BESCHWERDEKAMMERN DES EUROPÄISCHEN PATENTAMTS | BOARDS OF APPEAL OF THE EUROPEAN PATENT OFFICE | CHAMBRES DE RECOURS DE L'OFFICE EUROPEEN DES BREVETS

Internal distribution code:
(A) [ ] Publication in OJ
(B) [ ] To Chairmen and Members
(C) [X] To Chairmen

D E C I S I O N
of 29 September 1994

Case Number: T 0957/91 - 3.3.3

Application Number: 84114872.9

Publication Number: 0146084

IPC: D01F 6/14

Language of the proceedings: EN

Title of invention:
Ultra-high-tenacity polyvinyl alcohol fiber and process for producing same

Patentee:
TORAY INDUSTRIES, INC.

Opponents:
I. Akzo Nobel Faser AG
II. Unitika Ltd.
III. Stamicarbon bv
IV. Kuraray Co., Ltd.

Headword:
-

Relevant legal provisions:
EPC Art. 54, 56, 87, 123(2)

Keyword:
"Priority entitlement (yes)"
"'Product-by-process' features in product claim (yes)"
"Novelty (yes - implicit disclosure in prior art denied)"
"Inventive step - product and process (yes)"

Decisions cited:
T 0150/82, T 0081/87, T 0129/88, T 0065/92

Catchword:
-

Europäisches Patentamt | European Patent Office | Office européen des brevets

Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0957/91 - 3.3.3

D E C I S I O N
of the Technical Board of Appeal 3.3.3
of 29 September 1994

Appellant: (Proprietor of the patent)
TORAY INDUSTRIES, INC.
2, Nihonbashi-Muromachi 2-chome
Chuo-ku
Tokyo 103 (JP)

Representative:
Kador & Partner
Corneliusstrasse 15
D-80469 München (DE)

Respondent(s): I (Opponent I)
Akzo Nobel Faser AG
Kasinostrasse 19 - 21
D-42103 Wuppertal (DE)

Respondent: II (Opponent II)
Unitika Ltd.
No. 50, Higashihonmachi 1-chome
Amagasaki-shi, Hyogo (JP)

Representative:
Brauns, Hans-Adolf, Dr. rer. nat.
Hoffmann, Eitle & Partner
Patentanwälte
Postfach 81 04 20
D-81904 München (DE)

Respondent: III (Opponent III)
Stamicarbon bv
Octrooiafdeling
Postbus 605
NL-6160 AP Geleen (NL)

Respondent: IV (Opponent IV)
Kuraray Co., Ltd.
2045-1, Aoeyama, Sakazu
Kurashiki City, Okayama (JP)

Representative: VOSSIUS & PARTNER
Postfach 86 07 67
D-81634 München (DE)

Decision under appeal: **Decision of the Opposition Division of the European Patent Office announced orally on 2 July 1991 and posted on 21 October 1991 revoking European patent No. 0 146 084 pursuant to Article 102(1) EPC.**

Composition of the Board:

Chairman: C. Gérardin
Members: P. Kitzmantel
M. K. S. Aúz Castro

Summary of Facts and Submissions

I. European patent application No. 84 114 872.9 in the name of Toray Industries, Inc., which had been filed on 6 December 1984, claiming priority from two Japanese applications both filed on 12 December 1983, resulted in the grant of European patent No. 0 146 084 on 9 November 1988, on the basis of 11 claims, independent Claims 1 and 7 reading as follows:

"1. An ultra-high-tenacity multifilament fiber of polyvinyl alcohol having a degree of polymerization of at least 1500, characterized in that the individual filaments composing the multifilament fibre have a tensile strength of at least 135 g/tex (15 g/d) and an initial modulus of at least 2700 g/tex (300 g/d)."

"7. A process for producing the ultra-high-tenacity polyvinyl alcohol fiber according to one of the preceding claims, characterized in that it comprises the steps of dissolving polyvinyl alcohol having a degree of polymerization of at least 1500 in a solvent, extruding the resulting polymer solution from a spinneret through a layer of air or inert gas into a coagulating bath, and drawing the coagulated filaments at a total effective draw ratio of at least 20 times."

Granted Claims 2 to 6 and 8 to 11 were appendant to Claims 1 and 7, respectively.

II. Notice of Opposition was filed by:

Opponent I (Respondent I), Akzo Nobel Faser AG (change of name from Enka AG), on 1 August 1989 (with letter dated 28 July 1989),

Opponent II (Respondent II), Unitika Ltd., on 3 August 1989,

Opponent III (Respondent III), Stamicarbon bv, on 3 August 1989 (with letter dated 1 August 1989), and

Opponent IV (Respondent IV), Kuraray Co. Ltd., on 8 August 1989,

requesting revocation of the patent in its entirety, on the grounds of lack of novelty and/or inventive step (Article 100(a) EPC), having regard to, among others, the following documents:

D1: EP-A-0 105 169,
D3: DE-B-2 219 703,
D4: CA-A-0 711 166,
D7: GB-A-1 314 000,
D9: JP-A-47-81 86 (and English translation),
D13: US-A-3 412 191,
D16: JP-A-43-16 675 (and English translation),

and also on the ground of insufficiency of the disclosure (Article 100(b) EPC).

III. The decision under appeal was based on a Main Request and an Auxiliary Request, both comprising an amended Claim 1 which, with respect to the granted Claim 1 (cf. point I above), was restricted to a minimum degree of polymerization of 2500, a maximum weight average molecular weight of the polyvinyl alcohol of less than 500.000, a tensile strength of at least 158 g/tex (17.5 g/d) and an initial modulus of at least 3150 g/tex (350 g/d); the Main Request further comprising an independent Claim 6 directed to a process for producing such fiber which differed from Claim 7 as granted in that (i) the distance between the face of the spinneret

and the liquid level of the coagulating bath was 2 to 20 mm and (ii) minor amendments had been made to the definitions of the solvent for the polyvinyl alcohol and the liquid in the coagulating bath; and Claim 6 of the Auxiliary Request being different from Claim 6 of the Main Request only with respect to a "total effective draw ratio of at least 30 times".

