In the Matter of

CERTAIN ARAMID FIBER

Investigation No. 337-TA-194

USITC PUBLICATION 1824

MARCH 1986

United States International Trade Commission I Washington, DC 20436

UNITED STATES INTERNATIONAL TRADE COMMISSION

COMMISSIONERS

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Washington, DC 20436

ADDITIONAL AND DISSENTING VIEWS OF

VICE CHAIRMAN SUSAN W. LIEBELER

I join in the Commission majority's determination that there is a violation of section 337 of the Tariff Act of 1930 by virtue of the importation of aramid fiber made by a process that infringes claim 13 of U.S. Letters Patent 3,767.756 ('756 patent). I do not join with their opinion on the issues of remedy and public interest. I dissent from the majority's determination that the appropriate remedy in this investigation is a limited exclusion order covering only "basic" forms of aramid fiber. I believe the Commission should have sought additional information on the issue of remedy to determine whether a broader exclusion order should have been fashioned.[1] Furthermore, I believe the majority has established a new standard for injury that is not in accord with the statutory language. In these additional and dissenting views, I set forth my own views on injury, remedy. and public interest.

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[1] The Commission could have requested additional information by approving the request contained in action jacket GC-85-156. Action jacket GC-85-156 recommended that the Commission request additional information regarding (1) the TSUS numbers of the products that complainant DuPont wants excluded; (2) the percentage of manufacturing cost represented by aramid fiber in a particular finished product; (3) and the anticipated volume of imports for each type of product specified. Such information would have enabled the Commission to draft the appropriate order. Action jacket GC-85-156 was disapproved by a vote of 3 to 2.

Section 337(a) declares unfair methods of competition to be unlawful:

> Unfair methods of competition and unfair acts in the importation of articles into the United States, or in their sale . . ., the effect or tendency of which is to destroy or substantially injure an industry, efficiently and economically operated, in the United States, or to prevent the establishment of such an industry . . . are declared unlawful . . .[2]

In the instant investigation, the ALJ determined that imports of aramid fiber made by a process that infringes claim 13 of the '756 patent have the tendency to cause substantial injury to the domestic industry.[3] The Commission has adopted these findings.

Once the Commission has determined that there is a violation of section 337(a), section 337(d) directs the Commission to exclude the offending articles from entry into the United States unless considerations of public interest dictate otherwise. The operative language of section 337(d) is as follows:

> If the Commission determines . . . that there is a violation of this section, it shall direct that the articles concerned . . . be excluded from entry into the United States, unless, after considering the effect of such exclusion upon the public health and welfare, competitive conditions in the United States economy, the production of like or directly competitive articles in the United States, and United States consumers, it finds that such articles should not be excluded from entry.[4]

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[2] 19 U.S.C. S 1337(a) (1982).

[3] ID at 452.

[4] 19 U.S.C. S 1337(d) (1982).

UNITED STATES INTERNATIONAL TRADE COMMISSION
Washington, D.C. 20436

In the Matter of

CERTAIN ARAMID FIBER

Investigationcifo. 364-TA-104

NOTICE OF ISSUANCE OF LIMITED EXCLUSION ORDER

AGENCY: U.S. International Trade Commission.

ACTION: Notice is hereby given that the Commission has issued a limited exclusion order in the above-captioned investigation prohibiting the unlicensed importation of certain aramid fiber in the form of fiber, yarn, pulp, staple, chopped fiber, paper, felt, or fabric, manufactured abroad by Akzo N.V., Enka N.V., Aramide Maatschappij VoF., or Akzona, Inc. or any of their affiliated companies, parents, subsidiaries, licensees, or other related business entities, or their successors or assigns.

FOR FURTHER INFORMATION CONTACT: Catherine R. Field, Esq., Office of the General Counsel, U.S. International Trade Commission, telephone 202-523-0189.

SUPPLEMENTARY INFORMATION: On April 18, 1984, the Commission received a complaint filed on behalf of E.I. du Pont de NamourS & Co. (Du Pont) of Wilmington, Delaware. The complaint alleged unfair methods of competition and unfair acts in the importation or sale of certain aramid fiber. On May 14, 1984, the Commission voted to institute an investigation to determine whether there was a violation of subsection (a) of, section 337 of the Tariff Act of 1930, 19 U.S.C. S 1337, and 19 U.S.C. S 1337a, in the unlawful importation of certain aramid fiber into the United States or in its sale, by reason of alleged production of such fiber overseas by means of a process allegedly covered by the claims of U.S. Letters Patent 3,767,756, the effect or tendency of which is to destroy or substantially injure an industry, efficiently and economically operated, in the United States. 49 Fed. Reg. 21806. The notice of investigation named the following respondents: Akzo N.V., Enka B.V., and Aramide Maatschappij VoF, all of the Netherlands, and Akzona, Inc., of Enka, North Carolina.

On July 15, 1985, the Commission affirmed the initial determination (ID) of the presiding administrative law judge (ALJ) that there was a violation of section 337 of the Tariff Act of 1930 in the unauthorized importation into the United States, and in the sale, of certain aramid fibers manufactured abroad by a process that, if practiced in the United States, would infringe claim 13 of the '756 patent with the tendency to substantially injure an industry, efficiently and economically operated, in the United States. 50 Fed. Reg. 30246.

