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Datasheet for the decision of 22 July 2014

Case Number: T 1263/11 - 3.3.03

Application Number: 03811953.3

Publication Number: 1566394

IPC: C08G59/18

Language of the proceedings: EN

Title of invention:
PROCESSES FOR PRODUCING FIBER-REINFORCED COMPOSITE MATERIAL

Patent Proprietor:
MITSUBISHI RAYON CO., LTD.

Opponent:
Daimler AG

Headword:

Relevant legal provisions:
EPC Art. 56
RPBA Art. 12, 13

Keyword:
Inventive step - main request (yes)
Late-filed document - admitted (yes)

Decisions cited:
T 0035/85, T 0197/86, T 1250/08

Catchword:

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Case Number: T 1263/11 - 3.3.03

D E C I S I O N
of Technical Board of Appeal 3.3.03
of 22 July 2014

Appellant: (Opponent)	Daimler AG Mercedesstrasse 137 70327 Stuttgart (DE)
Respondent: (Patent Proprietor)	MITSUBISHI RAYON CO., LTD. 6-41, Konan 1-chome, Minato-ku Tokyo 108-8506 (JP)
Representative:	HOFFMANN EITLE Patent- und Rechtsanwälte Arabellastrasse 4 81925 München (DE)
Decision under appeal:	**Interlocutory decision of the Opposition Division of the European Patent Office posted on 7 April 2011 concerning maintenance of the European Patent No. 1566394 in amended form.**

Composition of the Board:

Chairman	B. ter Laan
Members:	O. Dury
	R. Cramer

Summary of Facts and Submissions

I. The appeal by the opponent lies against the decision of the opposition division posted on 7 April 2011 maintaining European patent No. 1 566 394 (based on application No. 03 811 953.3) in amended form.

II. The granted patent was based on 8 claims of which claims 1 and 6 read:

"1. A method for producing a fiber-reinforced composite material molding comprising:

i) preliminarily adjusting the temperature of a mold having one side surface area S_2 to the curing temperature of a thermosetting resin or higher;

ii) putting a molding material of a substantially continuous reinforced fiber impregnated with the thermosetting resin and having one side surface area S_1 into the temperature-adjusted mold;

iii) fastening the mold;

iv) filling the whole inside of the mold with a molding material; and

v) conducting compression molding such that S_1/S_2 is 0.8-1."

"6. The method of any of the preceding claims, wherein the thermosetting resin is an epoxy resin composition."

The remaining claims were dependent claims directed to embodiments of claim 1.

III. A notice of opposition against the patent was filed in which the revocation of the patent in its entirety was requested on the grounds of Art.100(a) EPC (lack of novelty and lack of an inventive step). During the opposition procedure the following documents were *inter alia* cited:

E3: DE 199 49 318 A1
E8: US 4 868 050
Experimental Reports I and II:
filed with patent proprietor's letter
dated 25 November 2010

IV. In its decision, the opposition division decided to maintain the patent in amended form according to the main request (7 claims) filed with letter of 20 October 2009.

Claim 1 of the main request corresponded to claim 1 of the granted patent in which the thermosetting resin was further characterized as being an epoxy resin composition (as in claim 6 as granted). The wording of claims 2-7 corresponded to that of granted claims 2-5 and 7-8, respectively.

The opposition division held in particular that the requirements of Art. 56 EPC were met, starting from E3 as the closest prior art, since there was no hint in the cited documents towards either the surface ratio (S_1/S_2) specified in present claim 1 or the use of an epoxy resin in order to provide a sheet moulding method for moulded parts displaying:

- improved bending properties,
- improved macroscopic surface properties, and
- improved microscopic surface properties.

