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

Case Number: T 0486/92 - 3.3.3

Application Number: 85302685.4

Publication Number: 0168131

IPC: C08J 5/06

Language of the proceedings: EN

Title of invention:
Method for adhering of aromatic polyamide fibers to rubber

Patentee:
Bridgestone Corporation

Opponent:
HOECHST Aktiengesellschaft Zentrale Patentabteilung

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (denied)"
"Application of customary treatment"
"Solution of stated problem a matter of course"

Decisions cited:
T 0021/81

Catchword:
-

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Case Number: T 0486/92 - 3.3.3

D E C I S I O N
of the Technical Board of Appeal 3.3.3
of 4 April 1995

Appellant: (Opponent)
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Representative: -

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Decision under appeal: Decision of the Opposition Division of the European Patent Office dated 23 March 1992 rejecting the opposition filed against European patent No. 0 168 131 pursuant to Article 102(2) EPC.

Composition of the Board:

Chairman: C. Gérardin
Members: R. Young
M. K. S. Aúz Castro

Summary of Facts and Submissions

I. The grant of European patent No. 0 168 131, with eleven claims, in respect of European patent application No. 85 302 685.4, filed on 17 April 1985 and claiming JP priorities of 25 May 1984 (JP 104 671/84) and 12 December 1984 (JP 260 891/84) was announced on 12 July 1989 (cf. Bulletin 89/28). Claim 1 reads as follows:

"Method for adhering of aromatic polyamide fibers to rubber characterized by treating said fibers in an environment of low temperature plasma gas under a reduced pressure, impregnating said fibers with an adhesive comprising a precondensate of a phenol with an aldehyde and a rubber latex, heating said fibers impregnated with said adhesive, fixing said fibers onto unvulcanized rubber, and heating with pressing said two together for vulcanization and adhesion."

Claims 2 to 11 are directed to elaborations of the method of Claim 1.

II. Notice of Opposition was filed on 30 March 1990 on the grounds of lack of novelty and inventive step. The Opposition was supported inter alia by the documents:

D1: US-A-3 853 657;
D2: Ullmanns Encyklopädie der technischen Chemie, 4th Edition, Vol. 13 (1977), pages 662-663;
D3: CA-A-1 122 566; and
D4: EP-A-0 006 275.

III. By a decision dated 23 March 1992 the Opposition Division rejected the opposition.

According to the decision, novelty was given in that the difference compared with D1, which was the closest state of the art, lay in the type of fibres, since D1 was directed to polyester fibres and not to aramid (aromatic polyamide) fibres. A combination with D3, which (like D4) disclosed the treatment of aramid fibres in low temperature plasma under reduced pressure would imply that the properties of polyester fibres and aramid fibres were the same, which they were not, and would not lead to the invention, because D3 did not disclose the adhesive of the disputed patent. The epoxy adhesive disclosed in D4 would result in an unsatisfactory bond under dynamic conditions.

IV. On 23 May 1992, a Notice of Appeal was filed against the above decision and the prescribed fee paid on the same day.

In the Statement of Grounds of Appeal, filed on 14 July 1992, the Appellant (Opponent) argued substantially as follows:

(i) The teaching of D4 was not limited to the use of an epoxy adhesive, but was also concerned with improving the adhesion between aramid fibres and rubbers, in the latter case via one or more interlayers. It was generally known, however, that the bond between fibres and rubber was routinely improved with a resorcinol-formaldehyde latex (RFL), as was illustrated, under "RFL Präparationen", in D2. Consequently, Claim 1 lacked novelty.

(ii) In the event that novelty were recognised, the technical problem was that of bonding aromatic polyamide fibres firmly to rubber without excessive embrittlement and consequent deficient

flexibility and fatigue resistance of the fibre cord occurring. The references to reinforcing rubbers and the production of tyres in D4 showed clearly that the flexibility and fatigue resistance were not adversely affected by the plasma treatment. Thus the difference between the solutions proposed by D4 and the patent in suit could not be regarded as inventive.

V. The Respondent (Patentee) on the other hand, argued in essence:

(i) The thrust of D4 was rigid structural reinforcement, where dynamic strength was not important, as could be seen from the reference to the fibre stiffness obtained. The skilled person reading the reference to intermediate layers in D4 would look at the examples to find out what they were. Only epoxy resins were disclosed. Such layers for other applications would not necessarily be appropriate. Consequently, Claim 1 was novel.

(ii) The technical problem which the patent in suit addressed was the poor bonding of aromatic polyamide fibres to rubber under **dynamic conditions** as encountered with tyres in use. It was essential for tyres to exhibit good dynamic durability as shown in Example 4 of the patent in suit. None of the citations identified this problem. Use of the adhesive exemplified in D4 would not lead to a solution of the technical problem.

