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D E C I S I O N
of 27 September 1995

Case Number: T 0793/93 - 3.3.3

Application Number: 86107119.9

Publication Number: 0205960

IPC: D01F 6/04

Language of the proceedings: EN

Title of invention:
Very low creep, ultra high modulus, low shrink, high tenacity polyolefin fiber having good strength retention at high temperatures and method to produce such fiber

Patentee:
AlliedSignal Inc.

Opponent:
DSM N.V. Patent Department

Headword:
-

Relevant legal provisions:
EPC Art. 54, 56

Keyword:
"Novelty (yes) - no unambiguous disclosure - reworking inappropriate to prove inevitable outcome"
"Inventive step (yes) - choice of closest prior art"

Decisions cited:
-

Catchword:
In deciding what is or is not the inevitable outcome of an express literal disclosure in a particular prior art document, a standard of proof much stricter than the balance of probability, to wit "beyond all reasonable doubt" needs to be applied. It follows that if any reasonable doubt exists as to what might or might not be the result of carrying out the literal disclosure and instructions of a prior art document, in other words if there remains a "grey area" then the case on anticipation based on such a document must fail.

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Case Number: T 0793/93 - 3.3.3

D E C I S I O N
of the Technical Board of Appeal 3.3.3
of 27 September 1995

Appellant: (Opponent)
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-

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Decision under appeal:
Interlocutory decision of the Opposition Division of the European Patent Office announced orally on 16 June 1993 with written reasons published on 5 July 1993 concerning maintenance of European patent No. 0 205 960 in amended form.

Composition of the Board:

Chairman: C. Gérardin
Members: P. Kitzmantel
J. A. Stephens-Ofner

Summary of Facts and Submissions

I. European patent application No. 86 107 119.9 in the name of AlliedSignal Inc. (previously Allied Corporation) which had been filed on 26 May 1986, claiming priority from a US application filed on 17 June 1985, resulted in the grant of European patent No. 205 960 on 24 October 1990, on the basis of 15 claims, independent Claims 1, 6 and 11 reading as follows:

"1. A method to prepare low creep, high modulus, low shrink, high strength, high molecular weight polyolefin fabric having improved strength at high temperatures, characterized by
forming said fabric from polyolefin which had been highly oriented by drawing at a temperature of within 10°C of its melting point,
poststretching at a drawing rate of less than 1 second^{-1} at a temperature within 10°C of the melting point of the polyolefin, and
cooling said fabric under tension sufficient to retain its highly oriented state."

"6. A method to prepare low creep, high modulus, low shrink, high strength, high molecular weight polyolefin fiber having improved strength at a high temperature, characterized by
forming said fiber from polyolefin which had been highly oriented by drawing at a temperature of within 10°C of its melting point,
poststretching at a drawing rate of less than 1 second^{-1} at a temperature within 10°C of the melting point of the polyolefin, and
cooling said fiber under tension sufficient to retain its highly oriented state."

"11. A polyethylene fiber obtainable by the process of Claim 6, said fiber having, when compared to the same fiber before poststretching,
at least a ten percent increase in tensile modulus,
at least a twenty percent decrease in creep rate measured at 71.1C (160°F) under 270 MPa (39,150 psi) load,
retention of the same tenacity at a temperature at least 15°C higher, and
total shrinkage when measured at 135°C of less than 2.5 percent."

The further granted claims are appendant to Claim 1 (Claims 2 to 5), Claim 6 (Claims 7 to 10) and Claim 11 (Claims 12 to 14); in view of the overall structure of the claims, Claim 15, although referring back to Claim 6, should correctly be appendant to Claim 11 (as in the German and French translations of the claims in the patent document).

II. Notice of Opposition was filed by DSM N.V. on 24 July 1991 requesting revocation of the patent in its entirety, on the grounds of Article 100 EPC. The Opponent contended in particular that the claimed subject-matter lacked novelty and/or inventive step i.a. over the documents

(1) B. Kalb & A.J. Pennings, Polymer Bulletin 1, 871-876 (1979);

(2) J. Smook, M. Flinterman & A. J. Pennings, Polymer Bulletin 2, 775-783 (1980);

(5) B. Kalb & A.J. Pennings, Journal of Materials Science 15, 2584-2590 (1980);

(7) I.M. Ward & M.A. Wilding, Journal of Polymer Science: Polymer Physics Edition 22, 561-575 (1984); and

(8) US-A-4 413 110.