By its decision announced orally on 2 July 1991 (written decision date-stamped 21 October 1991) the Opposition Division revoked the patent, holding that the subject-matter of Claim 1 was novel over the cited prior art (especially over D1, owing to the molecular weight disclaimer of "less than 500.000"), but did not involve an inventive step over D7, particularly Example 7, because an enhancement of the tensile strength of 17,2 g/d and initial modulus of 310 g/d of the polyvinyl alcohol filaments according to said example to the moderately improved values of amended Claim 1 (tensile strength $\geq$ 17,5 g/d, initial modulus $\geq$ 350 g/d) was within the ambit of routine experimentation of the skilled person who would be aware that these properties could be upgraded by an increase of the total draw ratio which was already contemplated in D7.

Similarly, the process according to Claim 6 was considered devoid of inventive merit, because it was known from D3, particularly Example 6, but also from D4 and D13, that the provision of a gap between spinneret and surface of the coagulating bath permitted a greater drawability as compared with the conventional wet spinning process. Considering furthermore that D16 taught that the use of certain organic solvents and coagulating liquids led to an increased drawability, the choice of such organic solvents and the concurrent drawability advantage could not lead to any surprising

results in that respect. Thus, neither the process of Claim 6 of the Main Request, nor that of the Auxiliary Request involved an inventive step, since the minimum drawing ratios of 20 or 30, respectively, must be regarded as obvious and easily obtainable desiderata.

The disclosure of the claimed invention was considered to be sufficient by the Opposition Division.

IV. On 12 December 1991 the Appellant (Patentee) lodged an appeal against the revocation of the patent and paid the appeal fee. The Statement of Grounds of Appeal was submitted on 20 February 1992, including a set of further restricted claims, whose scope - partly in response to issues raised by the Board in its communication of 17 May 1994 - was narrowed down even more in subsequent submissions.

V. Oral Proceedings, which were attended by the Appellant and Respondents II and IV, were held on 29 September 1994. By letters received on 8 September 1994 and 28 April 1994 Respondents I and III had informed the Board that they would not attend the oral proceedings.

VI. At the outset of the oral proceedings the Appellant abandoned all its previous requests and presented six sets of new requests. Following a negative opinion of the Board concerning the admissibility under Article 123(2) EPC of two of these requests, the Appellant withdrew them and submitted as Main Request a set of seven claims comprising the following independent Claims 1 and 6:

"1. An ultra-high-tenacity multifilament fiber of polyvinyl alcohol having a degree of polymerization of at least 3500 and an average molecular weight of less than about 500000, **characterized in that** the individual

filaments composing the multifilament fiber have a tensile strength of at least 173 g/tex (19,2 g/d) and an initial modulus of at least 3780 g/tex (420 g/d), the fiber being obtainable by a process which comprises the steps of dissolving the polyvinyl alcohol in a solvent, extruding the resulting polymer solution from a spinneret through a layer of air or inert gas into a coagulating bath, and drawing the coagulated filaments under dry heat conditions or in at least two stages whereby the drawing in the second stage is accomplished under dry heat conditions, the maximum draw ratio of the coagulated filament being at least 29,4 times, the distance between the face of the spinneret and the liquid level of the coagulating bath being 2 to 20 mm [obvious correction by the Board of the clerical error "mmn" in the version as filed], said solvent for the polyvinylalcohol being an organic solvent and the liquid in said coagulating bath being an alcohol, acetone, benzene or toluene or a mixture thereof with dimethylsulfoxide."

"6. A process for producing the ultra-high tenacity polyvinylalcohol fiber according to one of the preceding [obvious correction by the Board of the clerical error "preceeding" in the version as filed] claims, **characterized in that** it comprises the steps of dissolving the polyvinyl alcohol having a degree of polymerization of at least 3500 and an average molecular weight of less than about 500000 in a solvent, extruding the resulting polymer solution from a spinneret through a layer of air or inert gas into a coagulating bath, and drawing the coagulated filaments under dry heat conditions or in at least two stages whereby the drawing in the second stage is accomplished under dry heat conditions, the maximum draw ratio of the coagulated filament being at least 29,4 times, the distance between the face of the spinneret and the

liquid level of the coagulating bath being 2 to 20 mm, said solvent for the polyvinylalcohol being an organic solvent and the liquid in said coagulating bath being an alcohol, acetone, benzene, or toluene or a mixture thereof with dimethylsulfoxide."

Additionally, the Appellant submitted three further sets of claims to be considered as auxiliary requests.

VII. The arguments presented by the Appellant can be summarized as follows:

(i) Concerning the objection to the priority entitlement of the claimed subject-matter raised by Respondent IV, the Appellant argued that, although the relevant priority document JP 58-232692 did not disclose the figure "29,4" for the maximum draw ratio, the mention of a "total stretching ratio of 30 times or more" in said document was a basis sufficient to establish identity of the invention disclosed in that priority document and the now claimed subject-matter of the patent in suit.

(ii) The characterization of the filaments in Claim 1 by ranges of tensile strength (hereinafter "TS") and initial modulus (hereinafter "IM") being defined only by a lower limit and by product-by-process features should be admissible.

(iii) The Appellant denied the objections of the Respondents of lack of novelty of the subject-matter of Claim 1 in view of an alleged implicit disclosure in documents D7 and D9 of fibers from polyvinyl alcohol (hereinafter "EVOH") exhibiting values of TS and IM meeting the respective values in said claim. To that end and

also in order to demonstrate that the high drawing ratios now required could not be attained by the wet spinning processes according to D7 or D9, but only by the claimed "dry-jet wet" spinning process, the Appellant submitted experimental evidence (Annexes B and C of Appellant's submissions of 24 August 1994) and questioned the conclusiveness of the counter-evidence (Experimental Reports (1) and (2)) filed by Respondent IV with letter of 7 July 1992, inter alia because they failed to strictly adhere to the experimental conditions of D7, Example 7.