The Commission published a notice in the Federal Register requesting written submissions on the issues of remedy, public interest, and bonding. In addition to submissions from the parties to the investigation, the Commission received comments from the Government of the Netherlands, the Delegation of the European Communities, the U.S. Customs Service, and several members of the public.

Copies of the Commission's Action and Order, the nonconfidential version of the ALJ's ID, and all other nonconfidential documents filed in connection with this investigation are available for inspection during official business hours (8:45 a.m. to 5:15 p.m.) in the Office of the Secretary, U.S. International Trade Commission, 701 E Street NW., Washington, D.C. 20436, telephone 202-523-0161. Hearing-impaired individuals are advised that information on this matter can be obtained by contacting the Commission's TDD terminal on 202-724-0002.

By order of the Commission.

Kenneth R. Mason
Secretary

Issued: November 25, 1985

UNITED STATES INTERNATIONAL TRADE COMMISSION
Washington, D.C. 20436

In the Matter of)
) Investigation No. 337-TA-194
CERTAIN ARAMID FIBER)

COMMISSION ACTION AND ORDER

Background

On April 18, 1984, the Commission received a complaint filed on behalf of E.I. du Pont de Nemours & Co. (Du Pont) of Wilmington, Delaware. The complaint alleged unfair methods of competition and unfair acts in the importation or sale of certain aramid fiber. On May 14, 1984, the Commission voted to institute an investigation to determine whether there was a violation of subsection (a) of section 337 of the Tariff Act of 1930, 19 U.S.C. S 1337, and 19 U.S.C. S 1337a, in the unlawful importation of certain aramid fiber into the United States or in its sale, by reason of alleged production of such fiber overseas by means of a process allegedly covered by the claims of U.S. Letters Patent 3,767,756 (the '756 patent), the effect or tendency of which is to destroy or substantially injure an industry, efficiently and economically operated, in the United States. 49 Fed. Reg. 21806. The notice of investigation named the following respondents: Akzo N.V., Enka B.V., and Aramide Maatschappij VoF, all of the Netherlands, and Akzona, Inc., of Enka, North Carolina.

On July 15, 1985, the Commission affirmed the initial determination (ID) of the presiding administrative law judge (ALJ) that there was a violation of section 337 of the Tariff Act of 1930, in the unauthorized importation into the United States, and in the sale of certain aramid fiber manufactured abroad by a process that, if practiced in the United States, would infringe claim 13 of the '756 patent with the tendency to substantially injure an industry, efficiently and economically operated, in the United States. 50 Fed. Reg. 30246.

The Commission published a notice in the Federal Register requesting written submissions on the issues of remedy, public interest, and bonding. In addition to submissions from the parties to the investigation, the Commission received comments from the Government of the Netherlands, the Delegation of the European Communities, the U.S. Customs Service, and several members of the public.

Action

After reviewing the submissions on remedy, public interest, and bonding, and the evidence and information relating io those issues on the record, the Commission has determined to issue a limited exclusion order prohibiting the entry of aramid fiber in the form of fiber, yarn, pulp, staple, chopped fiber, paper, felt, or fabric, made abroad by Akzo N.V., Enka N.V., Aramide Maatschappij VoF., or Akzona, Inc., or any of their affiliated companies, parents, subsidiaries, licensees, or other related business entities, or their successors or assigns, by a process that, if practiced in the United States, would infringe claim 13 of U.S. Letters Patent 3,767,756, except under license of the patent owner or as provided by law.

The Commission has also determined that the public interest factors enumerated in section 337(d) of the Tariff Act of 1930 do not preclude issuance of such an exclusion order and that the bond during the Presidential review period should be in the amount of 30 percent of the entered value of the articles covered.

Order

Accordingly, it is hereby ORDERED THAT--

1. Aramid fiber in the form of fiber, yarn, pulp, staple, chopped fiber, paper, felt, or fabric, made abroad by Akzo N.V., Enka N.V., Aramide Maatschappij VoF., or Akzona, Inc., or any of their affiliated companies, parents, subsidiaries, licensees, or other related business entities, or their successors or assigns, by a process that, if practiced in the United States, would infringe claim 13 of U.S. Letters Patent 3,767,756, shall be excluded for the remaining life of the patent, except under license of the patent owner or as provided by law;

2. The aramid fiber ordered to be excluded is entitled to entry into the United States under bond in the amount of 30 percent of the entered value of the subject article, from the day after this order is received by the President, pursuant to subsection (g) of section 337 of the Tariff Act of 1930, until such time as the President notifies the Commission that he approves or disapproves this action, but, no later than 60 days after the date of receipt of this action and order by the President;

3. Pursuant to procedures to be specified by the U.S. Customs Service, persons seeking to import aramid fiber in the forms covered by this Order shall, prior to the entry of such fiber into the United States, certify that the manufacturer of such fiber is E.I. du Pont de Nemours & Co. or a licensee of E.I. du Pont de Nemours & Co.;

4. The Commission may amend this Order in accordance with the procedure described in 19 C.F.R. S 211.57; and

5. The Secretary shall serve a copy of this Action and Order and of the Commission Opinion in support thereof upon each party of record to this investigation, the Department of Justice, the

Federal Trade Commission, and the Secretary of the Treasury and he shall publish notice thereof in the Federal Register;

By order of the Commission.

Kenneth R. Mason
Secretary

Issued: November 25, 1985

U.S. INTERNATIONAL TRADE COMMISSION
Washington, D.C.

