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Bezeichnung der Erfindung: A method of manufacturing a composite material

Title of invention:

Titre de l'invention :

Klassifikation / Classification / Classement : B29D 3/02

### ENTSCHEIDUNG / DECISION

vom / of / du 30 July 1989

Anmelder / Applicant / Demandeur :

Patentinhaber / Proprietor of the patent /

Titulaire du brevet :

Rolls-Royce plc.

Einsprechender / Opponent / Opposant :

BASF Aktiengesellschaft

Stichwort / Headword / Référence :

EPÜ / EPC / CBE Articles 54 and 56

Schlagwort / Keyword / Mot clé :

"Inventive step (yes)"

Leitsatz / Headnote / Sommaire

Europäisches  
Patentamt

European Patent  
Office

Office européen  
des brevets

Beschwerdekammern

Boards of Appeal

Chambres de recours



Case Number : T 372/87 - 3.2.2

**D E C I S I O N**  
of the Technical Board of Appeal 3.2.2  
of 30 July 1989

**Appellant :** Rolls-Royce plc.  
(Proprietor of the patent) 65 Buckingham Gate  
London SW1E 6AT (GB)

**Representative :**

**Respondent :** BASF Aktiengesellschaft  
(Opponent) Carl-Bosch-Straße 38  
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**Representative :**

**Decision under appeal :** Decision of the Opposition Division of the European Patent Office dated 8 September 1987 revoking European patent No. 0 047 576 pursuant to Article 102(1) EPC.

**Composition of the Board :**

**Chairman :** G. Szabo  
**Members :** C. Andries  
W. Moser

## Summary of Facts and Submissions

- I. European patent No. 47576 comprising ten claims was granted to the Appellant on 20 February 1985 in response to European patent application No. 81 303 195.2 filed on 13 July 1981.

Claim 1 reads as follows:

"A method of manufacturing a composite material comprising the steps of applying a first high temperature resistant thermoplastic polymer to a layer or layers of reinforcing filaments, forming a structure of the or each layer of filaments and sheets of a second high temperature resistant thermoplastic polymer so that the or each layer of filaments is interposed between sheets of said thermoplastic polymer, compressing said structure at an elevated temperature, cooling the thus formed composite material under compression in order to avoid any distortion thereof and subsequently discontinuing said compression characterised in that said first thermoplastic polymer is applied to said filaments in an amount sufficient only to lightly bind said filaments together and said structure is maintained under said compression at a temperature at which said first thermoplastic polymer does not thermally decompose and at which said second thermoplastic polymer is mobile, for sufficient time for said second thermoplastic polymer to impregnate said layer or layers of bound filaments and for at least a major portion of said first thermoplastic polymer to diffuse into said second thermoplastic polymer."

- II. The Respondent filed an opposition against the European patent and requested the revocation of the patent on the

grounds that its subject-matter was not patentable (Articles 52 to 57 EPC) in the light of documents

D1: GB-A-1 570 000;

D2: DE-A-1 769 943;

D3: H. Hagen "Glasfaserverstärkte Kunststoffe", 1961, Springer-Verlag, Berlin, pages 196 and 212;

D4: DE-A-1 619 307.

- III. In its decision dated 8 September 1987 the Opposition Division revoked the patent. According to the decision the subject-matter of the sole independent Claim 1 lacked an inventive step with respect to document D1.
- IV. The Appellant lodged an appeal against this decision on 8 October 1987, paying the appeal fee on 6 October 1987, and submitting the statement of grounds on 1 December 1987.

The Appellant stated that the subject-matter of Claim 1 as published would be patentable in view of the cited prior art.

- V. The Respondent contested the arguments brought forward, and pointed out:
- that in the method according to document D1 the used conditions of compression, temperature and time are sufficient for a major portion of a thermoplastic polymer to diffuse into the other thermoplastic polymer;
  - that it is obvious for a skilled person to reduce the amount of the soluble first thermoplastic polymer in order to reduce the susceptibility to solvent attack;

- that document D1 has to be considered as novelty destroying for the subject-matter of Claim 1; and
- - that documents D2, D3 and D4 disclose the fact that amounts lower than 5% of a thermoplastic polymer are sufficient to bind the reinforcing filaments together.

VI. The Appellant requested that the decision under appeal should be set aside and the opposition rejected. Alternatively, the Appellant requested that the patent be maintained as amended.

The Respondent requested that the appeal be dismissed.

#### Reasons for the Decision

1. The appeal is admissible.
2. Clarity and interpretation
  - 2.1 With respect to the objections of the Respondent relating to lack of clarity of the expression "an amount sufficient only to lightly bind the filaments together", the Board would like to point out that these objections, based on Article 84 EPC, are no grounds for opposition as defined in Article 100 EPC (cf. T 301/87, Alpha-interferons/BIOGEN, Points 3.7 and 3.8 of the reasoning, to be reported).