(iii) D1 only provided tests for static adhesion. Furthermore, other adhesives than RFL could be used. D3 did not disclose the adhesive which in combination with the plasma treatment provided a superior bond under dynamic conditions.

Consequently, neither a combination of D1 with D3 nor with D4 would lead to the claimed subject-matter.

VI. Oral proceedings were appointed in accordance with the auxiliary requests of both parties. Shortly before the appointed date of 4 April 1995, however, the Respondent informed the Office, with a telefax dated 31 March 1995, that its request for oral proceedings was withdrawn, and that it would not, in any case, be attending the oral proceedings.

Oral proceedings were thus held in the absence of the Respondent. During the oral proceedings, the Appellant in essence repeated the arguments already submitted in writing.

VII. The Appellant requested that the decision under appeal be set aside and the patent be revoked in its entirety.

By telefax of 20 January 1993, the Respondent had implicitly requested that the appeal be dismissed.

Reasons for the Decision

1. The appeal is admissible.

2. The patent in suit is concerned with improving the adhesion of aramid fibres to rubber, especially when used under dynamic conditions as a reinforcement in tyres.

2.1 Such a process is, however, acknowledged in the patent in suit as having previously been proposed by Du Pont. The known process is said to be a two-step bonding method, according to which firstly an undercoating agent is applied, after which the widely used adhesive comprising RFL (resorcinol-formaldehyde latex) is applied for bonding aromatic polyamide fibres with rubber. The undercoating formulation comprises an epoxy compound, specifically the diglycidyl ether of glycerol (cf. page 2, lines 27 to 44). According to a preferred embodiment of this prior art, a multifilament cord of poly-p-phenylene terephthalamide is treated according to this two-step method and after each impregnation the cord is heated at 240°C for 60 seconds. It is then contacted with unvulcanised rubber and the combination is bonded by vulcanisation at 160°C for 20 min. (cf. page 12, Referential Example).

Although this process has not been identified by reference to a specific document, the Board is prepared to accept, in line with the terms of the acknowledgement itself and the submission of the Appellant at the oral proceedings, that such a process does indeed belong to the state of the art in the sense of Article 54(2) EPC. This is considered by the Board to represent the closest state of the art.

2.2 Compared with this state of the art, the technical problem is to be seen in the improvement of the bonding of aramid fibres to rubber under dynamic conditions as encountered with tyres in use, in particular in terms of reduced fibre embrittlement and fatigue.

2.3 The solution proposed according to Claim 1 of the patent in suit is to treat the fibres in an environment of low temperature plasma gas under a reduced pressure before impregnating the fibres with RFL adhesive.

2.3.1 According to the uncontested results of a tyre dynamic durability comparison test, filed during the examination proceedings (cf. submission dated 15 March 1988), the adhesion after a high speed drum test was 109% compared with 94% for the two-bath treatment, and after a high loading drum test was 105% compared with 97% for the two-bath treatment.

2.3.2 Furthermore, it can be seen from the information in the examples of the patent in suit that both initial Adhesion Against Peeling (Example 5, Table 5) and % Strength Holding Rate after 500 000 cycles of flex fatigue (Example 8, Table 8) are considerably improved with the treatment according to Claim 1, as compared with the two-bath treatment (Referential Example).

2.3.3 The allegation of the Appellant, at the oral proceedings, that Comparative Experiment 1 in Example 4 gave better results, in terms of Strength Holding Rates, than the corresponding illustrative Experiments 10 to 26 is inconclusive, since it is not stated in this particular example in what respect the comparison differed.

2.3.4 In any event, in the light of the uncontested evidence referred to above, the Board is prepared to accept that an improvement in the adhesion behaviour under dynamic conditions is obtained with the plasma pretreatment of the patent in suit, compared with the two-bath process.

Consequently, it is plausible that the proposed measures provide an effective solution of the stated problem.

3. *Novelty*

3.1 The allegation of lack of novelty is limited to the disclosure of D4 read in the light of general knowledge as represented by D2 (cf. section IV. (i), above).

3.1.1 According to D4, the adherence properties of aromatic polyamide fibres are improved by drawing the fibres through an area, which is preferably air cooled, wherein a reduced pressure is maintained and wherein a plasma is generated by means of a high frequency field caused by a solenoid placed around the area (Claim 1; page 8). The fibre may be used in a plastic or rubber matrix (Claim 3).

3.1.2 In particular, the adherence of the aromatic polyamides, via one or more interlayers, with rubbers is considerably improved, while the other properties are hardly influenced (page 6, lines 14 to 24). Construction materials containing the treated fibres can be used in areas where low density and resistance against corrosion are important, namely in air and space uses, sport articles, ultracentrifuges, fly wheels and for the weaponing (reinforcing) of motor tyres (page 7, lines 7 to 13).