V. On 7 June 2011, the opponent (appellant) lodged an appeal against the above decision. The prescribed fee was paid on the same day. In its statement of grounds of appeal filed on 3 August 2011, the appellant requested that the decision of the opposition division be set aside and the patent in suit be revoked in its entirety. The following document was also filed:

E9: Handbuch, Faserverbundwerkstoffe; Neue Technologien, Neue Werkstoffe, R&G Faserverbundwerkstoffe GmbH; 3. aktualisierte Auflage 2000/2001 (pages 1 to 100)

With letter of 11 July 2012 the appellant filed further arguments and the following documents:

E9-1: Brief von Mr. Groß, der Firma R&G Faserverbundwerkstoffe GmbH
E9-2: Brief von Ms. Fesdjian, der Firma R&G Faserverbundwerkstoffe GmbH

VI. By letter dated 17 February 2012, the patent proprietor (respondent) requested that the appeal be dismissed or, alternatively, that the patent be maintained in amended form according to the auxiliary request filed therewith. With letter of 7 June 2013 the respondent filed further arguments.

VII. In a communication dated 20 May 2014 the Board set out its preliminary view of the case, *inter alia* regarding inventive step.

VIII. The respondent submitted further arguments by letter dated 20 June 2014.

IX. Oral proceedings were held on 22 July 2014 in the presence of both parties.

X. The appellant's arguments relevant for the present decision may be summarised as follows:

Main request - Inventive step

a) Starting from E3 as the closest prior art, the problem to be solved was to provide a sheet moulding method for moulded parts displaying:
- improved bending properties,
- improved macroscopic surface properties, and
- improved microscopic surface properties.

b) The solution to that problem according to claim 1 of the main request resided only in the use of an epoxy resin. The claimed ratio S_1/S_2 overlapped with the range of coverage mentioned in E3 and could not be considered as a selection within the meaning of the Case Law of the Boards of Appeal; it could therefore not be seen as a distinguishing feature over E3. A preheating step i) was already mentioned in E3. The skilled person, seeking a quick and cheap process, would apply preheating at the curing temperature of the resins, typically 140 to 160°C, as mentioned also in E9. This step could therefore not be considered to be a distinguishing feature either.

Should the heating step i) nevertheless be considered as a distinguishing feature over E3, which was contested, it was not linked to any technical effect. Heating was mentioned in E3 and the skilled reader would understand from E9 that methods involving press moulding techniques using

a prepreg were advantageously carried out at 140-160°C, typically the curing temperature of thermosetting resins. The skilled person would also preheat the mould and keep it at the same temperature, without cooling, because his aim was to provide a quick and cheap process.

c) The evidence on file did not demonstrate any improvement of the moulding's surface properties due to the use of an epoxy resin; such an effect was at most due to the known specific ratio S_1/S_2. Moreover, no effect had been shown for epoxy resins in comparison with unsaturated polyesters, which were also cited in E3. For those reasons, the claimed subject-matter was not inventive over the whole breadth of the claims.

d) E9 described fiber-reinforced thermosetting composite materials as well as heat compression moulding techniques. E9 showed that the bending stress and bending strength of epoxy resins were superior over those of vinyl esters and unsaturated polyesters. Epoxy resins showed the lowest strength reduction, and thus the highest dynamic strength upon load, which was required for the production of composite materials with good reliability and longevity. Thus, E9 contained a clear teaching of the advantages of epoxy resins so that the skilled person would have been motivated to replace the vinyl ester resins or unsaturated polyester resins mentioned in E3 with an epoxy resin in order to improve the bending properties of the resulting moulding.

e) Even though E9 mentioned that the fibers were mostly responsible for the moulding's strength,

that would not have dissuaded the skilled person from using epoxy resins in order to solve the mechanical aspect of the problem, since it was well known that the nature of the resin embedding the fibers also had an influence on the product's E-module and hence its strength. Moreover, in E3 the strongest type of fibers, namely carbon fibers, was already used, leaving no room for improvement in that respect.

f) Regarding the moulding's surface properties, E9 taught that compared to vinyl esters and in particular unsaturated polyesters, epoxy resins showed better values regarding processing shrinkage and post shrinkage, which was favourable for a high surface quality and better surface properties. It was already acknowledged in E3 that mouldings with excellent, so called "Class A" surfaces could be obtained when using resins that did not shrink upon production. The solution to the problem of improving the moulding's surface properties by using an epoxy resin instead of the vinyl esters or unsaturated polyesters disclosed in E3, was therefore also obvious in view of E9.

g) E9 provided the user with solutions to hypothetical problems that might occur while using epoxy resins for making composite materials. For press moulding processes according to the claimed subject-matter, E9 did not dissuade the skilled person from using epoxy resins.

h) For those reasons, the main request was not inventive in the light of E3 alone or in combination with E9.