In spite of this, the Board would like to remark that Claim 1 as worded, especially if it is interpreted in the light of the description, is clear for a man skilled in the art.

The description of the patent in suit prescribes ("it is necessary ...") such a very low amount, i.e. up to 5% (cf. column 3, lines 20-25) and the Examples indicate an increase of weight of the fibres by 4.5%. Therefore, a skilled person has no difficulty in understanding what is meant by the expression nor in determining, by empirical methods, the amount of the first thermoplastic polymer which would be sufficient to achieve such light binding.

2.2 The Board wants to state that the table on top of page 5 of the patent in suit contains a clerical error. In view of the description (column 5, line 60 to column 6, line 2) it is clear that the units used in the table for the variables "flexural strength" and "flexural modulus" are GN/m<sup>2</sup> instead of MN/m<sup>2</sup> as used in the table.

3. Closest state of the art

3.1 The patent relates to a method of manufacturing a composite material according to the precharacterising portion of Claim 1. Such a method is known from document D1 which is recognised by the Board as the closest state of the art.

3.2 This document describes a method of producing a substantially stiff fibre-reinforced polymeric material, including the step of stacking alternately layers of a first thermoplastic material and one or more layers of reinforcing fibres which have been impregnated with a second thermoplastic material applied in a solvent to the reinforcing fibres prior to stacking.

According to the teaching of document D1, not only an already existing layer of reinforcing fibres is used in the form of a woven layer, a cloth or a tape, but also this layer is impregnated (throughout its thickness) with

a thermoplastic material. The amount of thermoplastic material used to impregnate the layer of reinforcing fibres is indicated in the description (examples) and results according to these examples in an increase of weight of the layer between 16% (example 9) and 50% (example 8: from 40 gr. to 60 gr.). The obtained values for flexural strength in the different examples varies from 250 MPa (0,25 GPa; Example 4) up to 1443 MPa (1,443 GPa; Example 1).

3.3 However, according to the disclosure of the patent in suit in respect of the citation, this means that whilst the method permits the use of films of high viscosity thermoplastic polymers, the resultant composite material is prone to solvent attack, even if the thermoplastic polymer of the film is of low solvent solubility. Whilst the thermoplastic polymer used for the films may have desirable properties as a matrix material, the incorporation of a relatively large amount of a different thermoplastic polymer in that matrix may have a deleterious effect upon the properties of the resultant composite material.

#### 4. The problem and the solution

4.1 The technical problem to be solved in respect of the above state of the art consists, accordingly (cf. column 2, lines 55-60), in providing a method of manufacturing a composite material wherein the aforementioned difficulties in manufacturing filament reinforced thermoplastic polymer matrix composite materials are substantially avoided. An objective assessment of what is actually achieved over the prior art allows the problem to be formulated as providing a method which allows to obtain a resultant composite

material with improved properties, in particular with respect of the flexural strength and modulus and the breaking strain.

- 4.2 The Board accepts, in view of the comparative results in the table on top of page 5 of the patent in suit and in view of the corresponding values (flexural strength) disclosed in document D1, that the problem is plausibly solved by the features present in the characterising portion of Claim 1. In essence, these consist in
- (i) the use of an amount of first thermoplastic material sufficient only to lightly bind the material to the reinforcing fibres; and
  - (ii) the claimed combination of compression, temperature and time sufficient for a major portion of the first thermoplastic polymer to diffuse into the second thermoplastic polymer.
- 4.3 By using a minimum amount of a first thermoplastic polymer, the reinforcing filaments are not only lightly binded together so that these filaments can be easily handled without losing their initial general configuration, but this would also allow that a large proportion of said second polymer to be brought in contact with the filaments in the resultant composite material due to the diffusion of a major portion of the first thermoplastic polymers into the second polymer. If, for example, the first polymer is readily soluble in organic solvents and the second polymer is not, then the resultant composite material will be less prone to organic solvent attack than composite materials in which diffusion is limited or non-existent.



5. **Novelty**

5.1 In view of the above distinctions over document D1, the claimed subject-matter is novel over the disclosure of this document. Indeed, the Board cannot follow, for the reasons set out in above points 2.1 and 3.2, the argument of the Respondent that the amounts of thermoplastic material, used to impregnate the layer of reinforcing fibres, as indicated in document D1, can be compared with the amounts in the meaning of the invention, which, according to Claim 1, have only to be sufficient to lightly bind the filaments together.

The other documents cited in the patent specification and in the proceedings represent further differences and were not raised against the novelty of the claims in the case either, and need not, therefore, be considered in this respect any further.

