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D E C I S I O N
of 5 October 2004

Case Number: T 0627/02 - 3.2.6

Application Number: 95119745.8

Publication Number: 0713934

IPC: D03D 15/00

Language of the proceedings: EN

Title of invention:
Fiber-resin composition

Patentee:
Toray Industries, Inc.

Opponent:
Tenax Fibers GmbH & Co. KG

Headword:
-

Relevant legal provisions:
EPC Art. 100(a), 100(b)

Keyword:
"Sufficiency of disclosure (yes)"
"Novelty (yes)"
"Inventive step (yes)"

Decisions cited:
-

Catchword:
-

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Case Number: T 0627/02 - 3.2.6

D E C I S I O N
of the Technical Board of Appeal 3.2.6
of 5 October 2004

Appellant: (Opponent)
Tenax Fibers GmbH & Co. KG
Kasinostraße 19 - 21
D-42103 Wuppertal (DE)

Representative:
Muth, Arno, Dipl.-Ing.
CPW GmbH
Kasinostraße 19 - 21
D-42103 Wuppertal (DE)

Respondent: (Proprietor of the patent)
Toray Industries, Inc.
2 - 1, Nihonbashi Muromachi 2-chome
Chuo-ku
Tokyo 103 - 8666 (JP)

Representative:
Weber, Joachim, Dr.
Hoefer & Partner
Patentanwälte
Gabriel-Max-Straße 29
D-81545 München (DE)

Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted 15 April 2002 rejecting the opposition filed against European patent No. 0713934 pursuant to Article 102(2) EPC.**

Composition of the Board:

Chairman: P. Alting van Geusau
Members: G. L. De Crignis
J. H. van Moer

Summary of Facts and Submissions

I. The mention of the grant of European patent No. 0 713 934 in respect of European patent application No. 95 119 745.8, which had been filed on 8 September 1993 claiming two JP priorities of 8 September 1992 (JP 23922492) and of 5 April 1993 (JP 7796793) respectively, was published on 12 April 2000 on the basis of 11 claims.

Claim 1 read as follows:

"A fiber-resin composition which comprises a carbon fiber woven fabric having a flat carbon fiber yarn consisting of many carbon fibers as at least its warp (T_{wr}) or weft (T_{wf}),
said flat carbon fiber yarn being twist-free and the number of carbon fibers thereof being 6,000 to 36,000, the yarn size from 3,000 to 30,000 deniers, the yarn width from 4 to 16 mm, the yarn thickness from 0.07 to 0.6 mm, and the ratio of yarn width to yarn thickness from 20 to 150, and
said carbon fiber woven fabric using said flat carbon fiber yarn has a ratio of the weaving yarn pitch between the warps and between the wefts to said yarn width ranging from 1.0 to 1.2, a fabric thickness ranging from 0.1 to 0.6 mm, a weight of woven fabric ranging from 90 to 500 g/m², and a fiber density of woven fabric ranging from 0.8 to 1.2 g/cm³,
wherein said fiber-resin composition is infiltrated with a matrix resin of 30 to 67 percentage by weight."

Claim 6 read as follows:

"A fiber-resin composition which comprises a carbon fiber woven fabric having a flat carbon fiber yarn consisting of many carbon fibers as at least its warp (T_{wr}) or weft (T_{wf}),
wherein said flat carbon fiber yarn is twist-free and consists of a plurality of layers of flat, unit carbon fiber yarn, the number of the carbon fibers of the unit carbon fiber yarn ranging from 3,000 to 12,000, a yarn size ranging from 1,500 to 10,000 deniers, a yarn width ranging from 4 to 16 mm, a yarn thickness ranging from 0.07 to 0.2 mm, and a ratio of yarn width to yarn thickness from 30 to 150, and
said carbon fiber woven fabric has a ratio of the weaving yarn pitch to the yarn width ranging form 1.0 to 1.2, a woven fabric thickness ranging from 0.2 to 0.6 mm, a weight of woven fabric ranging from 200 to 500 g/m², and a fiber density of woven fabric ranging from 0.8 to 1.2 g/cm³,
wherein said fiber-resin composition is infiltrated with a matrix resin of 30 to 67 percentage by weight."