III. By its interlocutory decision announced orally on 16 June 1993 (written decision date-stamped 5 July 1993) the Opposition Division held that there were no grounds of opposition to the maintenance of the patent in the form as amended according to the Auxiliary Request; i.e. with the claims essentially as granted but for the substitution in Claims 1 and 6 of the final statement "cooling ... at a tension of at least 2 g/den (176.6 mN/tex) whereby to retain its highly oriented state" for the statement in the granted version "cooling ... under tension sufficient to retain its highly oriented state".

That decision held that the subject-matter of the claims as granted (Main Request) lacked novelty, but that after amendment (Auxiliary Request) both novelty and inventive step could be recognized over the citations (1), (2) and (8). In particular, it was held that all features, the final cooling step unter tension inclusive, of the two-stage drawing method according to Claim 6 of the Main Request (version as granted) was disclosed in document (2), but that this document was silent about the feature of the lower limit of 2 g/den of the cooling tension introduced into Claim 6 of the Auxiliary Request. Novelty of the fibres according to Claim 11 of both requests was acknowledged because the Opponent's reworking of document (1) was not recognized as being a correct duplication.

For the assessment of inventive step, Example 548 of document (8) was regarded as the closest prior art and it was found that the improvement of the creep properties of the final fibres, achieved according to the patent in suit by enhancement of the temperature during the first drawing stage, was non-obvious.

IV. Appeals against the interlocutory decision of the Opposition Division were lodged by the Opponent on 28 August 1993 and by the Patentee on 6 September 1993. Together with their Notices of Appeal both Appellants paid the appeal fee; Statements of Grounds of Appeal were submitted on 8 November 1993 by the Patentee and on 15 November 1993 by the Opponent.

V. Oral proceedings were held on 27 September 1995.

VI. In support of his appeal the Opponent argued that the method according to Claim 6, as well as the polyolefin fibres produced thereby according to Claim 11, were anticipated by both documents (1) and (2), respectively. As to Claim 6, there could not be any reasonable doubt that according to these citations during and after the poststretching step the fibres retained their integrity, and were thus cooled and wound up under tension, rather than breaking beforehand. The anticipation of the polyolefin fibres according to Claim 11 resulted from their being the inevitable product of the old method of Claim 6; this was moreover proved by the Opponent's reworking of document (1).

With regard to inventive step, the Opponent stressed that the real purpose of the alleged invention was the improvement of tenacity and of modulus, and that the closest prior art was therefore represented by documents (1) and (2). Pursuant to these citations the provision of a post-stretching step with subsequent cooling under tension would have been obvious. The skilled person was furthermore aware that an enhancement of the tenacity and modulus of the fibres would also reduce their creep, as disclosed in document (7). In view of the high tenacity and modulus values as well as the low creep values achieved according to the

two-stage stretching experiments disclosed in document (8), the inventivity of the fibres according to present Claim 11 was also challenged on the basis of that document.

VII. The Patentee maintained that the method according to Claim 6 of his Main Request was novel, because there was no unambiguous disclosure in either of document (1) or of (2) of the cooling under tension of the fibres as they emerged from the poststretching stage. When interpreting these citations, account also had to be taken of the fact that they related to the drawing of polyolefin fibres of much higher porosity than that of the fibres disclosed in document (8), which were precursor fibres typical for the patent in suit. The polyolefin fibres according to Claim 11 were likewise novel, since none of the citations disclosed the features of this claim and since the Opponent's reworking of document (1) was not a true duplication, as shown i.a. by the different tensile strength values obtained after the drawing operations.

For the assessment of inventive step the relevant problem to be solved was the provision of polyolefin fibres having improved creep properties as well as high tenacity and modulus. Since documents (1) and (2) were both silent about the creep properties, and since a correlation between creep on the one hand, and tenacity and modulus on the other hand was not apparent, document (8) was clearly the most appropriate starting point for the invention. It did not, however, suggest the combination of process steps as defined in Claim 6 of the patent in suit. Thus, not only this process but also the fibres resulting therefrom were founded on an inventive step.

VIII. The Opponent (Appellant) requested that the appealed decision be set aside and that the patent be revoked in its entirety.

The Patentee (Cross-appellant) requested that the Opponent's appeal be dismissed and that the patent be maintained as granted (Main Request) or in the form as allowed by the Opposition Division (Auxiliary Request).