Admissibility of E9, E9-1, E9-2

E9, E9-1 and E9-2 had been submitted in order to address deficiencies mentioned in the decision of the opposition division (E9) and the respondent's doubts as to the publication date of E9 (E9-1, E9-2) and should therefore be admitted to the proceedings.

XI. The respondent's arguments relevant for the present decision may be summarised as follows:

Main request - Inventive step

a) Starting from E3 as the closest prior art, the problem to be solved was to provide a sheet-moulding method for producing moulding parts displaying:
- improved bending properties,
- improved macroscopic surface properties ("appearance", as referred to in the patent in suit), and
- improved microscopic surface properties, ("no pin holes or voids" or improved "surface roughness", as referred to in the patent in suit).

b) The solution to that problem resided not only in the use of an epoxy resin but also in the selection of the ratio S_1/S_2 within the claimed range. Only a partial overlap existed between the claimed range and the range disclosed in E3. The preheating step (i) to the curing temperature of the resin was also not explicitly disclosed in E3.

c) Regarding the question whether the problem had been solved by the claimed subject-matter,

Example 52 and comparative examples 17 and 18 as well as Experimental Report II provided evidence that the moulding's surface appearance and roughness were improved with a ratio S_1/S_2 within the ambit of claim 1, if used in the context of the claimed method, in accordance with the general statement of the patent. Despite the fact that the number of layers in the moulding sheets varied, they were nevertheless comparable in view of their volume. It was essential to provide moulding sheets with similar volumes before compressing, close to the volume available in the mould, in order to allow a fair comparison between them. Therefore, if S_1 was changed, the thickness (number of layers) had to be adapted in order to achieve the same volume.

d) Experimental Report I showed that when replacing a vinyl ester resin by an epoxy resin, the actual improvements in terms of bending strength were remarkably and unexpectedly higher than what could be expected from E9. Moreover, the moulding's surface roughness was also significantly improved.

e) A comparison with unsaturated polyesters, cited in E3, was not provided since the latter were clearly inferior to vinyl esters regarding the properties relevant for the claimed subject-matter, as shown in E9.

f) Therefore, the problem as defined was effectively solved by the process according to claim 1 of the main request.

g) E3 did not concern the problem of bending properties, and its only brief reference to

surface properties could not motivate the skilled person to adopt the solution of the claimed subject-matter in order to solve the problem as defined.

h) Neither E8 nor E9 taught the use of epoxy resins for achieving the mechanical aspect of the defined problem, in particular that a remarkable improvement in bending strength could be achieved. E8 even taught away from using epoxy resins showing that an epoxy based moulding sheet had an unsatisfactory bending strength when not combined with a polyimide-based interleaf layer. E9 suggested to vary the fibres rather than the resin by stating that fibres were mainly responsible for *inter alia* the bending strength, whereas the resin contributed mainly to chemical, ageing, scratch resistance, electrical properties as well as the curing shrinkage. Even though the starting point in E3 already used the toughest fibres available, namely those made of carbon, there was still room for improvement by varying their type or arrangement in the matrix for instance.

i) E8 did not address the problem of the surface properties. E9 taught that the processing shrinkage values of vinyl ester resins were better than those of epoxy resins. Hence, considering that shrinkage affected the molding's appearance and surface properties, the skilled person would not select epoxy resins in order to solve the surface aspects of the defined problem.

j) E9 even taught away from the use of epoxy resins by informing the user that when working with such resins, pinholes could occur, which had a negative

impact on the surface properties. In addition, the solution suggested by E9 for overcoming such defects was completely different from the solution provided by the claims of the main request.

k) None of the methods disclosed in E9 proposed a preheating step, let alone at the curing temperature of the resin. On the contrary, methods involving cold curing were acknowledged in E9 as being the simplest to carry out.

l) Under these circumstances, the claimed subject-matter was not obvious over E3 alone or in combination with E9.