In the Matter of

CERTAIN ARAMID FIBER

Investigation No. 337-TA-194

COMMISSION OPINION ON VIOLATION, REMEDY, PUBLIC INTEREST, AND BONDING 1/

On May 9, 1985, the presiding administrative law judge (ALJ) issued an initial determination (ID) finding that there is a violation of section 337 of the Tariff Act of 1930, 19 U.S.C. S 1337, in the unauthorized importation into the United States, and in the sale of certain aramid fiber by reason of infringement of claim 13 of U.S. Letters Patent 3,767,756 ('756 patent), with the tendency to destroy or substantially injure an industry, efficiently and economically operated, in the United States.

On July 15, 1985, the Commission determined to review a portion of the ID relating to the validity of the '756 patent. The ALJ made no specific finding of fact regarding the level of ordinary skill in the art. It appeared from the ID, however, that the ALJ resolved this question and analyzed the issues of anticipation and obviousness in light of his conclusions. In the absence of express findings on the level of ordinary skill in the art, however, the Commission examined the record in this investigation and reached a conclusion

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1/ Vice Chairman Liebeler dissents from those portions of this opinion relating to remedy and public interest. See Vice Chairman Liebeler's Additional and Dissenting Views infra.

on this point. Based upon its conclusions regarding the level of ordinary skill in the art, the Commission affirmed the ALJ's finding with regard to obviousness and anticipation and that the '756 patent is valid. The Commission determined not to review the remainder of the ID and, thus, the Commission concluded that there is a violation of section 337 in this investigation. 50 Fed. Reg. 30246.

Having determined that there is a violation of section 337, the Commission requested and received written submissions on the issues of remedy, public interest, and bonding. In addition to submissions from Du Pont, Akzo, and the investigative attorney (IA), several parties, including the Government of the Netherlands, the Delegation of the Commission of the European Communities, and U.S. users of aramid fiber, filed comments on the public interest considerations.

PROCEDURAL HISTORY

On April 18, 1984, the Commission received a complaint filed on behalf of Du Pont pursuant to sections 1337 of the Tariff Act of 1930, 19 U.S.C. S 1337 and 19 U.S.C. § 1337a. The complaint alleged unfair methods of competition and unfair acts in the importation of certain aramid fiber into the United States, or in its sale, by reason of alleged (1) production overseas by a process allegedly covered by the claims of U.S. Letters Patent 3,767,756, and (2) unfair **methods of competition** by misappropriation of benefits of Du Pont's investments in **the development of commercial uses and customers for aramid fiber.** The complaint also alleged that the effect or tendency of the unfair methods of competition and unfair acts is to destroy or substantially injure an industry, efficiently and economically operated, in the United States. On May 14, 1984, the Commission ordered that an investigation be instituted to determine whether there was a violation of section 337(a) in the unlawful importation of certain aramid fiber into the United States, or in its sale, by reason of alleged production of such fiber overseas by means of a process allegedly covered by the claims of the '756 patent, the effect or tendency of which is to destroy or substantially injure an industry, efficiently and economically operated, in the United States. 2/

The evidentiary hearing on violation commenced on February 11, 1985, and concluded on February 23, 1985. Pursuant to rule 210.53(g) of the Commission's Rules of Practice and Procedure, 3/ the ALJ reopened the record on February 28, 1985, and March 5, 1985, to hear additional rebuttal testimony. The ALJ heard closing arguments on March 19, 1985.

On May 9, 1985, the ALJ issued his ID finding that there was a violation of section 337 in the unauthorized importation into the United States, and in the sale of certain aramid fiber by reason of infringement of claim 13 of the '756 patent, with the tendency to substantially injure an industry, efficiently and economically operated, in the United States. The ALJ made the following conclusions of law in the ID:

1. Claim 13 of U.S. Letters Patent 3,767,756 is not invalid under 35 U.S.C. SS 102, 103, and 112.
2. Claim 13 of the '756 patent is not unenforceable because of any misconduct, violation of the antitrust laws or patent misuse, or for any reason based on the record before the ALJ.
3. Claim 13 of the '756 patent has been infringed by each of the respondents.
4. There is a domestic industry in the manufacture of aramid fiber which is efficiently and economically operated.
5. Importation of the aramid fiber made by claim 13 of the '756 patent has not substantially injured the domestic industry.

2/ 49 Fed. Reg. 21806.

3/ 19 C.F.R. § 210.53(g).

6. Importation of the aramid fiber made by claim 13 of the '756 patent does have the tendency to substantially injure the domestic industry.

7 There is a violation of section 337 of the Tariff Act of 1930, as amended, 19 U.S.C. § 1337, by each of the respondents.

ID at 452.

The Commission has determined to review only the ALJ's conclusion that claim 13 of the '756 patent is not invalid under 35 U.S.C. §§ 102 and 103.