Claims 2 to 5 and 7 to 11 were dependent claims.

II. Notice of opposition requesting revocation of the patent in its entirety on the grounds of Article 100(a) and (b) EPC was filed by the appellant (opponent) on 8 January 2001.

The opposition was, *inter alia*, supported by the following documents of which D1 to D7 related to an alleged prior use:

D1 Brochure "Quadrax, The New Wave In Advanced Composites"
D2 Information folder of Quadrax, "Let Your Imagination Run Wide", 1988
D3 Information folder of Quadrax, 1988
D4 Information folder of Quadrax Biaxial Tape
D5 Letter of the Air Force, dated 13 December 1989, and annexed thereto an excerpt of a presentation related to Quadrax Biaxial Tape held from 1 to 4 August 1989 in Bejing, China at the 7th International Conference on Composite Materials.
D6 Letter of Quadrax to Akzo, dated 24 April 1989, confirming that there was a joint AKZO/Quadrax conformability test program
D7 Data sheet "EP 0 713 934 versus Quadrax Samples"
D8 WO-A-94/12708
D10 US-A-4 320 160
D11 EP-A-0 302 449
D13 WO-A-89/05229

III. By its decision issued in writing on 15 April 2002, the opposition division rejected the opposition.

The opposition division held that because the patent disclosed the mechanism by which the shape and dimension of the yarn were controlled the skilled person was able to control the shape and dimensions of the final fabric so as to arrive at the claimed product. Therefore, the invention was disclosed sufficiently clearly and completely to be carried out.

The subject-matter of claims 1 and 6 was novel over the Quadrax Biaxial Tape (QBT) being the subject of the alleged prior use (D1 - D7 and related D13) since the documents in support of the prior use did not show a fiber-resin composition where the fabric was infiltrated with the specified percentage of matrix resin.

The subject-matter of claims 1 and 6 was also novel over D8 (relevant under Article 54(3) and (4) EPC for DE, GB and IT) since this document likewise lacked the feature of a carbon fiber fabric being infiltrated with matrix resin of 30 - 67 percentage of weight.

The compositions in accordance with claims 1 and 6 involved an inventive step. The problem to be solved starting from the QBT (D1 to D7, D13) was to avoid air voids in a fiber reinforced plastic. The documents relating to QBT disclosed that it was disadvantageous to impregnate a composition as a whole. The use of QBT could thus not render the solution as claimed obvious. The problem to be solved starting from D10 was flattening the fibre yarns which according to the opponent was suggested by D11. However, the method of D11 was intended for flattening carbon fiber yarns which themselves were interlaced to form the weft and the warp. The fabric of D10 was not related to such fabric and disclosed the use of auxiliary filamentary yarns in the composites. Therefore, a combination of D10 and D11 would not have been taken into consideration by the skilled person.
D12 another prior art document relied upon by the opponent in combination with D11, was concerned with

respect to the resistance to lateral expansion. The solution suggested in D12 concerned the use of individual filaments of the yarn bundles that were decollimated and commingled with numerous cross-over points in order to resist lateral expansion. Thus, D12 was considered to teach the opposite of the invention and thus could not be regarded as an appropriate starting point, accordingly also a combination with D11 would not have been taken into consideration by the skilled person.

IV. On 11. June 2002 the appellant (opponent) lodged an appeal against the above decision and paid the prescribed fee simultaneously. The statement of Grounds of Appeal was filed on 2. August 2002.

V. In reply to the summons for oral proceedings, the appellant submitted with letter of 3 September 2004 further documents:

D15 Certificate by Prof. Dr.-Ing. Axel S. Herrmann
D16 DIN Norm WL 8.3509
D17 DIN Norm WL 8.3515

VI. Oral proceedings were held on 5 October 2004. The appellant (opponent) requested that the decision under appeal be set aside and that the patent be revoked. The respondent (patent proprietor) requested to dismiss the appeal.