Reasons for the Decision

1. Both appeals are admissible.

Main Request of Patentee

2. *Novelty*

2.1 General legal observations

Concerning the issue of novelty, Article 54(2) EPC defines a state of the art as comprising "everything **made available** to the public by means of written or oral description, by use or in any other way". The term "available" clearly goes beyond literal or diagrammatical description, and implies a communication, express or implicit, of technical information by other means as well. In the case where a prior art document fails explicitly to disclose something falling within a claim, availability in the sense of Article 54 may still be established if the **inevitable** outcome of what is literally or explicitly disclosed falls within the ambit of that claim.

It was submitted by the Opponent that in deciding what does or does not inevitably fall within the ambit of a claim, the Board should adhere to the normal standard of proof used by the Boards, namely the balance of probability, that is to say the acceptance of a proposition as being true simply on the basis that it is more likely or more probable to be true than the contradictory proposition, one or another proposition being the basis of deciding the point at issue in the case. On this basis, while he admitted that there was a measure of uncertainty as to the outcomes both of documents (1) and (2), this should not of necessity be fatal to his case on novelty on the basis of inevitable outcome, because it was more likely than not that the disclosures of one or both of these documents would inevitably lead to something falling within the claims in suit.

In the Board's judgment the concept of "balance of probability" requires the presence of some kind of balance between two substantially credible and valid but contradictory propositions. By contrast, the term "inevitable" means "unavoidable, sure to happen, something that is bound to occur or appear, so true to nature as to preclude alternatives or solutions" (see Concise Oxford Dictionary). It is therefore self-evident that inevitability precludes the existence of a credible or valid alternative outcome or choice: in other words it is tantamount to 100% probability.

It is worth noting that the Boards of Appeal have in the past applied standards of proof more strict than the balance of probability, eg in relation to the allowability of amendments: see T 113/86 of 28 October 1987 (point 2.2) and T 383/88 of 1 December 1992 (point 2.2), both not published in the OJ EPO. In both those cases it was held that amendments requested by

the Patentee should not be allowed if there was the slightest doubt as to the direct and unambiguous derivability of the proposed amended claim from the application as filed, because the requirement of "directly and unambiguously derivable" was logically inconsistent with a process of derivation that was acceptable merely on the balance of probabilities.

By parity of reasoning, the Board finds in the present case that, in deciding what is or is not the inevitable outcome of an express literal disclosure in a particular prior art document, a standard of proof much stricter than the balance of probability, to wit "beyond all reasonable doubt", needs to be applied. It follows that if any reasonable doubt exists as to what might or might not be the result of carrying out the literal disclosure and instructions of a prior art document, in other words if there remains a "grey area", then the case on anticipation based on such a document must fail.

2.2 Claim 6

The gist of this claim resides in the poststretching at a temperature within 10°C of its melting point and below a drawing rate of 1 second^{-1} of a high molecular weight polyolefin precursor fibre of highly oriented structure obtained on its turn by drawing of a spun fibre at a temperature within 10°C of its melting point. The poststretched fibre is then cooled under tension.

Tables I to VII of the patent in suit (pages 8 to 12) demonstrate that by a poststretching operation in accordance with Claim 6 ultimate tensile strength (UTS), modulus, creep and free shrinkage can be improved.

2.2.1 Novelty with respect to document (1)

2.2.1.1 Document (1) relates to the preparation of high molecular weight polyethylene fibres by solution spinning and subsequent drawing in a temperature gradient from 100 to 148°C (page 872, "Experimental"). Figure 1 on page 873 reports a "second drawing experiment" where a previously drawn fibre was drawn a second time at a constant temperature of 153°C. Thereby a fibre with "markedly higher tensile strength" was obtained, the tensile strength being almost linearly related to the drawing stress (page 873, Figure 1, full circles; page 874, lines 13 to 24).

Pursuant to the aforementioned section "Experimental" and the legend to Figure 1 on page 873 of document (1) (see particularly the use of the definite article "**the** drawing tube") both drawings were carried out in a glass cylinder of a length of 1 m. The velocity of the fibre entering the tube is said to be 2.65 cm/min, without indicating whether this figure applies to the first, the second or to both drawing steps.

For the "strongest" fibre illustrated in Figure 1 a draw ratio (ratio of speeds at the exit and the entrance of the tube: V_{out}/V_{in}) of about 38 is indicated (page 874, lines 19 to 22); again it is not made clear whether this value is an overall stretch ratio or what else.

Finally, the only information concerning the further treatment of the double-stretched fibres in document (1) is contained in the last sentence on page 872, above the section "Results and Discussion", where it is said that "Stress on the fibre during drawing was applied by means of a free-hanging wheel positioned before the wind-up".

