures and materials for use in aircraft, and confirms that he had read the patent in suit and other papers associated with the opposition proceedings.

4.2.2 In his statement, he draws attention to the fact that in the aircraft industry adhesive bonding is normally carried out after a phosphating surface treatment, care being taken to bond immediately after surface treatment. The surface treated component had to be handled with gloves, and care was taken to avoid surface contamination. He goes on to say that in 1983 he would have regarded such procedures as essential to obtaining a strong adhesive bond between aluminium alloy sheets, and that he would have expected contamination to make it impossible to obtain reliably strong adhesive bonds. On this topic, his concluding words are as follows:

"I would have said that any project for making load-bearing structures of motor vehicles depending upon adhesively bonded aluminium parts and which involved lubricating and/or forming surface-pretreated aluminium sheet could not be successful."

4.2.3 Seen against the background of the prior art which has been dealt with in detail above, the Board finds that statement inherently credible.

4.3 In the light of the prior art summarised in paragraph 4.1 above, and in the light of the confirmatory statement by Dr Clementson, the Board concludes that at the priority date of the patent in suit, the skilled worker would not have expected that a bond strong enough to withstand the main structural loads of an automotive vehicle could be formed by adhesively bonding aluminium sheets in the presence of such residual amounts of lubricant as would remain after the sheets had been formed by pressing in the presence of sufficient lubricant to permit forming by conventional press techniques.

4.4 In connection with the Respondent's contention that it was known to make structural components of automobile bodies out of aluminium alloys, based on document (X) which refers to Daimler-Benz's experience since 1979, it is observed that there is no mention of the structural components there concerned being bonded by adhesives.

4.5 It follows from the above that the Board is satisfied that it was not obvious to make a load bearing structure of a vehicle by forming aluminium sheets in the presence of an adhesive-compatible press lubricant, and adhesive bonding in the presence of residual amounts of press lubricant. Having so found, the Board has no need to investigate the disputed issue of whether the pretreatment of aluminium sheet by chromating as disclosed in documents (5), (8) and (9) has in itself inventive merit. Accordingly the Board holds that the subject-matter of Claim 1 involves an inventive step.

5. *Product Claim 17*

The product claim is directed to an aluminium sheet suitable for forming a load-bearing structure of a vehicle, which has both a chromium containing surface

coating as there defined, and an adhesive-compatible press lubricant on the surface coating. The novelty of this claim was not challenged. In the Board's view its subject-matter is inventive because there would be no reason to make the claimed product in the absence of an awareness of its potential usefulness in the process of Claim 1 for making load-bearing structures.

6. *Conclusion*

The subject-matter of Claims 1 and 17 being regarded as inventive, the same applies to dependent Claims 2 to 16 and 18 to 20, which are directed to preferred embodiements according to Claims 1 or 17, and whose inventiveness is supported thereby.

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 with the Claims 1 to 20 in accordance with the main request (Set A) filed with the Appellant's letter of 15 May 1995, and a description to be adapted.

The Registrar: The Chairman:

S. Fabiani H. Seidenschwarz