The Appellant stressed in particular that, in spite of the indication in D7 and D9 of draw ratios being (only) 80% of the "maximum drawing ratio", filaments which had been drawn over and above the draw ratios indicated in the worked examples of D7 and D9 have not been available to the skilled person within the meaning of Article 54 (2) EPC. Even less was it justified to assume that any such hypothetical filaments met the TS and IM requirements of the present claims; in contrast thereto the Appellant's experiments demonstrated that the high minimum values of draw ratio, TS and IM were unattainable by the wet spinning techniques according to D7 or D9.

(iv) Besides being novel, the claimed EVOH fibers were also non-obvious over the disclosure of these citations. Moreover, there was no suggestion in the other documents, especially in D3, D4 or D13, that the provision of a gap between the spinneret and the surface of the coagulation bath, this being the essential

feature of the "dry-jet wet" spinning process according to the patent in suit, could lead to an increased drawability of the coagulated filaments, which in turn would lead to an enhanced TS and IM. In particular, a correct analysis of D3 would show that despite the single result in Example 6 pointing at a drawability increasing influence of a gap between of the spinneret and the coagulation bath, there was no general teaching in D3 that the provision of such a gap would be critical for the manufacture of high tenacity EVOH fibres. Thus, the claimed "dry-jet wet" process involved also an inventive step.

VIII. The arguments of the Respondents may be summarized as follows:

(i) Repondent IV argued that the subject-matter of Claims 1 and 6 of the Main Request was not entitled to the claimed priority date, since the figure "29,4" indicated as lower limit of the maximum draw ratio was not disclosed in the relevant Japanese priority application 58-232692. Thus, D1 was prior art within the terms of Article 54 (2) EPC.

(ii) Respondent IV opined furthermore that the wording of Claims 1 and 6 contravened Article 123 (2) EPC, because - contrary to the statement on page 4, lines 5 and 6 of the opposed patent - the drawing step under dry heat conditions referred to in these claims was not restricted to the temperature range of 200° to 250°C.

(iii) The incorporation into Claim 1 of product-by-process features was objected because it contravened the principle explained in T 150/82, OJ EPO 1984, 309 that "claims for products defined in terms of processes for their preparation (...) are admissible only if the products themselves fulfil the requirements for patentability and there is no other information available in the application which would enable the applicant to define the product satisfactorily by reference to its composition, structure or some other testable parameter."

(iv) Since both D7 and D9 disclosed that the filaments were drawn to only 80% of the maximum draw ratio, it would be self-evident that EVOH filaments having been drawn to the actual maximum draw ratio, i.e. to 100%, were within the actual teaching of these documents. It followed that filaments prepared in accordance with the conditions of D7, Example 7, but for the draw ratio in the third drawing stage being increased to the maximum of 1,44 (thus attaining a total draw ratio of 28,1), exhibited values of TS and IM meeting those of present Claim 1, as demonstrated by Experimental Report (1) of Respondent IV. Consequently, the subject matter of Claim 1 was not new.

(v) By its Experimental Report (2), reporting a draw ratio of 30,5 for EVOH filaments prepared according to the wet spinning technique, Respondent IV refuted the Appellant's allegation that the attainment of draw ratios in excess of 29,4 would only be possible according to the "dry-jet wet" technique. This, in conjunction with the fact known from

D8: Sen-i Gakkaishi, Vol. 29, No.5 (1973) T-197 to T-204 and

D24: Pol. Eng. Sc., Vol. 23, No. 13 (1983), 697 to 703,

namely that TS and IM were directly proportional to the draw ratio, was a clear pointer for the skilled person heading for high tenacity EVOH fibers, that this could be achieved by applying appropriately high draw ratios to filaments prepared by the conventional wet spinning technique according to D7 or D9. Thus, even if novelty of the fibers of Claim 1 could be acknowledged, they would lack an inventive step.

(vi) Concerning the inventive merits of process Claim 6, the Respondents contended that it was obvious for the expert aiming to enhance the drawability of EVOH filaments prepared according to the wet spinning method of D7 to provide a gap between the spinneret and the surface of the coagulating bath, since it was known from D3, particularly Example 6, that thereby this object could be achieved. The fact that D3 was concerned with polyaramide fibers could not detract from the applicability of this general teaching to EVOH fibers, because the contested patent itself referred to the favourable tenacity of polyaramide fibers and made thus clear that fibers made from these two polymers belonged to a common state of the art. Similar conclusions could be drawn from D4 and D13 which showed also the positive influence of a gap between the spinneret and the coagulating bath on the jet-stretchability of the spun fibers.

(vii) With respect to the restriction of the claims to the use of organic solvents the Respondents pointed to D16 which would already show the considerable IM advantages attained by the use of dimethylsulfoxide (DMSO) and its mixtures with other organic solvents.

IX. The Appellant requested that the decision under appeal be set aside and the patent be maintained on the basis of Claims 1 to 7 filed together with an adapted description during oral proceedings and the figures as granted or, alternatively, on the basis of any of the three sets of claims submitted during oral proceedings as auxiliary requests.

The Respondents requested that the appeal be dismissed.

In the course of the written appeal proceedings Respondent IV had requested referral to the Enlarged Board according to Article 122 EPC of the question of "whether an applicant is entitled to claim his or her invention only in terms of lower limits of physical parameters when the improvement of these parameters constitutes the very object of the invention, especially when only a small range above the claimed lower limit of the parameter can be achieved by the actual disclosure of the application."