Admissibility of E9, E9-1, E9-2

No clear publication date could be established for E9. The decision regarding the admissibility of E9 as well as E9-1 and E9-2 was left to the Board.

XII. The appellant (opponent) requested that the decision under appeal be set aside and that European patent No. 1 566 394 be revoked in its entirety.

The respondent (patent proprietor) requested that the appeal be dismissed or alternatively that the decision under appeal be set aside and the patent be maintained in amended form on the basis of the auxiliary request filed with the letter of 17 February 2012.

XIII. The Board announced its decision at the end of the oral proceedings.

Reasons for the Decision

1. The appeal is admissible.

Main request

2. Inventive step

2.1 Closest prior art

2.1.1 The patent in suit relates to methods for producing by compression moulding and in a short time a fibre-reinforced composite material having a substantially continuous fibre as a reinforcer. The composite materials so obtained have high strength and excellent design (paragraphs [0001], [0044] and [0189]).

2.1.2 Such processes are known from E3, which both parties considered to be the closest prior art document. The Board sees no reason to depart from that view.

2.2 Problem to be solved

2.2.1 E3 discloses sheet moulding compounds (SMC) for producing fibre-reinforced thermosetting components consisting of a resin matrix which is fibre-reinforced with unidirectional (UD) fibres arranged in axial alignment and advantageously with additional cut fibres (random fibres) arranged in non-aligned manner in the resin matrix, characterised in that several layers of SMC containing unidirectional fibres, at least one layer having a different axial alignment from another layer, are arranged in the component (claim 1). The fibres may be carbon fibres (claim 3). According to E3, usual SMC resins are a vinyl ester or an unsaturated polyester (column 1, lines 10-11). Once produced

(column 4, lines 15-16 and Fig. 1), the SMC is pressed to form the final shaped product (column 4, lines 48-53 and Figure 4). These SMCs show high strength (column 1, lines 55-59) and may possess excellent surface properties (column 3, lines 56-60).

E3 further discloses that the SMC covers 60-95 % of the pressing mould (column 2, lines 33-34). In view of the passage in column 4, lines 48-52 and Fig. 4 of E3, which both relate to the pressing of the SMC to form the shaped product, the "coverage" of 60-95 % mentioned in column 2 of E3 is to be seen as meaning the ratio "S_1/S_2" according to operative claim 1. That conclusion was not contested by the parties during the oral proceedings.

2.2.2 Compared to E3 the respondent formulated the problem to be solved as to provide a sheet-moulding method for producing moulding parts displaying:
- improved bending strength
- improved macroscopic surface properties, and
- improved microscopic surface properties.

2.2.3 In respect of the subject-matter of operative claim 1, which corresponds to the fourth embodiment defined in the patent specification (paragraphs [0188]-[0195]), the patent in suit contains no explicit disclosure related to "bending strength" but only to "high strength" (paragraph [0189]). However, in the examples reference is consistently made to "bending strength " and "bending test". Since no other kind of "strength" is disclosed in the patent in suit, also in respect of the three other embodiments disclosed in the specification (see for example paragraphs [0234], [0243], [0246]), the formulation of the problem to be solved in relation to "bending strength" can be

accepted.

There is no disclosure of the terms "microscopic surface properties" and "macroscopic surface properties" in the patent in suit. It was not shown that those terms had well defined, unambiguous definitions in the art. Consequently, they cannot be used to formulate the problem to be solved. However, in paragraph [0032], surface and hence design deterioration upon compression moulding due to disturbance of the alignment of the fibres is described. Also paragraphs [0302], [0304] and [0306] mention this aspect. In paragraph [0299] it is stated that no pinholes or voids on the surfaces of the mouldings occurred and that the appearance was excellent.

Therefore, based on the patent in suit, the problem to be solved has to be formulated as providing a compression moulding method for producing moulding parts displaying improved bending strength as well as improved appearance (less deterioration of the fibers' alignment) and improved roughness (less pin holes or voids).