VALIDITY OF CLAIM 13 OF THE '756 PATENT

In the ID, the ALJ noted the statutory presumption of validity under 35 U.S.C. § 282. In light of that presumption, Akzo must establish invalidity of the '756 patent by clear and convincing evidence. In attempting to establish the invalidity of the '756 patent, Akzo relied primarily upon two references: Monsanto's Morgan '645 patent and Du Pont's Kwolek '542 patent. Both of these patents were of record during the prosecution of the '756 patent and provided the basis for the patent examiner's initial rejections of the '756 patent. Du Pont, however, overcame those objections and the '756 patent issued. The ALJ noted that this prosecution history increases the burden on the party asserting invalidity because that party has the additional burden of overcoming the deference that is due to a qualified government agency (the U.S. Patent and Trademark Office) presumed to have properly done its job. 4/

A. **No anticipation** of claim 13 under 35 U.S.C. § 102

Anticipation under 35 U.S.C. § 102 requires disclosure of each and every

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4/ ID at 37-38, citing, Fromson v. Advance Offset Plate, Inc., 755 F.2d 1549 (Fed. Cir. 1985); American Hoist & Derrick Co. v. Sowa & Sons, Inc., 725 F.2d 1350, 1359, 220 USPQ 763, 770 (Fed. Cir. 1984).

element of the claimed invention in a single prior art reference. 5/ addition, the relevant reference must be an enabling disclosure to the extent that the prior art places the allegedly disclosed matter in the possession of the public. 6/

The ALJ's analysis of what the allegedly anticipatory patents disclosed and whether that disclosure constituted the necessary enablement was based in part on how a person of ordinary skill in the art would interpret the allegedly anticipatory prior art at the time of the '756 invention. Thus, for example, the ALJ found that the Morgan '645 patent was not anticipatory in that it does not disclose a process involving sulfuric acid of "at least 98%" concentration as required by all of the claims of the '756 patent. This concentration is critical for the formation of the anisotropic dopes used in the '756 patent claims. The ALJ found that concentrated sulfuric acid is not inherently sulfuric acid of at least 98 percent. The ALJ noted that Du Pont used the term concentrated sulfuric acid to refer to concentrations as low as 95 percent and also made findings regarding the common understanding of the term concentrated sulfuric acid as demonstrated in various texts. 7/ The ALJ rejected Akzo's argument that the Smith '125 patent referred to in the '645 patent and the recitation of "concentrated sulfuric acid" in the '645 patent taught that the sulfuric acid was of at least 98 percent concentration. 8/

The ALJ rejected Akzo's argument that scientists within Du Pont would have understood (or interpreted) the term concentrated sulfuric acid as used

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5/ ID at 38, <u>citing among others,</u> Connel v. Sears, Roebuck 6 Co., 722 F.2d 1542, 220 USPQ 193 (Fed. Cir. 1983); SSIH Equipment S.A. v. USITC, 718 F.2d 365, 218 USPQ 678 (Fed. Cir. 1983).

6/ Id., <u>citing,</u> In re Brown, 329 F.2d 1006, 1011, 141 USPQ 245, 249 (C.C.P.A. 1964).

7/ Finding of Fact (FF) 389.

8/ Id. at 41.

in the '645 patent to mean a concentration of at least 98 percent and suitable for making anisotropic dopes of 4,4'—DABT. 9/ It is clear from these two points that the ALJ considered the ordinary level of skill in the art in assessing how practitioners in the field would interpret the allegedly anticipatory prior art.

B. Nonobviousness of claim 13 under 35 U.S.C. S 103

The ALJ found that claim 13 was not obvious under 35 U.S.C. S 103. Again it is clear that the ALJ considered the ordinary level of skill in the art at the time of the invention. Indeed, the ALJ cited testimony of Du Pont's expert witness, Dr. Uhlmann, to the effect that one skilled in the art would be directed by the teachings of various prior art patents not to combine them. FF 340.

Although the ALJ implicitly analyzed the level of ordinary skill in the art, 10/ we recognize that the ALJ did not make an express finding of fact on this point. In an effort to clarify any ambiguity on this point, we have examined the record and reached our own conclusion on this issue. 11/ Moreover, our finding on the level of ordinary skill in the art at the time of the Blades invention is consistent with the ALJ's conclusions regarding anticipation and obviousness.

Among the factors which we considered in assessing the level of ordinary skill in the art are (1) the educational level of the inventor, (2) the

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9/ FF 389 lists various definitions of concentrated sulfuric acid dating from 1952 to 1984. Moreover, the ALJ noted that Akzo buys commercially available 96 percent sulfuric acid and acids oleum in a ratio of 11 to 9 oleum to make sulfuric acid of approximately 100 percent concentration. FF 390.

10/ ID at 55; ACS Hospital Systems, Inc. v. Montefiore Hospital, 732 F.2d 1572, 1576 (Fed. Cir. 1984).

11/ See Jones v. Hardy, 727 F.2d 1524 (Fed. Cir. 1984).

various prior art approaches employed, (3) the types of problems encountered in the art, (4) the rapidity with which inventions are made, (5) the sophistication of the technology involved, and (6) the educational background of those actively working in the field. 12/ It is clear from the record that the educational level of the inventor and those actively working in the area was extremely high, normally consisting of a doctoral degree. The prior art concerned synthetic fiber spinning from many types of polymers including para-oriented polyamides. At least four major firms—Monsanto, Celenese, Akzo, and Du Pont—were engaged in searching for commercially viable, high tenacity synthetic fibers. Thus, we do not believe that the level of skill exemplified among certain scientists at Du Pont is dispositive of the issue. The technology concerned, to the extent that the appropriate spinning process was dependent upon the characteristics of a specific polymer, was extremely involved and inventions in this area often took years to develop. Thus, -we believe that the level of ordinary skill in the art at the time of the invention was high, requiring at least a doctoral degree in chemistry and experience in the field of spinning various polymers. The ALJ's analysis is consistent with this view.