Reasons for the Decision

1. The appeal is admissible.

2. *Admission of the Main Request into the proceedings*

As compared with the "Auxiliary Request", filed on 24 August 1994, Claim 1 of the Main Request comprises two amendments:

(i) insertion after "... and drawing the coagulated filaments under dry heat conditions" of the statement "or in at least two stages whereby the drawing in the second stage is accomplished under dry heat conditions", and

(ii) replacement of the term "total effective draw ratio" by "maximum draw ratio".

It was explained by the Appellant that the first amendment was made in order to make more conspicuous that the embodiment of Example 3, where the dry drawing step was preceded by a drawing step while washing the filaments with methanol, was within the scope of Claim 1, a problem which was also realized and commented by the Board at the outset of the oral proceedings. The second amendment was made upon suggestion of the Board and in the interest of consistency between the language of the claims and of Table 1 on page 5, from where the figures for the degree of polymerization (hereinafter "DP"), TS, IM and draw ratio have been taken. Independent Claim 6 has been amended in an analogous manner.

In view of the fact that the amendments in the claims of the Main Request were straightforward and not objected to by the Respondents, the Board decided to admit them into the proceedings.

3. *Admissibility under Article 123(2) and (3) EPC*

In comparison with the granted version, Claim 1 contains the following amendments; their basis in the application as originally filed (and in the patent specification) is indicated in paranthesis:

(a) DP of at least 3500, TS of at least 173 g/tex (19,2 g/d), IM of at least 3780 g/tex (420 g/d), maximum draw ratio of at least 29,4 times (page 16, respectively page 5, Table 1, third run);

(b) average molecular weight of polyvinyl alcohol of less than about 500000 (disclaimer based on the disclosure in D1: page 4, line 12; page 5, line 5; page 10, line 3 and claim 10);

(c) product-by-process feature "... being obtainable by a process which comprises ..." :

(c1) dissolving EVOH in a solvent, extruding the polymer solution from a spinneret through a layer of air or inert gas into a coagulating bath, and drawing the coagulated fibers (Claim 9, respectively Claim 7);

(c2) drawing under dry heat conditions (Examples 1, 2, 4, 5 of the application as filed and the patent as granted);

(c3) or drawing in at least two stages, whereby the drawing in the second stage is accomplished under dry heat conditions

(page 11, lines 3 to 6, respectively page 4, lines 5 to 6);

(c4) maximum draw ratio of at least 29,4 times (see feature a) above);

(c5) distance between spinneret and coagulating bath being 2 to 20 mm (page 10, lines 1 to 4, respectively page 3, lines 55 to 56);

(c6) organic solvent for the EVOH (page 9, lines 4 to 7, respectively page 3, lines 44 to 45);

(c7) coagulating bath being an alcohol, acetone, benzene or toluene or a mixture thereof with dimethylsulfoxide (page 10, lines 14 to 18, respectively page 3, lines 62 to 64).

With respect to feature (c3), the Board is of the opinion that the statement on page 11, lines 5 and 6 of the original application "..the second stage [drawing] should preferably be accomplished under dry heat conditions at 200 to 250°C" does not strictly limit the application of dry heat conditions to the indicated range of temperatures because in the present context drawing under dry heat conditions is clearly opposed to drawing under wet conditions (presence of solvent or, particularly water vapour) and the indicated temperature range is therefore to be interpreted only as exemplary.

The conclusions drawn with respect to the "product-by-process" features of Claim 1 apply equally to the same features in process Claim 6.

Dependent Claims 2 to 5 and 7 are based respectively on Claims 5 to 8 and 12 of the application as originally filed, corresponding to Claims 3 to 6 and 10 of the patent as granted.

The amendments in the claims amount thus to a restriction of the granted scope.

In consequence, the Main Request complies with the requirements of Article 123(2) and (3).

4. *Admissibility of the "product-by process" feature in Claim 1*

As referred to in section VIII (iii) above, the incorporation into present Claim 1 of the product-by-process feature was considered an offense against the EPC, particularly in view of T 150/82.

Case T 150/82 was concerned with the question whether a product-by-process claim was allowable under Article 52 (1) and 84 EPC when the product itself was not new; in that case the Board came to the conclusion that such a claim should not be allowed "in order to minimise uncertainty" (cf. Reasons 10). The present situation is different in that the product-by-process feature is used in a product claim directed to a novel product in order to limit the otherwise open-ended scope of the parameter definition. This is a situation similar to the one in case T 129/88 OJ EPO 1993, 598 where it was held that in a claim to a fiber, defined i.a. by lower limits of some physical properties, process features could legitimately be used to impose a practical upper limit on the physical properties concerned.

Article 84 and Rule 29 contain the criteria of the EPC for the formulation of claims. According to Article 84

"The claims shall define the matter for which protection is sought. They shall be clear and concise and be supported by the description". Rule 29 specifies that "The claims should define the matter for which protection is sought in terms of technical features of the invention." The Board is unable to recognize any contravention of these obligations by the present Claim 1; on the contrary, it is clearly in the interest of a better delimitation of the subject-matter for which protection is sought to restrict the scope of the claim to those results which are achievable by the only technique ("dry-jet wet") which is disclosed to actually yield the desired TS and IM properties. Thereby any possible problem of lack of sufficiency of disclosure (Article 83 EPC) is avoided, which problem may have existed (prior to this amendment) with regard to fibers having TS and IM properties which cannot be obtained by the "dry-jet wet" technique and which nevertheless would have been covered literally by the open-ended TS and IM ranges.

5. *Entitlement to priority*

5.1 The right to priority is governed by Articles 87 to 89 EPC which require that the European patent application and the application whose priority is claimed relate to the **same invention**, i.e. to the same subject-matter. Thus the main criterion in this respect is whether the claimed subject-matter is disclosed in the priority document(s) as a matter of substance, i.e. with all its essential features.

5.2 The patent in suit claims two priorities, both of the same date 12 December 1983: JP 232691/83 (hereinafter "P1") and JP 232692/83 (hereinafter "P2").