2.2.1.2 The information comprised by document (1) is not sufficient to calculate the drawing rate (V_2) applied during the second drawing operation and it is hence not possible with reasonable certainty to decide whether this rate V_2 was below the drawing rate of 1 second^{-1} required for the poststretching according to Claim 6 of the patent in suit.

At page 2, line 64, of that document the drawing rate is defined as "the drawing velocity difference (V_{out} - V_{in}) divided by the length of the drawing zone (L)" (parentheses added).

The Opponent argued that, even on the assumption of an "unrealistically" high second stage drawing ratio (DR_2) of 1000, the second stage drawing rate V2 (V2 = V_{in}*(DR_2 - 1)/L) would only be 0.44 second^{-1}, thus within the claimed range of "less than 1 second^{-1}" (in this calculation: V_{in}= 2.65 cm/min and L = 1 m).

This argument was countered by the Patentee by reference to document (5), which in his submission had to be considered in combination with document (1), since it concerned the same scientific investigations regarding the solution spinning and drawing of high molecular weight polyethylene fibres, carried out in the same time interval 1979/1980 by the same working group (B. Kalb & A. J. Pennings). In (5) it was pointed out in the paragraphs bridging pages 2585 and 2586 as well as pages 2586 and 2587 that "an exceptionally high drawing force" or drawing "without a temperature gradient at a temperature of 148°C" may cause fibre necking leading to a reduction of the fibre cross-section within a small region. According to Figure 1 of document (5) this necking effect may occur above a drawing stress σ_D of about 0.2 GPa (see broken line in said Figure 1).

In this event, assuming a necking of the order of the fibre's diameter, but otherwise under the same conditions as in the Opponent's calculation, the Patentee calculated a drawing rate V_2 of 11 second^{-1}, and thus largely above the upper limit of 1 second^{-1} required according to Claim 6.

2.2.1.3 In the Board's judgment, it is justified, in the interpretation of document (1), to consider the disclosure of document (5), not only because of the Patentee's arguments set out above, but also because, with regard to the experimental conditions, document (5) explicitly refers to document (1) (see document (5) page 2584, right hand column, last paragraph: "Reference 2" is document (1)). Moreover, both documents use the same polyethylene (Hifax 1900 having a weight average molecular weight of $4x10^6$ gmol^{-1}), cover the same solution concentration (5% by weight) and the same solvent (dodecane) and use also the same entering velocity (V_{in}) of the undrawn fibre (2.65 cm/min) (see document (1) page 872 "Experimental" and document (5), page 2584 "Experimental procedure"). Consequently, since according to document (1) the second drawing operation was carried out under conditions which according to document (5) may cause necking (i.e. at a drawing stress of 0.3 GPa (Figure 1) and at a constant temperature of the drawing tube of 153°C (page 874, line 18)), it cannot be ruled out that the necking phenomenon reported in (5) may have occurred also in the second drawing step disclosed in document (1).

2.2.1.4 Thus, though leading to completely different results, either of the calculations of the second stage drawing rate of both parties is based on prima facie reasonable

assumptions. The fragmentary disclosure in document (1) does not enable one to decide which one of the two calculations reflects the processing conditions actually used.

2.2.1.5 In these circumstances and following the observations made in Section 2.1. above, the novelty of the subject-matter of Claim 6 of the patent in suit over the disclosure of document (1) must be recognized.

2.2.1.6 Another line of the Opponent's arguments was based on the allegation that the two consecutive drawing operations made according to Claim 6 would be anticipated by the single drawing operation in a temperature gradient from 100° to 148°C performed according to document (1). More specifically, (i) there had to be a point in the drawing tube where high fibre orientation was obtained at a temperature within 10°C of the melting point, and (ii) continuation of the drawing thereafter would inevitably amount to "poststretching" within the meaning of Claim 6, because the wording of this claim was silent with regard to any treatment of the fibre between the first drawing and the poststretching which would make these two operations distinguishable.

The Board cannot accept this reasoning because mere logic requires that the literal separation in Claim 6 of a first drawing step from the poststretching step implies also a physical separation, be it an intermediate storage of the wound-up fibre or just the passage from one to another drawing device.

Any possible doubt is removed by reference to the description of the patent in suit which, according to Article 69 EPC, shall be used to interpret the claims.

In particular, Examples 4 to 7 provide additional information about possible features of the poststretching step, e.g. how this is to be carried out in the framework of the process as claimed.

This novelty objection, too, is therefore unfounded.