5.2 The subject-matter of Claim 1 is therefore novel within the meaning of Article 54 EPC.

6. **Inventive step.**

6.1 Document D1 suggests, in order to reduce or to eliminate the presence of voids in fibre reinforced thermoplastics, to use thermoplastic resins which are not particularly soluble in solvents conventionally used in impregnation or to use first and second thermoplastics which are the same (page 2, lines 53 to 70). Therefore, there is no indication in this document towards an amount of thermoplastic material, which not only is sufficient to lightly bind the reinforcing layer (cf. above point 5.1) but which also, for at least a major portion, has to be diffused into another thermoplastic material.

- 6.2 In addition, Document D1 discloses that the whole structure is maintained under compression and at a temperature for time sufficient to cause the thermoplastic materials to flow and bond the different layers together. Implicitly, it is clear for a skilled person that the impregnating thermoplastic material does not thermally decompose thereby and that both thermoplastic materials are mobile (flow). There was, however, no hint in document D1 which suggested that such use of heat and compression be also sufficient to allow the impregnated thermoplastic polymer to diffuse into the other polymer, so that due to the minimum amount of the first polymer, a large proportion of the second polymer, which impregnates said layers, is brought in contact with the filaments in the resultant composite material.
- 6.3 Furthermore, in view of the pressure, temperature and time used in the examples and in view of the values of flexural strength obtained with these variables, it becomes clear that these conditions cannot be compared with the conditions requested by Claim 1 of the patent in suit. Although it is true that due to the pressure, temperature and time conditions used in the method according to D1 a certain mixing of the two thermoplastic materials will take place, a diffusion of at least a major portion of said first into said second thermoplastic material, so that the second material comes in contact with the reinforcing fibres, is neither suggested, nor indicated.
- 6.4 Furthermore, the Appellant failed to show convincingly that only with the help of a decrease of the amount of the first thermoplastic material which was used to impregnate the layers of reinforcing fibres, composites with improved properties can be obtained. Therefore, it is only an ex post facto conclusion that a decrease of the amount of

the first thermoplastic materials leads to the method according to Claim 1, particularly since it is not obvious for a skilled man to use a minimum binding amount of a first thermoplastic material in combination with the required conditions.

- 6.5 The skilled person would not have been in a position to recognise the characteristics of Claim 1 in other disclosures, as associated with the effects necessary to solve the technical problems underlying the present invention. Document D2 describes a method to obtain a resultant composite with a high percentage of reinforcing fibres. The teaching of this document therefore solves a completely different problem, i.e. its aim is associated with the provision of different effects. Although, as indicated in the description (examples) of document D2, the amount of first thermoplastic material impregnating the reinforcing fibres represents a very low weight-percentage, this is not relevant to solve the above indicated problem in the present case (cf. point 4.1), since that amount is not only used for a different purpose (obtain a resultant composite with a high percentage of reinforcing fibres) but also involves a completely different manufacturing method (i.e. cutting a cable of reinforcing fibres into pieces after the cable has been impregnated with the first thermoplastic material; these pieces are mixed with a second thermoplastic material and the mixture is then used for injection-moulding purposes).

Therefore, there is, according to the Board, no suggestion in document D2 that such a low amount combined with the different manufacturing method can lead to an improved product in the sense of the present invention.

6.6 Document D3 gives no hint either disclosing the problem (cf. point 4.1) or the added features relevant to the present invention, so that a person skilled in the art cannot be led by this document to modify D1 as required. Document D4 discloses that binding resins can be used in small amounts only to bind the reinforcing fibres and to hold them together. A specific limitation of the amount is, however, not essential although indicated (page 8, lines 4 to 9: 5 to 10 weight %; lower and higher percentages are possible). Furthermore, the disclosed method implies the use of a temperature which decomposes the thermoplastic material. A suggestion that the first thermoplastic material diffuses into the second one is not entertained either.

Thus, a person skilled in the art cannot find in these or other documents, which are even more removed from the invention, a suggestion how to solve the technical problem forming the basis of the present invention, in a manner indicated in Claim 1.

6.7 To sum up it can be said that none of the cited documents, even in combination with each other, provides the skilled person with all the steps specified in Claim 1. Therefore, the subject-matter of Claim 1 involves an inventive step within the meaning of Article 56 EPC.

Consequently, Claim 1, as well as dependent Claims 2 to 9, which concern preferred methods of the method according to Claim 1, are allowable under Article 52(1) EPC.

**Order**

For these reasons, it is decided that:

1. The decision under appeal is set aside.
2. The European patent is maintained as granted.

The Registrar:

The Chairman:

*S. Fabiani*

S. Fabiani

*G. Szabo*  
G. Szabo