In light of this **analysis, we concur with the ALJ's conclusions** that claim 13 of **the '756 patent is not invalid under 35 U.S.C. SS 102 or 103. Thus, we find that there is a violation of section 337 of the Tariff Act of 1930, 19 U.S.C. S 1337.**

12/ Orthopedic Equipment, Inc. v. All Orthopedic Appliances, Inc., --F.2d--, 217 USPQ 1281, 1285 (Fed. Cir. 1985).

REMEDY

Du Pont has requested that the Commission issue a limited exclusion order—

> covering the basic forms of aramid fiber manufactured by Akzo and articles fabricated from such basic forms. It is not the intent of this proposed order to cover high value products such as aircraft and automobiles which contain relatively minor component parts fabricated from Akzo's fiber. It is the intent of the order to cover articles made from Akzo's fiber, such as protective apparel, ropes and cables, separately marketed aircraft, automotive and marine composite parts, brake blocks and clutches, hose, power transmission and conveyor belts, tires, printed wiring boards, and fabric. 13/

In determining the scope of the remedy accorded a complainant, the Commission has an obligation to reconcile complainant's interest in the most complete relief possible for the unfair act found to exist with the need to avoid disruption of legitimate trade. 14/ 15/

13/ Du Pont's' Memorandum on Remedy and Bonding at 2.

14/ See Certain Plastic Food Storage Containers, Inv. No. 337—TA-152, USITC Pub. No. 1563 at 5 (1984); Certain Personal Computers and Components Thereof, Inv. No. 337—TA-140, USITC Pub. No. 1504 at 45 (1984); Certain Airless Spray Pumps and Components Thereof, Inv. No. 337—TA-90, USITC Pub. No. 1199 at 18, 216 USPQ 465 (1981).

15/ Chairwoman Stern notes that Vice Chairman Liebeler is in fact rejecting this standard. This is a natural consequence of her basic misreading of the statute. As the statute now stands, findings regarding both the existence of an economic and efficiently operated domestic industry and the existence of substantial injury (or the tendency to substantially injure) such a domestic industry are _required,._

There is always a place for legitimate dissent in Commission determinations. Although every case before the Commission presents each Commissioner with the opportunity to exercise judgment on questions of fact and proper statutory interpretation, the clear intent of the statute cannot be changed by rhetoric. Further, a responsible dissent requires a fair and proper reading of the precedent fromhwhich one is dissenting. For example, investigations such as _Personal Computers_ involve the question of whether imports of components substantially injure the domestic industry producing the complete product and should be included within the scope of the remedy. This

(footnote continued on next page)

Aramid fiber is a highly specialized product manufactured through a sophisticated process involving expensive technology. The process covered by claim 13 of the '756 patent is the only known method for producing aramid fiber on a commercial basis. Importantly, only Du Pont and Akzo have the capability to produce aramid fiber on a commercial basis.

Aramid fiber made by means of the process disclosed in claim 13 of the '756 patent has many diverse applications including use in spacecraft, aircraft, ropes and cables, bullet resistant and other protective clothing, hard armor, tires, boat hulls, and gaskets, among others. New applications for aramid fiber and aramid fiber products are being developed constantly. Aramid fiber is essentially a basic product that can be processed and combined with other products before reaching a final form.

Du Pont's sales of aramid fiber products are typically to manufacturers or processors. These products include aramid fiber in the form of fiber, yarn, pulp, staple, chopped fiber, and "wet lap" rolls of coarsely formed paper. In addition, the record shows that Du Pont subcontracts weaving of aramid fiber fabric for sampling and product development purposes. 16/ Thus,

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15/ (footnote continued from previous page)
question differs from the issue presented in the present investigation. This investigation involves the question of whether imports of finished products containing the infringing component cause substantial injury and should be included in the scope of the remedy. There are obvious analytical differences between the two factual situations and treating them differently is in no sense an inconsistent application of precedent.

Despite the fact that the Vice Chairman gives a nod to the obligation of the Commission to balance the need of complainant for effective relief and the need to avoid disruption of legitimate trade, she nevertheless has made a finding in this investigation "that millions of dollars of aramid fiber contained in finished products will enter the United States," although the record contains no useful information regarding the volume of imports of finished products containing aramid fiber, prices of these products, or the impact of these imports on the domestic industry. Any balancing of complete relief with avoidance of disruption of legitimate trade in this situation could not have led to the remedy recommendation of the Vice Chairman.

16/ ID at 116-17, FF 19-21; Appendix to complainant's Reply on Remedy, Exhibit 4.

Du Pont does not manufacture many of the finished products that it requests the Commission to include within the scope of the remedy.

Akzo's current activity in the United States is limited to providing samples of its aramid fiber to prospective customers of commercial quantities of aramid fiber. Based on this and other considerations set forth in the ID, the Commission found that Akzo's unfair acts and methods of competition have the tendency to substantially injure the domestic industry. Thus, substantial injury will occur in the future if the unfair acts are not remedied. The record in this investigation shows that Akzo either presently produces fiber, yarn, pulp, staple, chopped fiber, fabric, paper and felt or has the ability to do so in the near future. 17/

We have determined that a limited exclusion order covering imports of aramid fiber in the form of fiber, yarn, pulp, staple, chopped fiber, paper, felt, and fabric made by Akzo is the appropriate remedy in this investigation. 18/ 19/ Complainant has requested an order also covering a broad range of products that may be produced using the aramid fiber products covered by this order. The importation of an article containing aramid fiber made by the infringing process, no matter how small the amount of such fiber, may be an unfair act under the terms of section 337a. However, for the reasons outlined below, we decline to issue such a broad order.