As the patent in suit, both Japanese applications relate to the "dry-jet wet" spinning technique of EVOH fibers. On page 11, 2nd paragraph of P1 (English translation) it is said that the fibers should be stretched as highly as possible and "preferably to at least 20 times, or more preferably more than 25 times of the original length"; in Example 2 a draw ratio of 30,7 is disclosed for a EVOH of a DP of 4500. P2 (English translation) discloses on page 11, paragraphs 1 and 2 a drawing ratio of "at least 20 times or, more preferably, 25 times"; it is furthermore stated for an EVOH of a DP of 3100 or greater that "it is feasible to attain a total stretching ratio of 30 times or more"; in Example 3 P2 discloses a total draw ratio of 30,6 (6-time plus 5,1-time); contrary to the corresponding Table 1 on the patent in suit, Table 1 of P2 does not indicate the maximum draw ratio of the different runs.

While, thus, neither P1 nor P2 comprises a combined disclosure of all numerical values in Claim 1 (TS, IM, DP and draw ratio), they both contain the teaching that a draw ratio of up to and above 30 can be achieved with EVOH fibers of appropriately high DP. It can furthermore be inferred from Table 1 of P2 that EVOH fibers having a DP of at least 3500 may attain TS and IM values of at least 19,2 g/d and 420 g/d, respectively, (these being the lower DP, TS and IM limits of present Claim 1).

5.3 It must therefore be concluded that at least P2 discloses all essential features of the patent in suit. The fact that the figure "29,4" for the lower limit of the draw ratio was not expressly mentioned in P2, cannot, in a situation where the very close figure of 30 is disclosed in conjunction with the same quantitative and qualitative correlation of this feature (draw ratio) to the other relevant essential

criteria (DP, TS, IM), change the substance of the subject-matter concerned. There can therefore be no doubt that the subject-matter of the Main Request is directed to the same invention as the one disclosed in P2. (cf. T 81/87 OJ EPO 1990, 250 and T 65/92 of 13 June 1993, section 3, not published in the OJ EPO)

5.4 Hence, the patent in suit as amended according to the Main Request is entitled to the claimed priority. D1, which was published after the valid priority date is therefore relevant only with respect to novelty under Article 54(3) EPC.

6. *Novelty*

6.1 Claim 1

6.1.1 It was no longer contested by the Respondents that novelty of the subject-matter of Claim 1 over D1 was established by the disclaimer "and an average molecular weight of less than about 500000". Since the Board is in agreement with this conclusion, there is no need for further reasoning on this point.

6.1.2 D7 relates to the wet spinning of EVOH fibers where an aqueous dope is spun into an aqueous alkaline coagulation bath and where the coagulated fibers are then subjected to a multi-stage drawing process. Preferably, and in order to draw to a greater extent, at a total draw ratio of above 20 times, the fibers should contain 20 to 50% by weight moisture during the second and subsequent drawing treatments at high temperature (cf. page 1, line 56 to page 2, line 68 and page 2, lines 99 to 106).

According to Example 7 EVOH of a DP of 3500 was spun to filaments which, after coagulation, were subjected to a

"spin-draw" of 5; after a neutralizing, washing and drying treatment the fibers were first drawn at a draw ratio of 3,0, treated to achieve a 30% moisture content, subjected to a second drawing step at a ratio of 1,3 and, after adjustment of the moisture content, subjected to a third drawing step at a draw ratio of 1,15. The total draw ratio was thus 22,4. The resulting filaments had a TS of 17,2 g/d and a dynamic modulus of $3,8 \times 10^{11}$ dynes/cm^2, which according to the Appellant and confirmed by the reworking of this Example 7 by Respondent II during the first instance opposition proceedings (results submitted on 5 April 1991) corresponded to an IM of 310 g/d.

6.1.3 The filaments according to present Claim 1 differ from those according to Example 7 of D7 by their greater TS (≥19,2 g/d) and greater IM (≥420 g/d) and have been prepared by applying a "maximum draw ratio" of ≥29,4 times. That these are not just theoretical desiderata, but that filaments exhibiting these properties can actually be prepared, is credibly proved by the results in Table 1, 3rd and 4th runs, and in Examples 3 and 5.

6.1.4 In D7, page 3, lines 61 to 63 it is stated under the heading "Experimental Example" i.a. that "The draw ratio at each stage was 80% of the maximum draw ratio at high temperature".

6.1.4.1 It was argued by the Respondent IV and allegedly proved in its Experimental Report (1), filed on 7 July 1992, that the above-quoted statement would imply that filaments having been drawn to the actual maximum draw ratio at breakage are within the disclosure of D7 and must necessarily fulfil the TS and IM requirements of present Claim 1. According to the second experiment of said Report a third stage draw ratio of 1,44 was employed, which - on the assumption that the third

stage draw ratio of 1,15 of D7, Example 7, was 80% of the maximum - amounts to the corresponding maximum draw ratio (100%) and a total draw ratio of 28,1. The resulting filaments were reported to exhibit a TS of 20,8 g/d and an IM of 510 g/d, thus being within the scope of present Claim 1.

6.1.4.2 The Appellant in its Annexe B, filed on 24 August 1994, presented the results of its reworking of Experimental Report (1) (but out of necessity - as the Appellant put it - using a higher spinning draft) concluding that "it was impossible to carry out an experiment at the total draw ratio of 28,1 because of occurrence of yarn breakage".

6.1.4.3 The Board shares the Appellants doubts concerning the correctness of the assumption of Respondent IV, namely that 100% of the draw ratio of 1,15 would amount to 1,44; this is because another equally reasonable possibility for calculating a 100% draw ratio could well be to start from the actual **amount** of stretching, which - at a draw ratio of 1,15 - is 15% and to take this as 80%-basis; in that case 100% from 15% would only be 18,75%, or in other words the 100% draw ratio would be about 1,19. There is no evidence available which could justify the assumption that such an increase of the draw ratio would bring about an enhancement of the TS from 17,2 to at least 19,2 g/d and of the IM from 310 to at least 420 g/d.