VII. The arguments of the appellant can be summarized as follows:

There was no disclosure which enabled the skilled person to perform the invention over the whole range claimed. Once the yarns in the finished fabric should be narrower and once be broader than the initial yarns without any technical instruction how to obtain such results. The examples related to small yarn sizes (3,600 d to 14,400 d) and did not form a sufficient basis for disclosure in respect of compositions which used carbon fiber yarn with a large yarn size (paragraphs 0007 to 0009 of the patent in suit), because large yarn sizes could not be treated with the apparatus described, particularly the combs, as shown in figure 1. Furthermore, the disclosed examples related only to thermosetting resins whereas according to claims 8 and 9 also thermoplastic resin should be within the scope of claims 1 and 6. Hence, in addition to a lack of disclosure in respect of manipulating the yarn width the skilled person also did not know how to proceed in case thermoplastic resins were used for impregnating the fabric.

D8 explicitly disclosed all features of the subject-matter of claim 1 with the exception of the infiltration with a matrix resin of 30 to 67 percentage by weight. However, this feature was contained implicitly. The certificate of Prof. Hermann (D15) explained that such a percentage of matrix resin was within the range which would be applied for fiber-resin compositions based on carbon fibre fabrics.

But also the QBT composite being the subject of the prior use complex D1 to D7 in combination with D13 disclosed all features of claim 1 of the patent in suit. Two samples of QBT composite material were present in the EPO in related proceedings. These two samples were the only available original samples and they should be taken into account. In fact D7 referred to values obtained by analyzing these two samples and showed that the values of the parameters of sample 1 complied with the values required according to claim 1. Hence, the subject-matter of claim 1 was known from sample 1 of QBT according to D7. That the QBT composite was publicly available before the priority date was proven by D2 and D3, which showed a date of 1988. D5 and D6 had been provided in support of the general public availability of QBT. Therefore, the prior use of QBT composite was proven.

As regards inventive step, the problem addressed in the patent in suit concerned improving the cover factor in order to avoid gaps in the finished composition. This general problem, however, was already solved by the prior art. D10 which was cited in the patent in suit as closest prior art referred to the use of auxiliary filamentary yarns. Since such auxiliary filamentary yarns were disadvantageous according to the problem of the patent in suit, D11 not having such auxiliary yarns was a more appropriate starting point and thus constituted the closest prior art for defining the underlying problem to be solved. D11 was concerned with the void ratio (page 4, lines 24 - 30) and with the reduction of open spaces (example 1). There would be no prejudice to use the vibrating roll disclosed in D11 in related manufacturing processes - also for higher

filament numbers as disclosed in D11 - and the vibration would lead to flat composites. D11 indicated to the skilled person that auxiliary yarns as used in D10 were not necessary but that vibration could influence the reduction of open spaces. The remaining ratios and parameter specified in claim 1 could not add an inventive step. The certificate of Prof. Herrmann (D15) showed that the percentage of matrix resin would in fact be the usual range and could not add an inventive step either.

VIII. The proprietor argued essentially as follows:

The skilled person was well aware of measures to influence the weaving conditions (tension, design of the combs and technical equipment of the weaving apparatus) which were appropriate for treating carbon fibers with up to 36,000 filaments and with a yarn size of up to 30,000 deniers. The patent in suit disclosed eight examples and eight comparison examples which provided the skilled person with sufficient information how to proceed and arrive at the claimed product.

The late filed certificate of Prof. Dr.-Ing. A. S. Herrmann (D15) and the DIN norms (D16 and D17) should not be admitted to be introduced into the proceedings, since they were filed at a very late stage and were not relevant.

Regarding novelty, none of the cited documents disclosed all the features of the claimed compositions. In particular, a fiber-resin composition being infiltrated with a matrix resin of 30 to 67 percentage by weight was disclosed neither explicitly nor

implicitly in any of the documents. With respect to the QBT sample 1 (D7), evidence was missing that the results presented in D7 were obtained on a publicly available fiber-resin composition.

As regards inventive step, none of the cited documents suggested to use a carbon fiber woven fabric with the values specified in claims 1 and 6 of the patent in suit. No conclusions concerning the problem of providing an appropriate cover factor could be drawn from the information present in any of the documents. Therefore, the claimed subject-matter was not obvious.