2.3 Solution

The solution to the problem identified above resides in the method according to claim 1. As mentioned in section 2.2.1 above, E3 describes a ratio S_1/S_2 of 0.6-0.95, which overlaps with the range of 0.8-1 now being claimed, the value of 0.95 disclosed in E3 falling within the present range. Therefore, it cannot qualify as a distinguishing feature over the teaching of E3.

E3 does not describe a step of temperature adjustment; the passage in column 1, line 32 of E3 which mentions the processing of SMC under heat, relates to background art and does not say at which point in time heating takes place. The appellant could not provide any evidence supporting the argument that a preheating step, especially at high temperature, was usual in the art, although that issue had explicitly been addressed by the Board in writing as well as during the oral proceedings. Therefore, the appellant's statement according to which a preheating step according to step (i) of operative claim 1 was implicitly disclosed in E3, cannot be followed.

It was not contested that E3 does not disclose the use of epoxy resins.

In view of the above, present claim 1 differs from E3 in the use of an epoxy resin and the step of preliminarily adjusting the temperature of the mould to the curing temperature of the thermosetting resin or higher (step (i)), neither of which is disclosed in E3.

2.4 Success of the solution - Problem effectively solved

2.4.1 In Experimental Report I, a moulding prepared by a process according to operative claim 1 is compared with a moulding prepared by the same process under the same conditions (ratio S_1/S_2 of 0.97, preheating of the mold at 140°C) using vinyl ester instead of epoxy resin.

The table on page 2 shows that the moulding obtained with vinyl ester has a strength of 65 MPa (90° bending test), whereas a moulding obtained with the epoxy resin achieved a value of 105 MPa under the same conditions.

In addition, the table at the bottom of page 3 shows that mouldings obtained with an epoxy resin have an improved surface roughness (Ra, RZ-DIN, Rmax-DIN significantly lower) compared to mouldings obtained from vinyl ester resin under the same conditions.

Therefore, the examples of Experimental Report I show that, all other things being equal, the choice of an epoxy resin leads to a moulded material having improved bending properties and improved roughness compared to material obtained from vinyl ester resin.

2.4.2 Those examples are no exact reproductions of E3, in particular the ratio S_1/S_2 of 0.97 is outside the range disclosed in E3. However, they represent an embodiment lying closer to the claimed subject-matter than the disclosure of E3, so that the advantageous effect attributable to the use of epoxy resin is in fact more clearly demonstrated (T 35/85 of 16 December 1986, not published in the OJ EPO; T 197/86, published in OJ EPO 1989, 371).

2.4.3 There is no evidence on file comparing epoxy resins with unsaturated polyesters, which are disclosed in E3 as equivalent alternatives to vinyl ester resins. However, E9 shows (second Table on page 14, Table on page 15) that vinyl ester resins exhibit superior properties compared to unsaturated polyesters in terms of bending strength and shrinkage values i.e. properties that are relevant for the problem defined above; the parties agreed that the shrinkage values provide information on the resulting moulding's surface properties, which is further confirmed by E3 (column 3, lines 55-60). In view of the above, the improvement shown in Experimental Report I for epoxy resins compared to vinyl ester resin renders it credible that

also compared to unsaturated polyesters an improvement in strength and appearance will be achieved. In the absence of any evidence to the contrary there is no reason to consider that the improvements shown in Experimental Report I would not be present over the whole breadth of the claims. Therefore, the appellant's argument in that respect cannot be followed.

2.4.4 Regarding examples 52 and comparative examples 17-18 of the patent in suit and Experimental Report II, to which the respondent referred, those examples compare the effects of values of S_1/S_2 outside and inside the range now being claimed. However, as explained in section 2.3 above, the ratio S_1/S_2 now being claimed does not constitute a distinguishing feature over E3. Since the question has to be answered which problem is effectively solved by the features distinguishing the claimed subject-matter from the closest prior art E3, any effect due to the selection of the claimed S_1/S_2 range cannot be taken into account.

2.4.5 In view of the above, the technical problem effectively solved over the closest prior art E3 by the subject-matter of operative claim 1 is seen as to provide a compression moulding method for producing moulding parts displaying improved bending strength and surface roughness.