In view of the unpredictability of the extent to which the TS and IM properties of the individual filaments of the filament yarn are different from those of the yarn itself (and only the data for the filament yarn are disclosed in D7, Example 7), this factor has been disregarded by the Board in view of lack of evidence concerning the correlation of TS and IM of EVOH

filaments and yarns (taking account of Respondent III's calculations in Annex 1.4 of its letter filed on 11 April 1991 during the first instance opposition proceedings); anyway this fact should not have any critical influence on the correctness of the conclusions drawn by the Board, since - according to D3, column 15, lines 41 to 51 - the effect should be contrary with regard to TS and IM: there it is reported for fibers from aromatic polyamides that the tensile strength of filaments is higher than that of yarns, while the modulus of filaments is lower than that of yarns.

6.1.4.4 There is thus considerable doubt concerning the correctness of both, the conclusiveness of the assertion that the disclosure of D7 implicitly comprises EVOH filaments of a DP ≥3500 which have been drawn to just below breakage, and the correctness of the experimental results which have been carried out on the assumption that such filaments have been implicitly disclosed. Under these circumstances it must be concluded that the Respondents did not discharge their burden of proof, that the subject-matter of Claim 1 was available to the public within the terms of Article 54(2) EPC (cf. T 219/83, OJ EPO 1986, 211).

6.1.5 In the Board's judgment, the novelty objections of Respondent IV, based on D9, are likewise unfounded. D9 describes, similarly to D7, the wet spinning of EVOH filaments from aqueous dopes. According to experiments described in D9 some filaments were drawn to breakage in order to establish the maximum draw ratio and others were then drawn to 80% of this maximum draw ratio (cf. English translation, Experiments 1 and 2). Furthermore, the 80% drawn filaments were subjected to a heat shrinkage treatment. In Table 2 a filament made from EVOH of a DP of 3500 is disclosed which was drawn to a

maximum total draw ratio of 19,8 and - after 5% heat shrinkage - exhibited a TS of 17,8 g/d. There is no information in D9 concerning the IM of the filaments. Irrespective of the fact whether or not the Respondent is right in its contention that D9 would implicitly disclose filaments which have not been heat-shrunk and which have been drawn to a 100% draw ratio, and which filaments would therefore exhibit TS values in excess of the lower limit of 19,2 g/d of present Claim 1, the Respondent's allegation that such filaments would necessarily exhibit IM values within the scope of the subject-matter of the patent in suit is not convincing; while Fig. 3 of D24 shows that tenacity and modulus of high tenacity polyethylene fibers increase with an increased draw ratio, Fig. 1 submitted on 28 July 94 by Respondent IV shows clearly that this general tendency cannot justify the conclusion that a high TS of EVOH filaments must go hand in hand with an equally high IM: rather this Fig. 1, which represents a TS/IM plot of all EVOH fibers disclosed in the various citations, demonstrates that fibers of very close TS values (cf. those between 15 and 20 g/d) have grossly diverging IM values (from below 300 to above 600 g/d). It was also correctly noted by the Appellant that the filaments according to D7, Example 7 having a high TS of 17,2 g/d exhibit a lower IM of 310 g/d than those according to D7, Example 3 which exhibit a IM of 371 g/d, but have only a TS of 14,6 g/d (Appellant's conversion of the IM value of Example 3 from the unit kg/mm^2 was uncontested).

From the above it results that at least the Respondent's contention of an implicit disclosure in D9 of EVOH filaments having IM values within the scope of present Claim 1 is not supported by the evidence available.

The subject-matter of said claim is therefore novel over D9.

6.2 Claim 6

The novelty of the subject-matter of process Claim 6 is uncontested; the cited prior art does not disclose a process for spinning EVOH filament where a gap is provided between the spinneret and the coagulating bath.

6.3 The Main Request relates therefore to novel subject-matter.

7. *Inventive step*

7.1 Claim 1

The problem to be solved by the subject-matter of the patent in suit was the provision of EVOH fibers having the DP, TS and IM properties as defined in this claim. That this problem has been credibly solved emerges from the experiments in the description (cf. section 6.1.3 above).

7.1.1 The Board concurs with the first instance and the parties in regarding D7 as the closest prior art for the subject-matter of Claim 1. The Repondents objected that, starting from D7, the skilled person would have been aware that by enhancement of the drawing ratio he could easily obtain EVOH filaments of TS and IM values higher than those explicitly disclosed in D7 and above the lower limits according to present Claim 1.

This opinion presupposed that

(i) it was known from D7 or any other prior art that drawing ratio, TS and IM of high tenacity EVOH filaments increase together in a fashion allowing to predict the attainment of simultaneously high TS and IM levels at appropriately high draw ratios, and that

(ii) it was possible by the wet spinning technique according to D7 or

(iii) by an obvious variation thereof to enhance the draw ratio over and above the draw ratios explicitly disclosed in D7.

7.1.2 In respect of item (i) of the preceding paragraph, D7, page 1, lines 29 to 32, states that a high degree of drawing improves the dynamic modulus (which is proportional to the Young's modulus (=IM): D7, page 3, lines 35 to 38) and other mechanical properties and Table 1 shows that strength (=TS) and dynamic modulus increase indeed with increasing total draw ratio (compare samples No. 1/2 and 4/5).

While thus the general tendency of TS and IM values increasing with the draw ratio was known from D7, it remains open to doubt whether this correlation is valid up to and above the TS and IM limits of present Claim 1; in this respect, as pointed out by the Appellant, it is self-evident that there is a natural limit for the draw ratio, namely the breakage point of the fibre.