Reasons for the Decision

1. The appeal is admissible.

2. *Insufficiency (Article 100(b) EPC)*

In so far as the flatness of the yarns and its change in cross-section during weaving are concerned the board follows the opposition division's opinion that the patent discloses in a sufficient manner how it influences such a change of size and shape.
It is true that in the examples disclosed in the patent in suit only flat carbon fiber yarns having up to 24,000 carbon fibres and a yarn size up to 14,400 denier are mentioned whereas the maximum values claimed are 36,000 and 30,000 d, respectively. However, it is the opponent that has the burden of proof to show that the claimed range is so broad that the invention cannot be carried out over the whole range claimed. A mere allegation in this respect is not a valid reason to

make a finding of insufficiency in respect of Article 100(b) EPC.

In the examples only thermosetting resins such as epoxy resin and vinyl ester resin are used. However, the use of a number of other known resins does not give rise to particular difficulties when infiltrating or impregnating a fiber fabric. The skilled person in the art of fiber resin composites must therefore be considered competent to use and apply either thermosetting, thermoplastic or any other suitable resin.

Therefore, since the disclosure of the patent in suit is sufficient in the sense of Article 83 EPC, the ground of opposition under Article 100(b) EPC does not prejudice the maintenance of the patent.

3. *Late filed documents*

D15 is a certificate of an expert in fiber composites with experience in carbon fiber reinforced composites. The expert is of the view that with an infiltration below 30 percent by weight no complete impregnation is possible and more than 50 percent by weight results in insufficiency of reinforcing fibers. Therefore, the expert came to the conclusion that carbon fibre woven fabrics have to be impregnated or infiltrated with 34 to 47% by weight of matrix resin in dependency of the applied manufacturing method. D16 and D17 were supplementing D15. The Board decided to admit D15 to D17 into the proceedings since they were filed in response to the question of the infiltration raised in

the communication of the board and they are relevant with respect to this issue.

4. *Novelty*

4.1 Article 54(3) and (4) EPC

D8 constitutes prior art under Article 54(3) and (4) EPC as far as the designated European countries DE, GB, IT are concerned. Since the subject-matter of granted claim 1 was only present in the second priority document, only the second priority date of 5 April 1993 is valid.

D8 refers to a woven fabric based on multifilament yarn. The fabric is intended for use in composite materials. "Tissu Nr. 3" in table 3 had a fiber volume ratio of 54% (table 3, D8) and was manufactured by additionally using vibration. However, D8 only discloses fabrics and no fiber-resin compositions. The reference of the appellant to the introductory sentences relating to textile structures provided for composite materials (D8: page 1, lines 5 - 12) and the background statement that such materials comprise a textile support and a resin matrix (D8: page 1, lines 13 - 17) disclose the intended use but fail to give support to any specific resin composition. The same applies for the appellant's reference to page 23, lines 9 to 11 of D8. Also, this passage leads to the conclusion that D8 does not disclose a fiber-resin composition itself but only a fabric which is prepared and designed for such a fiber-resin composition. There is thus no clear and unambiguous disclosure in D8 for a fiber-resin

composition as claimed in the patent in suit. Therefore, the subject-matter of claims 1 and 6 is novel.

4.2 Article 54(1) and (2) EPC

D1-D7 and D13 were cited in support of an alleged prior use of the QBT which constitutes a fiber-resin composite composed of pre-impregnated unidirectional tapes.

Considering the QBT being the subject of the alleged prior use it is to be noted that D1 to D6 and D13 do not specify any of the specific values claimed in claim 1 of the patent in suit.

D13 had been introduced as being the patent application relating to QBT and its manufacturing method. D13 relates to a fabric having yarns which are impregnated before interlacement but no mention is made of QBT nor is there a direct link between D13 and documents D1 to D7. Hence, none of documents D1 to D6 and D13 relates to the specific characteristics set out in claim 1 of the patent in suit.

The only document which provides data relevant with respect to the subject-matter of claim 1 is D7. D7 specifies values allegedly arrived at by analyzing two samples of QBT. However, there is no link in D7 identifying the samples with respect to any of the other documents D1 to D6 or D13. The analyzed QBT samples themselves were not available in the present proceedings and only during the oral proceedings before the Board the appellant submitted that the samples were present in another patent case in the EPO. Indeed, D7

represents an analysis of *inter alia* "sample 1" of QBT whose structural characteristics and parametrical values are within the ranges claimed in the patent in suit. Because of the lacking evidence as to the other requirements for substantiating a public prior use (when and how the information of D7 became publicly available), the information given in D7 is in itself not sufficient to decide a public prior use of the QBT sample described therein.