3.1.3 According to the examples, the interlaminar shear strength after plasma treatment is indicated as a measure for the adherence of aromatic polyamide fibre to epoxy resins (pages 9, 10; Tables A and B).

There is thus no explicit disclosure in D4 of the use of RFL adhesive for bonding the plasma-treated aramid fibres to rubber.

3.2 According to D2, a standard work of reference, for trouble-free use and long life of textile-reinforced rubber articles, the use of special adhesives is necessary when the filament yarns are present as synthetic fibres, which have little or no anchoring capability (page 662, right-hand col., last para.). RFL adhesives have been in use for this purpose since 1935. Whereas good adhesion can be obtained with certain types of fibres, e.g. rayon and nylon, polyester fibres present problems requiring special measures (page 663, left-hand column, first and last paras.). In this connection, there is disclosed a two-bath impregnation process, rather similar to that acknowledged in the patent in suit, for improving the adhesion of polyester fibres to rubber. In this process, which is also applied to aramid fibres, the first bath contains inter alia a polyepoxide, the second bath being a RFL adhesive. Furthermore, a one-bath version, in which the RFL is supplemented by further adhesion-improving additives has been developed (page 663, right-hand column, first two paras.).

It is thus evident that, in embedding aramid fibres in rubber, it is necessary to interpose one or more adhesive materials between the fibres and the rubber. Furthermore, this is conventionally done using a one-bath or two-bath impregnation of the fibres utilising RFL.

3.3 The skilled person would therefore understand, in the context of this general knowledge, that the phrase "via one or more interlayers" in D4 referred to layers of the necessarily applied adhesive. The argument of the Appellant, that this was also an implicit disclosure of RFL is not, however, convincing for the following reasons.

3.3.1 Firstly, there is no evidence of a direct link, e.g in the form of a cross-reference in or to D4, which would permit the two documents to be read as a single disclosure.

3.3.2 Secondly, although RFL is prominently disclosed in D2 for embedding synthetic fibres in general, and aramid fibres in particular, in rubbers, and although the fact of its use since 1935 points to its being a customary treatment of long-established preference, it is nevertheless not the only adhesive known in the art for this purpose. There is consequently no reason for concluding that it would be the inevitable choice of the skilled reader of an independent document such as D4.

Hence, there is no direct and unambiguous disclosure of the use of RFL in D4.

3.4 None of the other documents cited in the proceedings was alleged to disclose the combination of features forming the solution of the technical problem. The Board sees no reason to take a different view.

Consequently subject-matter claimed in the patent in suit is considered to be novel.

4. *Inventive step*

It is necessary to determine whether the skilled person would have expected to obtain better adhesion, under dynamic conditions of use, of the bond to rubber of aramid fibres than that obtainable in the two-bath process, by treating the fibres, before the application of the RFL adhesive, with a low pressure cold plasma gas.

4.1 Although the prior art documents do not explicitly consider dynamic conditions as encountered with tyres in use, this particular aspect, which has been accepted by the Board, following the Respondent's approach, for the definition of the technical problem underlying the patent in suit, does not represent a substantial difference, for the following reasons.

4.1.1 On the one hand, D1 discloses the application of a cold plasma treatment to polyester fibres followed by a RFL impregnation for the improvement of adhesion of polyester tyre cords embedded in the rubber (Claim 1); the information given in the examples concerns only the initial static adhesion of such tyre cords to the rubber. On the other hand, D3 and D4 describe a method of improving the surface properties, in particular of adhesion, of aramid fibres and their suitability for the manufacture of high-performance tyres (cf. D3, Claim 1 and page 1, lines 3 to 20, and D4, Claim 1, page 7, lines 7 to 13, respectively).

4.1.2 In the Board's view, the effects of initial static adhesion (as disclosed, for instance, in D1) and adhesion under dynamic conditions of use (with which the patent in suit is concerned) are intimately connected, and indeed have a common root, since the latter is essentially a measure of the retention, over

a period of time and under specific conditions of use, of the former. The general references to adhesion properties in D3 and D4, which relate inter alia to motor tyre applications are, moreover, broad enough to cover both categories.

4.1.3 The argument of the Respondent, that D4 is principally concerned with rigid structural reinforcement is not convincing, because of the clear references to aerospace applications, especially wheels and tyres, which are clearly subjected to dynamic flexing stresses in normal use. The reference to fibre "stiffness" in D4 in this connection (cf. page 6, lines 20 to 23) is made in relation to elasticity modulus and is therefore not inconsistent with the requirement for "flexibility" (i.e. a capability of flexing in use) in the patent in suit (cf. page 2, lines 18 to 22 and 45 to 48).

It follows that the relevant improvements promised by D3 and D4 would be expected to occur in an area (tyres) where dynamic conditions of use were inevitable, and where they would be obtained in the normal use of such a product.