17/ Appendix to Complainant's Reply on Remedy at Exhibit 9.

18/ 19 U.S.C. s 1337(a).

19/ Commissioner Lodwick believes that aramid fiber in the specified forms should be excluded. In that sense the decision to issue this limited - exclusion order is correct. However, a more appropriate remedy may have been to exclude from importation some articles fabricated from such basic forms as well. The Commission had the responsibility to exerise an informed judgment concerning this broader range of products. If necessary, the Commission could have called upon DuPont and Akzo to submit additional information on specific products or categories of products to supplement the present record. Such a procedure should seldom be used, but it was called for here since the Commission had not previously announced what issues must be addressed and what judicial procedure is to be employed in a case such as this.

Section 337 provides that unfair methods of competition and unfair acts in the importation or sale of articles must have the effect or tendency to destroy or substantially injure a domestic industry. This injury provision distinguishes section 337 as a cause of action from domestic patent law actions. 20/ Indeed, our reviewing court has specifically rejected the argument that any amount of injury is sufficient to satisfy the injury requirement. The patent holder must "normally establish that the infringer holds, or threatens to hold, a significant share of the domestic market in the covered articles of has made a significant amount of sales of the articles. 21/ Thus, it is clear that the Commission cannot assume the existence of substantial injury.

For the Commission to issue an exclusion order complainant must establish that each of the products to be excluded, individually or collectively, can have the effect or tendency to substantially injure or destroy the domestic industry. 22/ In this investigation, the AU made no

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20/ Textron, Inc. v. U.S. Intern. Trade Com n, 753 F. 2d 1019, 1028 (1985).

21/ Id. at 1028-29.

22/ Chairwoman Stern notes that the balance between the requirements of providing complainant with an adequate remedy and avoiding the disruption of legitimate trade **was uniquely difficult in:this** investigation. On the one hand, the Commission is **mandated to find an effective remedy for the injury to the domestic industry by the imports covered by the finding of violation. On the other hand, a domestic industry should not be denied relief because of the nature of the imported form of the article, if it is within the power of the Commission to reach such a remedy. There could certainly be a factual situation where the Commission is absolutely unable to fashion a remedy for the** injury **found to exist without considering a remedy broader than the articles covered by the finding of substantial injury. Section 337 directs us to consider equitable defenses; we should establish standards which** achieve equitable remedies as **well. Of course, the balancing principle from Food <u>Storage Containers,</u>** Inv. No. 337—TA-152 (1984), of providing the necessary relief without undue disruption to legitimate trade also applies in this situation. In this investigation Chairwoman Stern does not find a compelling reason to reach beyond **the basic forms of aramid fiber. She thus finds it appropriate in this case to concur with the result reached by the Commission. Cf. Certain Processes for the Manufacture of Skinless Sausage Casings and Resulting Product, Inv. No. 337—TA-148/169, and Personal Computers and Components Thereof, Inv. No. 337—TA-140 (1984). (footnote continued next pfile)** such findings as to products other than the basic forms of aramid fiber. The Commission notes that in the future, where there may be an issue concerning the scope of the products covered by an injury finding, the products covered by the finding should be stated in the ID.

The Commission finds that complainant has not established that imports of articles fabricated from basic forms of aramid fiber will have the effect or tendency to substantially injure or destroy the domestic industry. 23/ We note that the ALJ's findings, which were based on the basic forms of aramid fiber, found a tendency to substantially injure the domestic industry.

Although the Commission has issued exclusion orders covering components of complete products that have been found to have the effect or tendency to substantially injure a domestic industry, this investigation presents the

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22/ (footnote continued from previous page)

The information on the record at the time of the Commission's consideration of the ID clearly established the basis for this finding. Further, the information available to the Commission gave no indication that additional information on the question would result in a different remedy finding. Some of the finished products for which complainant sought relief were such that it would be difficult, if not impossible, to separate the infringing component from the imported product and in many cases, the value of the imported infringing components was small vis a vis the total value of the imports.

The difficulty of ascertaining the proper relief for complainants in similar situations in the future can be minimized through the fullest possible development of all issues relating to substantial injury, including all market conditions affecting trade in the products which exploit the intellectual property rights in question. This issue deserves further examination on a case by basis.

23/ Commissioner Lodwick notes that this finding of the Commission enhances the inherent ambiguity of the concept announced herein that "complainant must establish that each of the products to be excluded, individually or collectively, can have the effect or tendency to substantially injure or destroy the domestic industry." The Commission summarizes certain findings of the ALJ to the effect that the importation of aramid fiber in its basic forms has a tendency to substantially injure. One might have thought that, having made that finding, aramid fiber contained in finished products must necessarily contribute to an even larger collective injury, with the result that those finished products would also be excludable.

obverse of that factual situation. 24/ Whereas imports of components to be assembled into the complete product in the United States have the same effect or tendency to substantially injure the domestic industry producing the complete product the same may not be true for imports of products incorporating the infringing product. In the absence of such a finding we cannot include these imports within the scope of the exclusion order.