7.1.3 In respect to item (ii) of paragraph 7.1.1 it is to be noted that the filament yarn according to Example 7 of D7 (the example which, because of the DP of 3500, comes

closest to present Claim 1) exhibits a TS value of 17,2 g/d and an IM value of 310 g/d. Even if it may be admitted that the difference of this TS value to the limit value of 19,2 g/d according to present Claim 1 is so little that a TS of 19,2 can be assumed to be attainable by some limited increase of the draw ratio, the same conclusion is not applicable to the IM value, since there the difference to 420 g/d is considerable; there is no information in D7, or in any of the other documents relied upon by the Respondents, according to which the skilled person could reasonably expect that EVOH filaments exhibiting an IM of at least 420 g/d, as required by present Claim 1, could be obtained by simply enhancing the draw ratio of the filaments prepared according to the wet spinning method of D7.

Particularly, the relatively low values of the draw ratio (up to 18), the IM (up to below 3000 kg/mm^2 [which is below 300 g/d]) and the TS (up to 13 g/d) disclosed in D8, Figures 8 and 13 do not allow a serious prediction of the TS and IM values which are achievable when applying to the process of D7 the necessary much higher draw ratios (close to 30 times). Even less relevant is the information in D24 which, although referring in Table 3 to a EVOH fiber of a tenacity of 24 g/d drawn 19 times, is silent about the DP of the polymer and the IM value of the filament. Moreover, these fibers were drawn by a very special method at temperatures above the conventional melting point of the polymer: pages 699 to 699 "Zone Drawing". As set out above (point 6.1.5) the TS and IM data in Fig. 3 of D24 refer to polyethylene fibers and are therefore not applicable to EVOH filaments.

The EVOH fibers, which are the subject-matter of present Claim 1, were therefore not the result of an

obvious enhancement of the draw ratio of the wet spinning process according to D7.

This conclusion is not at variance with the results in Experimental Report (1) of Respondent IV, according to which an enhancement in Example 7 of D7 of the total draw ratio to 28,1 would be possible and would produce filaments having a TS of 20,8 and an IM of 510, thus being within the scope of present Claim 1; even if these results would be correct (and their correctness has been contested in Appellant's letter of 24 August 1994, Annexes B and C), this would not mean that in view of the problem to be solved the enhancement of the draw ratio to that extent was an obvious measure. As explained above, this was not the case.

7.1.4 With respect to item (iii) of paragraph 7.1.1 it remains to be decided, whether the skilled person, starting from D7, and being aware of the fact that TS and IM are properties which tend to increase with the draw ratio (cf. point 7.1.2 above), will know how to improve the drawability of EVOH filaments; the question being in particular whether the skilled person could reasonably expect that he would achieve this goal by the provision of a non-coagulating gap between the spinneret and the coagulating bath.

In the Board's judgment, the experimental evidence available demonstrates credibly that this effect of the gap on the drawability does in fact exist:

Table 1 of the patent in suit shows for all DPs a considerable enhancement of the maximum draw ratio of the filaments spun according to the "dry-jet wet" technique as compared with the conventional wet spinning technique. The experimental Report (2) filed by Respondent IV on 7 July 1992 cannot cast doubt on

the correctness of the results in said Table 1; under the conditions used for that report a maximum total draw ratio only marginally below or even higher than that achieved with the "dry-jet wet" technique could be achieved with the wet spinning technique (19,2 or 30,5 as compared with 20,0). However, in the Board's view the wet spinning conditions used in these experiments were not suitable for industrial use, and thus not realistic; as pointed out by the Appellant, at temperatures of the dope of 100°C (method 1) and also 60°C (method 2, which because of many differences is not comparable to the "dry-jet wet" experiment), the methanol of the coagulation bath, having a boiling point of 64,7°C, is likely to evaporate quickly around the nozzle, thus disturbing a stable spinning. Similarly, too low a temperature of the coagulating bath (here 5° or 7°C) will also destabilize the spinning operation by gel formation in the nozzle. The importance of the experimental conditions have in fact been demonstrated by the Appellant in Annex C of its letter filed 24 August 1994; according to that counter-evidence, at appropriate temperatures of the dope and the coagulating bath, the attainable total draw ratio is considerably lower according to the wet spinning technique (26,1) than according to the "dry-jet wet" technique (31,0).

The Board concludes thus that the claimed advantageous effect of the gap on the drawability of the spun filaments has been credibly established.

7.1.4.1 D3 is the most relevant document with regard to the question whether this effect was to be expected. It discloses a method for preparing fibers and films from aromatic polyamides by spinning the dope via a layer of a non-coagulating fluid into a coagulating bath (cf. Claim 2, last 3 lines; Fig. 1). The spun fibers are

drawn to a certain "spin-draw factor" ("Spinn-Streckfaktor") which is defined by the ratio of velocities of the fiber leaving the coagulating bath and leaving the spinneret (cf. column 12, line 47 to column 13, line 11). The importance of the "layer of non-coagulating liquid" is emphasized in Example 6 by a comparison of the results in the presence and absence of such a "layer". While in the presence of a "layer" (here an air gap) a spin-draw factor of 16 is achieved, in "sample e", this factor is reduced to 0,6 in the absence of such "layer" (Table V and column 38, lines 17 to 23). However, as becomes clear from the definition of the "spin-draw factor", what is determined according to D3 is not the stretching of the coagulated fiber (and it is the **coagulated** fiber/filament the draw ratio of which is of importance for the process as defined in present Claims 1 and 6), but the total stretching occurring in the "layer" and in the coagulating bath. This implies that the contribution to this "spin-draw factor" of the part of the spun fiber where it is more easily deformable, i.e. in the "layer", before any coagulation has occurred, must be considerable. Thus, this "spin-draw factor" tells nothing about the drawability of the coagulated fiber. In Example 1, where the coagulated, washed and dried yarn is drawn, a draw ratio of only 1,005 (cf. column 28, lines 38 to 45) is applied. Thus, the comparison set out in D3, Example 6 cannot be interpreted to teach that the "layer" enhanced the drawability of the **coagulated** fiber.