2.5 Obviousness

2.5.1 As pointed out above (section 2.3), E3 neither discloses the use of epoxy resins nor a preheating step. The appellant has not shown that any passage of E3 would have motivated the skilled person to modify its teaching so as to use an epoxy resin and to include step (i) according to operative claim 1. Hence, E3 on

its own does not point towards the solution proposed by the claimed subject-matter.

2.5.2 The appellant's arguments against inventive step were *inter alia* based on the combination of E3 with E9.

The admission to the proceedings of E9, which was filed by the appellant with the statement of grounds of appeal, as well as E9-1 and E9-2, both filed with letter of 11 July 2011, is subject to the Board's discretion (Art. 12(4) and Art. 13(1) RPBA).

E9 was filed with the statement of grounds of the appeal, i.e. as soon as possible in the appeal procedure. In fact its admissibility to the proceedings had never been contested by the respondent. The respondent's objections rather concerned the publication date of E9, which the appellant provided by filing E9-1 and E9-2 in response. E9-1 and E9-2 credibly show that E9 belongs to the prior art according to Art. 54(2) EPC. For those reasons, E9 as well as E9-1 and E9-2 are admitted to the proceedings (Art. 12(4) and 13(1) RPBA).

2.5.3 The data given in the table on page 15 of E9 show that epoxy resins are superior to vinyl ester resins and unsaturated polyesters in terms of bending strength (unsaturated polyester resin: bending strength of 60-120 MPa; vinyl ester resins: bending strength of 125-135 MPa; epoxy resins: bending strength of 140-160 MPa). Therefore, the skilled person would expect an improvement in bending strength when moving from unsaturated polyester resins or vinyl ester resins to epoxy resins. However, the table of Experimental Report I (page 2) shows that the replacement of vinyl ester or unsaturated polyester by an epoxy resin led to

a much higher improvement in bending strength than expected on the basis of E9 (from 65 MPa for vinyl ester to 105 MPa for epoxy resin).

2.5.4 Shrinkage values provide information on the resulting moulding's appearance. E9 (second Table of page 14) discloses that epoxy resins experience a shrinkage (1-3 and <1) that is better than that of unsaturated polyesters (6-10 and up to 3), but about the same as or even worse than that of vinyl ester resins (1 and up to 1). Based on the information of E3 according to which unsaturated polyesters and vinyl esters are both advantageous, the shrinkage values given in E9 would not encourage the skilled person to select an epoxy resin in order to solve the problem defined above.

2.5.5 E9 further does not suggest to work with a mould that has been preheated and in absence of any evidence of the contrary, there is no reason to conclude that the skilled person would preheat the mould at the resin's curing temperature as required by operative claim 1. It was also not shown that said feature was usual in the art and could be considered as implicitly disclosed in any of E3 and E9.

2.5.6 E8, which was relied upon by the respondent, concerns fiber-reinforced epoxy resin prepregs comprising a polyimide based interleaf layer for composite materials with excellent mechanical strength characteristics such as interlaminar shear strength and flexural breaking strength and with high toughness (claim 1, column 2, lines 6-11). In particular, E8 teaches that epoxy resins alone are not sufficient to give sufficient bending strength, and that the presence of the polyimide interleaf is necessary in order to achieve satisfactory results (Examples 1-4 versus Comparative

Example 1; Table 1). The problem of appearance is not addressed in E8.

Therefore, E8 would not have motivated the skilled person to use an epoxy resin as a thermoset resin in a process according to E3, nor to adjust the temperature of the mould to at least the curing temperature of the resin in order to solve the problems defined above.

2.6 Under these circumstances, in view of the teachings of E9 and E8, there is no reason why the skilled person would have modified the teaching of E3 by selecting an epoxy resin and adjusting the temperature of the mould at the curing temperature of the resin so as to arrive at the subject-matter of operative claim 1.

2.7 In view of the above, claim 1 of the main request fulfils the requirements of Art. 56 EPC. Since claims 2-7 are dependent on claim 1, those, too, fulfil the requirements of Art. 56 EPC.

3. The main request being inventive, there is no need to deal with the auxiliary request.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

I. Aperribay B. ter Laan

Decision electronically authenticated