In order to comprehend complainant's arguments for a broad exclusion order covering articles fabricated from basic forms of aramid fiber, it is necessary to understand the market. Foreign producers of articles fabricated from basic forms of aramid fiber have purchased the basic forms of aramid fiber from complainant and then exported some of these products back to the United States. Some of the foreign producers of articles fabricated from basic forms of aramid fiber are presently sampling and qualifying for their use one of the basic forms of aramid fiber manufactured by respondent.

Complainant's arguments for a broad exclusion order rest on several assumptions. Complainant assumes that foreign producers of articles fabricated from basic forms of aramid fiber who export such products to the United States will turn from domestically produced basic forms to foreign produced aramid fiber because of an alleged difference in price. Moreover, it is assumed that foreign producers of articles fabricated from basic forms of aramid fiber will continue to export their finished products to the United

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24/ See Certain Steel Rod Treating Apparatus and Components Thereof, Inv. No. 337-TA-97 (1982); Certain Headboxes and Papermaking Machine Forming Sections for the Continuous ProduCtion of Paper and Components Thereof, Inv. No. 337-TA-82A, 217 USPQ 179 (1981).

States and that such imports would cause substantial injury to the domestic industry.

The Commission's limited exclusion order covers those imported products that clearly have the potential to injure the domestic industry during the remaining life of the '756 patent, Products such as fabric, felt, and paper constitute primary commercial forms of aramid fiber and consist simply of aramid fiber that has been processed into a marketable form and are clearly identifiable as aramid fiber products. An order of this scope, thus, will best accomplish the goal of reconciling total relief with the need to avoid disruption of legitimate trade.

PUBLIC INTEREST CONSIDERATIONS

Section 337(d) provides that the Commission shall enter an exclusion order unless "after considering the effect of such exclusion upon the public health and welfare, competitive conditions in the United States economy, the production of like or directly competitive articles in the United States, and United States consumers, it finds that such articles should not be excluded from entry." 19 U.S.C. 1337(d), We determine that a limited exclusion order covering imports of aramid fiber in.the form of fiber, yarn, pulp, staple, chopped fiber, paper, felt, and fabric will not have an adverse effect on these public interest considerations and, thus, those articles should be excluded from importation into the United States.

Consideration of the public interest factors also leads us to the conclusion that the issuance of the broader exclusion order requested by complainant would not be in the public interest. In this investigation, issuance of a broader order, covering processed products, would be unduly burdensome on legitimate trade and difficult to enforce. 25/ The requested order could cover articles in which the aramid fiber content is minimal and the attempt to establish exclusions based on the value or volume of the aramid fiber content of particular products that may be imported in the future would be too uncertain and speculative.

The Commission has considered the effect that the selected remedy would have on the four public interest factors in light of complainant's right to enforce valid intellectual property rights. Du Pont may lawfully limit exploitation of the patented process until its patent expires in 1990. With

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25/ Commissioner Lodwick notes that these concerns should be met by drawing lines: drawing lines to separate some (not necessarily all) products which contain large amounts of aramid fiber from other products which contain small amounts; drawing lines to separate some products which appear potentially injurious to the domestic industry from other products which appear not to have a significant potential for injury, for the purpose of assessing public interest. This is how the Commission fulfills its "obligation to reconcile complainant's interest in the most complete relief possible . . . with the need to avoid disruption of legitimate trade." See discussion at note 14 **supra.** Devising rules by which to draw lines is difficult; and the drawing of the lines is difficult and in frequently attended by criticism. But as has been said elsewhere concerning courts, it is the job of the Commission to draw lines. As a mature agency, the Commission should be adept at that job and skillful in the use of devices (e.g. certification to Customs, advisory opinions) in fashioning a remedy and anticipating the means for its administrative maintenance. The Commission was not limited to choosing between "the broad order requested by DuPont" and the order which the Commission decided to issue. There were as many possibilities as there are finished products and combinations thereof. Whether the Commission could have devised an appropriate and effective order which, in addition to the basic forms of fiber, also excluded from importation some finished products, cannot now be known. The Commission should have made the effort to examine the possibilities. The Commission's failure to meet this responsibility is underscored by the potential for "circumvention" which is inherent in the order which the Commission has issued. Commerce is a highly resourceful activity. Somewhere near the "obvious—end" of the spectrum of possible commercial reactions to the Commission's order is "product—shifting", i.e., when importation of foreign—produced basic forms of aramid fiber is blocked the fiber is used by foreign manufacturers to produce finished products (rope, cable, etc.) which are then imported into the United States.

regard to the effect of an exclusion order on the public health and welfare and on United States consumers in general, Akzo has argued that Du Pont will have neither the capacity nor the desire to supply the asbestos replacement market in the future and that use of aramid fiber as an asbestos replacement will progress at a faster rate if a second source of the product is available. We find that Du Pont has sufficient capacity to satisfy demand during the life of the '756 patent including demand for aramid as an asbestos replacement. 26/ Moreover, customers' preference for a second source of a patented product does not provide generally a basis for denying relief under section 337. Although the Commission has recognized public interest exceptions to this rule, it has limited those exceptions to instances where the public as a whole suffered from the lack of availability of a patented article 27/ or tomplainant's product was an insufficient substitute for the imported product. 28/ Neither of these conditions exist in this investigation. Aramid fiber is available to consumers as a substitute for asbestos, and Akzo failed to establish that availability of a second source would actually increase the substitution rate. Moreover, Du Pont continues to engage in extensive research and product development, and both Du Pont's aramid fiber and Akzo's aramid fiber can be put to the same uses.