2.2.2 Novelty with respect to document (2)

2.2.2.1 Document (2) relates to the influence of spinning/hot drawing conditions on the tensile strength of porous high molecular weight polyethylene fibres and concerns thus the same research work as that reported in documents (1) and (5). A.J. Pennings is a co-author of all these papers. The experimental conditions used (see section "Experimental" on page 776) are very similar to those used in documents (1) and (5): a 5% by weight solution in paraffin oil of the linear polyethylene Hifax 1900 having a weight average molecular weight of 4×10^6 kg/mol was spun to fibres, which, after extraction and drying, were drawn in a glass tube of a length of 1.5 m at a temperature gradient of 80 to 148°C. The velocity of the fibre V_{in} entering the drawing tube was 4.4×10^{-4} m/sec (which is the same as the 2.65 cm/min indicated in document (1)). Drawing was accomplished by means of a different speed of the feed roll and the wind-up drum.

According to Experiment No. 6 in Table 1 on page 778 a two-stage drawing was performed: first drawing in the above mentioned temperature gradient to a draw ratio (V_{out}/V_{in}) of about 40 and subsequently "drawing maximally" at a drawing temperature of 150°C. On page 782, 2nd paragraph below Fig. 4, is set out with respect to the two-step drawing that when "subsequently

drawing until breakage (emphasis added) occurs at a drawing temperature of 150°C, without a gradient, a remarkable increase in tensile strength at break was noticed".

2.2.2.2 The issue of novelty focuses particularly on the question of whether document (2) discloses a two-stage drawing process where after the second drawing operation the fibres were cooled under tension, as required by Claim 6 of the patent in suit. It was argued by the Patentee that the term "drawing until breakage" would imply that the fibre pieces submitted to the test conditions reported in Table 1 were part of the ruptured fibre material remaining after fibre breakage under too high a drawing stress. According to the Opponent, this interpretation went against the normal understanding by one skilled in the art of the term "drawing until breakage", which simply meant that drawing was carried out maximally, but just below the point of breakage.

2.2.2.3 The Board holds that the disclosure in document (2), when read in conjunction with document (5), which is relevant for the interpretation of document (2) for the reasons set out in Sections 2.2.1.2 and 2.2.1.3 above, does not comprise a cooling step under tension which was subsequent to the second drawing operation.

Firstly, according to the statement in document (2), page 782, second paragraph below Figure 4, "Further investigations have to establish whether this was a lucky experiment or whether two-stage drawing leads to better results", only a single experiment with two drawing operations was carried out. Determination of the drawing stress required for fibre breakage would however require at least another experiment, for which there is no evidence in document (2). Secondly, the

fashion of applying drawing stress according to document (2), page 776, last but two sentences of the section "Experimental", "by means of different speed of the feed roll and the wind up drum" is apparently the same used according to document (5). It is said on page 2585, first column, last sentence above the section "3. Results and discussion" that "... the fibre feed at the entrance of the tube was stopped, whereupon the cross-sectional area of the drawn fibre decreased steadily until fracture occurred at a maximum drawing stress". Because of the identity of the way of applying the drawing stress via the wind-up roll in both documents (2) and (5), this manner of increasing the drawing stress should correspond to that applied in the second drawing operation of Experiment 6 (citation (2): page 778, Table 1). In these circumstances, the fibres resulting from the second drawing step were not cooled under tension, but torn apart anywhere between the feed roll and the wind-up drum.

2.2.2.4 The method according to Claim 6 of the patent in suit is thus novel over the disclosure in document (2).

2.2.3 Novelty with respect to document (8)

2.2.3.1 Document (8) relates to ultrahigh molecular weight polyethylene and polypropylene fibres having high tenacity (at least 20 g/den), high tensile modulus (at least 500 g/den), low creep (no more than 5% - when measured at 10% of breaking load for 50 days at 23°C), a porosity of less than 10% and a main melting temperature of at least 147°C measured at 10°C/minute heating rate by differential scanning calorimetry (Claim 1). It is stressed that during preparation the fibres may be stretched in a continuous operation to packages of indefinite length, which was in contrast to the high porosity fibres (23-65%) according to

document (2) (see column 1, lines 57 to 66). Figure 5 illustrates one variant for the production of the fibres, according to which the dried xerogel fibres are stretched in zone F in two stages (column 9, lines 11 to 28). This method, called "dry-dry" stretching, is exemplified in Examples 524 to 533 (column 26); there the temperature during the first stage was 120°C, that during the second stage was from 130°C to 150°C.