5. *Inventive step Article 56 EPC*

5.1 Problem and solution

The subject-matter of the patent in suit concerns a carbon fibre-resin composition. Claim 1 specifies for the carbon fiber yarns size, width and thickness, for the fabric thickness, weight and fiber density as well as the ratio of yarn pitch and for the woven fabric the percentage of resin infiltration. Such carbon fibre-resin compositions have to ensure high strength characteristics within a thin, flat structure.

The technical problem underlying the patent in suit may thus be seen in the provision of a fiber-resin composition which is more suitable for high strength applications (see page 3, lines 35, 36 of the patent in suit).

According to the patent in suit the problem is solved by the combination of features of claim 1, or, alternatively claim 6. The examples 1 to 8 in the patent specification demonstrate that the values for tensile strength are improved, the surface smoothness

is good and the void rate low for the examples in comparison to the comparative examples (table 4 and 5). Therefore, the Board concludes that the above-defined technical problem is effectively solved by the fiber-resin composition according to claim 1 or 6.

D11 is considered as closest prior art and as appropriate starting point for evaluating whether the subject-matter claimed involves an inventive step. D11 is concerned with the reduction of open spaces in carbon fiber woven fabrics after the fabric is woven. The solution according to D11 is to pass the woven fabric under pressure between a pair of rolls at least one of which vibrates in the axial direction thereof (figure 2). The problem to be solved is thus a similar to that in the patent in suit. However, the solution is different. D11 solves the problem by using a different manufacturing tool, namely the vibration roll.

D10 discloses a different solution to a related problem namely to provide high strength and high elasticity with a reinforcing fibrous structure. D10 refers to a fabric structure comprising two yarn groups which are integrated with each other by auxiliary filamentary yarns. However, in D10 the surfaces of the fiber reinforced structure become uneven, and since there remain gaps between the reinforcing filamentary yarns and the yarn groups, high strength cannot be achieved. The essence of the disclosure of D10 are the use of auxiliary filamentary yarns.

It follows that D11 either considered in isolation or in combination with D10 cannot be of any guidance for the solution of the technical problem in the manner as claimed in the patent in suit.

In contrast thereto, the inventive concept of the patent in suit is to design the fiber-resin composition from the beginning:

(a) designing the carbon fibre woven fabric in choosing the carbon fiber yarns and their characteristics and ratio in advance (a yarn width of 4 to 16 mm and a ratio of yarn width to yarn thickness of 20 to 150)

(b) weaving such carbon fiber woven fabrics with the specified characteristics (a ratio of weaving yarn pitch to yarn width of 1.0 to 1.2) which should be consistent with a fabric thickness of 0.1 to 0.6 mm, a weight of the woven fabric of 90 to 500 g/m^2, and a fiber density of 0.8 to 1.2 g/cm^3, (§ 0086 of the patent in suit) and

(c) infiltrating the woven fabric with a specified amount of matrix resin to arrive at the finished composite.

In D11 there is no teaching at all about the parameters and ratios likely to reduce the existence of gaps, thus there is no incentive to consider a specific combination of undisclosed characteristics of the carbon fibers or woven fabrics.

Also in none of the other cited documents is the ratio of yarn width to yarn thickness or the ratio of the weaving yarn pitch between the warps and between the wefts to the yarn width to be found. Hence, there is also no suggestion in any available document as to how these ratios could be related to the smoothness and open gaps of the finished composites. Therefore, neither of these documents nor their combination would lead without an inventive step to the subject-matter of claims 1 or 6.

5.2 For the above reasons, the Board comes to the conclusion that none of the documents relied upon by the opponent would render obvious the claimed subject-matter, whether considered in isolation or in combination, and that, as a consequence, the subject-matter of claim 1 involves an inventive step.

As Claims 1 and 6 of the main request are both allowable, the same applies for dependent claims 2 to 5 and 7 to 11.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

M. Patin P. Alting van Geusau