That such a "layer" was not provided for the purpose of enhancing the drawability is also plausible in view of

D23: US-A-3 414 645,

which is referred to in D3, column 2, last paragraph as relevant prior art with regard to the preparation of fibers of aromatic polyamide by spinning the dope into the coagulating bath via a gaseous layer, i.e. according to the"dry-jet wet" technique used in D3 and according to the patent in suit. In D23, column 3, lines 35 to 38 it is set out that "utilization of this technique leads to much improved extraction of inorganic salts from the polymer solution, improved structural properties of the shaped objects, and excellent thermal stability."

7.1.4.2 D4 solves the problem of spinning thin filaments from viscous dopes of copolymers of acrylonitrile or cellulose derivates by using a spinneret with rather large orifices and stretching the freshly formed filament plastically in a non coagulating air-zone before it enters the coagulating bath (cf. Claim 1; page 2, lines 1 to 6; page 5, lines 9 to 26).

Again, the plastical extension of the uncoagulated filament is unrelated to the situation according to the patent in suit, where the drawability of the coagulated fiber is improved by the provision of a gap between the spinneret and the coagulating bath.

7.1.4.3 In order to compensate the different "jet-strechability" of dopes of different polymers which are spun simultaneously into the same coagulating bath, D13 proposes that the dope, which coagulates faster and has thus an inferior "jet-stretchability", be first extruded into a gaseous medium and then directed into the coagulating bath, while the other dope is extruded directly into the coagulating bath (cf. Abstract of Disclosure; column 1, line 66 to column 2, line 16). Thereby higher take-up speeds of the bundle of filaments composed of the two different polymers can be

achieved (cf. column 1, lines 24 to 34). This effect is obviously obtained due to the retardation of the coagulation of that polymer filament which otherwise would coagulate quickly and would therefore be less stretchable than the filament from the other polymer, which - owing to its less coagulated structure - is more easily deformable, thus stretchable. Therefrom it results that the term "jet-stretchability" again does not relate to the drawability of the **coagulated** fibre, but to the deformability prior to and during coagulation. This document does not, therefore, comprise any incentive for the skilled person to operate along the teaching of the patent in suit.

7.1.5 In the Board's judgment therefore, the fibers as defined in present Claim 1 cannot be regarded as obvious for the skilled person starting from D7; while the TS and IM values used for their characterization may be regarded as obvious desiderata, D7 by itself or in combination with the other cited prior art documents does not comprise any information how these improved properties could be achieved.

7.1.6 For these reasons, the subject-matter of present Claim 1 involves an inventive step in accordance with Article 56 EPC.

7.2 Claim 6

7.2.1 This claim relates to the method of preparing the fibers according to Claim 1. The main features of this method are

(i) the provision of a "layer of air or inert gas between the spinneret and the coagulating bath ("dry-jet wet" spinning method),

(ii) the use of organic solvents for the dope and the coagulating bath, and

(iii) the use of a dry drawing method, at least in a second stage.

The problem to be solved by this process was the provision of EVOH filaments having the high TS and IM values according to Claim 1. That this problem has been solved can be concluded from the experimental evidence in the description (cf. section 6.1.3 above).

7.2.2 While in the decision under appeal and in the parties' submissions D7 was regarded as nearest prior art also for the process, in the present situation, where Claim 6 is restricted to the use of organic solvents (feature (ii) in the preceding paragraph), D16 becomes a more relevant starting point.

D16 discloses a conventional wet spinning process for EVOH fibers but, in contrast to D7, employs organic solvents for the dope and the coagulating bath; for the dope DMSO or a mixed solution mainly composed of DMSO and for the coagulation bath acetone, methanol, toluene, etc. or a mixture of DMSO therewith are used as solvents (English translation, entitled "(Examined/Registered)": page 1, first paragraph of "Detailed description of the invention"; page 2, 4th paragraph). It can be inferred from Example 1 (pages 4 and 4 of the translation) that by the use of such organic solvents distinct advantages with regard to drawability, TS and IM can be achieved. According to said Example 1 at a draw ratio of 18 (there "1800%") the TS is 10,7 g/d and the IM is 480 g/d. While thus the IM value according to this example is above the minimum required by the patent in suit, the draw ratio and the TS are considerably below.

D16 does not contain any pointer towards the provision of a gap between the spinneret and the coagulating bath; since the other relevant prior art documents do not comprise any suggestion that thereby the drawability and in consequence TS and IM of the drawn filaments can be further enhanced (cf. above sections 7.1.4.1 to 7.1.4.3), D16, either by itself or in combination with the further prior art, cannot render obvious the combination of features according to present Claim 6.

7.2.3 As set out in section 7.1 above, no other conclusion could be arrived at when starting from D7 as closest prior art.

7.3 The dependent Claims 2 to 5 and 7 relate to preferred embodiments within the scope of independent Claims 1 or 6, respectively. Consequently, the Main Request complies with the patentability requirements of Article 52 (1) EPC.

8. *Referral to the Enlarged Board*

Repondent IV's respective written request was not maintained during the oral proceedings. In the Board's judgment, this request has become redundant in view of the incorporation into Claim 1 of the product-by-process features derived from Claim 6. This ensures that the scope of Claim 1 cannot extend beyond the actual inventive contribution made by the claimed invention (cf. T 129/88 OJ EPO 1993, 598, Headnote II and Reasons 2.2.4).

9. The description has been correctly adapted to the claims of the Main Request.

10. Consequently, the patent and the invention to which it relates meet the requirements of the EPC.

There is thus no need to consider the auxiliary requests submitted by the Appellant.

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 on the basis of Claims 1 to 7 and an adapted description both filed during oral proceedings, and the figures as granted.

The Registrar: The Chairman:

E. Görgmaier C. Gérardin