2.2.3.2 Because of the second stage stretch temperature of 150°C, which meets the temperature criterion for the poststretching step according to present Claim 6, Examples 529 to 533 come the closest to the alleged invention. Novelty of the process according to said Claim 6 over this disclosure must however be recognized in view of the too low temperature of 120°C of the first drawing operation, which is below the range of "within 10°C its melting point" defined in Claim 6 (according to Example 523 the melting point after the first stretch was measured as being 146° and 153°C).

2.3 Claim 11

2.3.1 The polyethylene fibre according to this claim is defined by the combination of an absolute figure (total shrinkage) and relative figures (tensile modulus, creep rate and tenacity) expressed by reference to their respective values before poststretching.

2.3.2 About 5 weeks before the oral proceedings the Opponent, for the first time, raised Article 84 objections (lack of clarity) against this claim, arguing, on the one hand, that the claimed property improvements could not be measured on the finished fibre, and, on the other hand, that the features of this claim were mere desiderata representing only a problem but not its technical solution.

Since the Main Request, Claim 11 inclusive, is based on the unamended claims of the granted patent, the Board - in accordance with its established practice - has no power (Article 111 EPC in combination with Articles 100 to 102 EPC) to question the validity of a claim for reasons of deficient clarity alone. These objections must therefore be dismissed.

2.3.3 None of the citations **explicitly** discloses fibres possessing the characteristics defined in Claim 11. This was always admitted by the Opponent who alleged, however, that such fibres have been **implicitly** made available by the disclosure of document (1). In order to prove this allegation the Opponent had submitted an Experimental Report in annex to the Notice of Opposition where the properties of twice stretched Hifax 1900 polyethylene fibres were reported which met the requirements of present Claim 11.

In the Board's judgment this Experimental Report does not represent a true reworking of the relevant disclosure of document (1) from which it could be concluded that by adhering to this disclosure one would inevitably arrive at fibres having the characteristics defined in Claim 11.

Rather, as set out in the appealed decision, it follows from the tensile strength of 1.53 N/tex indicated in this report for the fibre after the first drawing operation that the process conditions must have been different from those applied according to document (1) which led to a tensile strength of only about 0.9 N/tex (conversion from 0.9 GPa at density of 1000 kg/m^3; see Figure 1 of (1)).

The Opponent's argument that the above mentioned tensile strength difference after the first drawing operation was without consequence because the final tensile strength after the poststretching was very close to that disclosed in (1) (Opponent's Experimental Report: 2.33 GPa; document (1) Figure 1: 2.5 GPa) is likewise not convincing. This conclusion is at variance with the common general knowledge of one skilled in the art who would be aware of the critical importance for the ultimate fibre properties of each parameter of each production step. This fact is emphasized by the discussion of the necessity of a temperature gradient in the first drawing step according to document (1) (see paragraph bridging pages 872/874) from which the importance for the process and its results of adequate drawing conditions emerges. The Opponent has failed to provide evidence cogent enough to prove his contention, namely that, despite the differences in the process conditions of document (1) and those applied according to his Experimental Report, which led to quite different tensile strength values of the fibres after the first drawing operation, the properties of the same fibres after the second drawing operation would correspond to those of the differently prepared twice drawn fibres disclosed in Figure 1 of document (1).

In accordance with the observations contained in paragraph 2.1 above, about the standard of proof required for the inevitable anticipation of claimed subject-matter on this basis, the Opponent's Experimental Report is clearly insufficient to prove that fibres having the properties defined in Claim 11 of the patent in suit are the inevitable result of a duplication of the disclosure of document (1).

The subject-matter of Claim 11 is therefore novel over document (1).

2.4 Claim 1

This claim relates to a method for the preparation of polyolefin fabric from polyolefin material which, as according to Claim 6, was drawn twice and finally cooled under tension.

The cited documents do not disclose a fabric which was so prepared. This was not contested by the Opponent and there is therefore no necessity for further reasoning on this issue.

3. *Inventive step*

3.1 Claim 6

3.2 Technical objectives and their realization

According to the first sentence of the patent specification (identical to the original application) the alleged invention "relates to very low creep, ultra high modulus, low shrink, high tenacity polyolefin fiber having good strength retention at high temperatures and the method to produce such fiber."