4.1.4 Furthermore, D4 associates the promised improvement with an aromatic polyamide fibre to which adhesive has been applied to form "one or more interlayers" (cf. "Novelty", sections 3.2, last sentence, and 3.3, above).

Consequently, although not explicitly giving a comparison with the two-bath process forming the closest state of the art, the "considerably improved adherence" promised by D4 evidently relates to aramid fibres which have been pretreated with adhesive for the same purpose.

4.1.5 In summary, D4 evidently holds the prospect of a solution of all the aspects of the stated problem. This, in the Board's view, would be a sufficient incentive for the skilled person to utilise its teaching to improve the closest state of the art.

4.2 It is necessary, consequently, to consider the sequence of steps involved in utilising such a teaching.

4.2.1 The first step would be, of course, to apply the preferred cooled, reduced pressure plasma treatment to aramid fibres as taught in D4 (cf. section 3.1.1, above).

4.2.2 The subsequent bonding of the pretreated fibres to rubber would, in the Board's view, be carried out by the skilled person in the light of the general technical knowledge available at the time, which, for the present purposes is represented by the standard reference work D2.

4.2.2.1 Whilst it is true that RFL is not the inevitable choice of adhesive for this purpose, nevertheless it would, for the reasons given in section 3.3.2, above, be the most likely first choice of the skilled person. This, following the conventional procedure of applying RFL in a one- or two-bath impregnation process would result in one or more interlayers of RFL.

4.2.2.2 The argument of the Respondent that the skilled person would look at the examples of D4 to determine which interlayer to use and thus choose an epoxy resin (instead of RFL) is not convincing because the epoxy resins are presented in D4 as independent embodiments of a matrix material and not as an adhesive material for rubber (page 7, lines 1 to 3).

4.2.2.3 Even if the skilled person were nevertheless to use an epoxy adhesive when applying the teaching of D4 to rubbers, this would in any case logically not be instead of, but in addition to, an RFL adhesive, since this is what is taught in D2 as being the customary procedure (cf. section 3.3.2, above). The resulting sequence of steps would result in interlayers of epoxy and RFL.

4.2.2.4 In this connection, there is no restriction in Claim 1 of the patent in suit, either as to the number of treatment steps or as to the number of components in the adhesive, the latter only being stated to "comprise" a precondensate of a phenol with an aldehyde and a rubber latex.

4.2.2.5 Consequently, such a sequence of steps corresponds to a solution of the stated problem (cf. section 2.3, above) and, whether involving interlayers of RFL alone or interlayers of both epoxy and RFL, would equally fall within the terms of Claim 1.

4.2.2.6 The argument that the bond resulting from the use of epoxy adhesive would be unsatisfactory under dynamic conditions of use is unsupported by any evidence. On the contrary, since, for the reasons given above, the epoxy component would be applied in a procedure also involving RFL, the assumption must be that such a process represents an effective solution of the stated problem (since it also falls within Claim 1) and therefore also yields the relevant advantage. If this were not so, it would mean that the stated problem was not effectively solved over the whole of the area claimed. This in turn would require reformulation of the problem in less ambitious terms - "a further process for adhering aramid fibres to rubber" - with the consequence that it was unnecessary for the skilled

person to enquire whether an improvement could be expected before deciding to utilise the same teaching of D4.

4.2.3 In summary, regardless of whether or not emphasis is placed on the use of epoxy resins as canvassed by the Respondent, the result of following the incentive of a solution of the stated problem by applying, in the light of the general knowledge of the skilled person, the teaching of D4 to the closest state of the art is a sequence of steps involving the application of a customary treatment which would, as a matter of course, solve the stated problem and also fulfil the terms of Claim 1 of the patent in suit.

4.3 Clearly, the result would not be different if the skilled person were merely, and regardless of the terms of the technical problem, to apply the teaching of D4, in the light of his general technical knowledge, to the embedding of aromatic polyamide fibres in rubber. In this connection the curing of the plasma- and RFL-treated fibres under heat and their subsequent attachment to unvulcanized rubber which is then vulcanized (cured) in a mould (i.e. under pressure) is in any case an entirely conventional treatment for embedding tyre cords, enshrined, for instance, in the standard ASTM D-2138 series of tests for determining static adhesion in such cases (cf. D1, col. 3, lines 27 to 57; col. 4, lines 1 to 18).

Thus the sequence of steps which would conventionally be carried out, including the plasma pretreatment specifically taught by D4, the customary one- or two-bath RFL treatment to form "one or more interlayers" as stated in D4, and the entirely conventional final fixing and vulcanisation steps would in practice be the same.

4.4 In other words, the subject-matter of Claim 1 does not involve an inventive step in the sense of Article 56 EPC.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The patent is revoked.

The Registrar: The Chairman:

E. Görgmaier C. Gérardin