The patent contains experimental evidence comparing the properties of poststretched fibre yarns with those of their respective feed yarns which were prepared according to document (8) by solution spinning and multi-step drawing of the dried xerogel fibres, first at about 130°C and thereafter at about 140-143°C, i.e. only the second drawing being within 10°C of the melting temperature of the fibres as required according to Claim 6 for both drawing operations (Example 3 on pages 3 to 4 of the patent in suit). Tables I and II of the patent in suit (page 8) demonstrate that by poststretching (once or twice) of such feed yarns

(Table I: Samples 1 and 4; Table II, Sample 1) ultimate tensile strength (UTS) and modulus are considerably enhanced, the ultimate elongation (UE) is reduced (Table I, Samples 2, 3 and Samples 5 to 9; Table II, Samples 2 to 5). The same effects of the poststretching of a prestretched feed yarn (see Samples 1) are demonstrated for Samples 2 and 3 in Tables V and VI of the patent in suit (pages 10 to 11). Tables V and VI show also that by poststretching the creep is considerably reduced (Table V: 30% load at room temperature; Table VI: 10% load at 71.1°C). Table VII of the patent in suit (page 12) demonstrates that by poststretching of feed yarns having respectively 800, 600 and 400 denier the free shrinkage at elevated temperatures (≥ 135°C) can be reduced to below 2.5%. Figure 1 of the patent comprises "tenacity vs temperature" plots of a prestretched feed yarn (Sample 1 of Table I) and of two poststretched yarns of 800 den (Sample 7 of Table I) and 600 den (Samples 2/3 of Table II). The figure shows that the poststretched yarns exhibit a higher tenacity at the same temperature as the control yarn (or, conversely, they preserve the same tenacity as the control yarn at higher temperatures) (description page 5, lines 24 to 33).

These experimental results show that all the desired property improvements may be attained by the poststretching of prestretched polyethylene fibres which were prepared in accordance with document (8).

3.3 Closest state of the art

For the assessment of inventive step, the most relevant of the cited documents is the one which not only comes close to the procedural steps taken according to

Claim 1 of the patent in suit, but also which contains, be it express or implicit, the most pertinent information with regard to the desired property improvements (see preceding paragraph).

It follows from the considerations set out below that these conditions are best fulfilled by document (8).

3.3.1 The process according to Examples 529 to 533 of document (8) is different from that according to Claim 6 of the patent in suit by the temperature of only 120°C in the first drawing operation (see Section 2.2.3.1 above). All other features of this claim are met by the conditions used according to these examples, particularly the drawing rate of the poststretching step which should be far below the 1 second $^{-1}$ limit according to Claim 6; at a stretch ratio (SR) of 2.5, a poststretch feed speed of 1 m/min and a length of the heated tube of 1,5 m (assumption based on column 11, line 58; column 17, last line; column 28, line 43) the draw rate $(V_{out} - V_{in})/L$, as calculated according to the patent in suit, is only 0.017 second^{-1}.

According to these Examples 529 to 533 (see table at column 26) the poststretched yarns exhibit a tensile strength, modulus and elongation which are considerably improved over those of the single step drawn yarn according to Example 523. Since these yarns are within the scope of Claim 1 of citation (8), their creep value should also be good (not more than 5%). The improvement of all these properties is thus part of the enabling disclosure of document (8).

As set out in Section 3.2 above there is experimental evidence in the patent in suit for a **further** improvement of some fibre properties (i.e. tenacity, modulus, elongation, creep) by two-stage drawing within

10°C of the melting temperature over a two-stage drawing according to document (8) comprising a first drawing at a temperature below the range of "within 10°C of the melting temperature" and a second drawing within this 10°C range (a melting temperature of 146° to 153°C is indicated in document (8) for the precursor fibre of Example 523; the lower limit of the 10°C range is therefore 136°C). It can therefore be recognized that by a two-step drawing according to present Claim 6, comprising two drawing steps within 10°C of the fibre melting temperature, tenacity, modulus, elongation and creep of the fibres can be further improved.

It follows from the above that the problem underlying the subject-matter of Claim 6 of the patent in suit with respect to document (8) was the definition of a process for the preparation of polyolefin fibres having (further) improved tenacity, modulus, elasticity and creep properties.

3.3.2 The issue of inventive step of the subject-matter of present Claim 6 over document (8) turns therefore on the question whether it was obvious to one skilled in the art that the above mentioned property improvement would be achieved by the claimed modification of the drawing conditions.

3.3.2.1 In the Board's judgment there is no information in document (8) which could lead a skilled person to conclude that by subjection of the fibres to two drawing operations close to their melting temperature, as according to the process of present Claim 6, a **further** property improvement would be achieved. The first drawing step in all double-stretch experiments carried out according to document (8) (Examples 503 to 551) was performed at 120°C and there is thus nothing

in this citation which would allow any conclusion with respect to the influence of temperature variations during the first drawing operation on the ultimate fibre properties.

The subject-matter of present Claim 6 was thus non-obvious over the disclosure of citation (8).

3.3.2.2 Documents (1) and (2) while i.a. relating to two-stage drawing processes at temperatures meeting the temperature conditions of present Claim 6, disclose that thereby an increase of the tensile strength at break (tenacity) can be achieved (document (1): page 873, Figure 1; document (2): page 782, 2nd paragraph below Figure 4). An improvement of other fibre properties is not explicitly disclosed.

In accordance with the observations contained in Section 3.3 above, these two documents could only then be regarded as being items of prior art lying closer to the subject-matter of Claim 6 than document (8) if it would be obvious to a skilled person that by the tenacity improvement the other desired property improvements (see Section 4.2 above) would by implication also be attained, at least to the same degree as according to document (8).

This, however, is not the case. Even if it is assumed that modulus and elongation will follow the change of tenacity in a predictable manner (compare e.g. the respective values in the document (8), table in column 26, Examples 523 to 533), there is no indication in any of the citations that the same was true for the creep; i.e. the Opponent's assumption that a tenacity enhancement will inevitably entail a creep reduction is unfounded. This is apparent from document (8), column 15, lines 18 to 58 where for the polyethylene

fibre of Example 71 having a tenacity of 37,6 d/den (see column 13, Table I, line 63) much better creep values of 0.1 to 1.45% are reported than for the "Surface Grown & Stretched Polyethylene" fibre having a (higher) tenacity of 41.5 g/den which exhibits creep values from 1.0 to 6.1% only.

3.3.2.3 The Board is also not convinced by the Opponent's reference to document (7) which, in his opinion, contained evidence for the parallelism of tenacity and creep improvement. Figure 7 of this document discloses that a higher draw ratio is accompanied by a lower creep (eg at the same drawing stress of 0.2 GPa the "plateau creep rates" (ϵp) decrease from above 10^{-4} to 10^{-7} when the draw ratio is enhanced from 10 to 30). Even if one admitted that a higher draw rate was equivalent to a higher tenacity, these results, which have been measured on melt spun fibres, one-stage drawn at 120°C, would not allow any conclusions to be drawn concerning a possible change of the creep properties of a two-stage drawn, solution spun fibre, the tenacity of which was enhanced by a temperature increase during the first of the two drawing operations. In other words, there is nothing in document (7) or in any other of the citations which would justify a generalisation of the data in Figure 7 of document (7) to the extent of a strict correlation of tenacity and creep independent from the "history" of preparation of the fibres. Furthermore, the Opponent has failed to provide the necessary evidence to establish the validity of such generalisation.

3.3.2.4 In these circumstances documents (1) and (2) are less relevant as starting points for the solution of the existing problem than document (8), and clearly cannot render obvious the subject-matter of Claim 6 of the patent in suit.

In view of the lacking information concerning a creep improvement in documents (1) and (2), even when combined with the disclosure in document (7), these citations do also not lend themselves to a combination with document (8) in this respect.

3.4 Claim 11

From the above reasoning with respect to the novelty of this claim and with respect to the inventivity of the subject-matter of Claim 6 it follows that none of the cited documents contains any suggestion as to how the property improvements defined in this claim could be achieved.

Consequently, the subject-matter of Claim 11 is based on an inventive step over the cited documents.

3.5 Claim 1

Since the process features of this claim are the same as those according to Claim 6, the same inventive step conclusions apply. It follows that the subject-matter of this claim does also meet the requirement of non-obviousness according to Article 56 EPC.

3.6 The dependent claims relate to preferred embodiments within the scope of the independent Claims 1, 6 and 11 and their subject-matter is, thus, likewise inventive.

4. It follows from the considerations set out above that the opposition failed to establish that the subject-matter of the patent in suit as granted did not comply with the requirements of Articles 54 and 56 EPC. Consequently, the patent must be maintained unamended.

5. Since the Patentee's Main Request can be allowed, his Auxiliary Request need not be considered in this appeal.

Order

For these reasons it is decided that:

1. The cross-appeal (Patentee's appeal) is allowed.

2. The case is remitted to the Opposition Division with the order to maintain the patent as granted.

The Registrar: The Chairman:

E. Görgmaier C. Gérardin