Akzo has contended that the U.S. Government's desire for a second source of aramid fiber provides a reason for denial to provide relief in this

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26/ ID at 108-109a.

27/ See Certain Fluidized Support Apparatus and Components Thereof, Inv. No. 337—TA-182/188, USITC Pub. No. 1667 (1984); Certain Inclined—Field Acceleration Tubes, Inv. No. 337—TA-62, USITC Pub. No. 1027 (1980); Certain Automatic Crankpin Grinders, Inv. No. 337—TA-60, USITC Pub. No. 1022 (1979).

28/ Certain Inclined—Field Acceleration Tubes, Inv. No. 337—TA-62, USITC Pub. No. 1027 (1980).

investigation. We find that section 337(i) provides Congress' solution to the problem of imports for or by the U.S. Government. 19 U.S.C. s 1337(i). Any Commission exclusion order would not apply to imports for or by the U.S. Government.

With regard to the effect of the proposed exclusion order on competitive conditions in the United States economy and the production of like or directly competitive articles in the United States, we note that aramid fiber faces competition from various products that can be used for the same end uses. In addition, the adoption of Du Pont's value—in—use pricing strategy reflects price competition with other substitute products for various end uses. 29/

BONQING

Articles subject to an exclusion order issued pursuant to section 337(d) are entitled to entry under bond during the 60—day Presidential review period. The lack of present commercial sales of Akzo fiber and Du Pont's practice of using value—in-use pricing preclude any direct price comparisons between Akzo's and Du Pont's aramid fiber. We determine that a bond of 30 percent of the entered value of the articles concerned will offset any competitive advantage resulting from the unfair act or method of competition found to exist in this investigation. We base this bond amount on testimony regarding potential deviations from Du Pont's price structure for sales of aramid fiber. This is the best information available on this issue, and this bond amount reflects an approximation of the advantage that would accrue to Akzo.

29/ Id. at 78-81.

DuPont has requested that the Commission issue a limited exclusion order

> covering the basic forms of aramid fiber manufactured by Azko and articles fabricated from such basic forms. It is not the intent of this proposed order to cover high value products such as aircraft and automobiles which contain relatively minor components fabricated from Azko's fiber. It is the intent of the order to cover articles made from Azko's fiber, such as protective apparel, ropes and cables, separately marketed aircraft, automotive and marine component parts, brake blocks and clutches, hose, power transmission and conveyor belts, tires, printed wiring boards, and fabric.[5]

The Commission majority has denied DuPont's request to exclude articles made from infringing fiber. I have three major disagreements with their decision. First. I do not think that DuPont had an obligation to prove, or that the ALJ had to determine, that imports of finished products, which contain aramid fiber made by a process that infringes claim 13 of the '756 patent, have the effect or tendency to destroy or substantially injure the domestic industry.[6] Section 337a instructs the Commission to treat products produced under process patents the same way as ptoducts that are themselves covered by patents:

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[5] DuPont's Memorandum on Remedy and Bonding at 2.

[6] 1 also disagree with any suggestion that the ALJ specifically determined that there was a tendency for the domestic industry to be injured by reason of imports of "basic" forms of aramid fiber and that he made no such finding with respect to finished products that contain aramid fiber. Rather the ALJ's finding was that aramid fiber made by a process that infringes claim 13 of the '756 patent, in <u>general,</u> had a tendency to substantially injure the domestic industry. ID at3 452.

> The importation for use, sale, or exchange of a product made, produced, processed, or mined under or by means of a process covered by the claims of any unexpired valid United States letters patent, shall have the same status for the purposes of section 1337 of this title as the importation of any product or article covered by the claims of any unexpired valid United States letters patent.?

Thus, according to the language of section 337a, for the purpose of determining injury there is no significance to the fact that aramid fiber is produced by a process patent and is not protected by a product patent.[8]

The importation or sale of a product that violates section 337 is not insulated when that product is imported or sold with other products. This is clear from Commission precedent. In Personal Computers and Components Thereof, the Commission excluded items that had not been explicitly found to have the effect or tendency to destroy or substantially injure the domestic industry.[9] Thus, to require a showing that finished products containing the infringing fiber have the effect or tendency to destroy or substantially injure a domestic industry is inconsistent with the Commission's decision in Personal Computers, in which there was no such requirement.

This position, that there is no separate inquiry concerning finished products, is also consistent with domestic patent

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[7] 19 U.S.C. S 1337a (1982).

[8] Aramid fiber is protected by product patents, but they are not at issue in this investigation.

9Investigation No. 337-TA-140, USITC Pub. 1504 (March 1984).

law. A party that imports infringing merchandise into the United States can be sued in United States district court as well as in the Commission.[10] It is not a defense to a patent infringement suit in the district court that the infringing product was not imported or sold separately, but only as a component of a finished product. This is because the patent gives its owner the exclusive right to produce and sell the product. regardless of whether the product is sold as a separate item of commerce or as a component.[11]

The majority's analysis also ignores the effect of sales of merchandise containing infringing aramid fiber on DuPont. DuPont is injured by sales in the United States of merchandise containing the infringing fiber because sales of finished goods made from aramid fiber reduce the demand for aramid fiber produced by DuPont. Moreover, because DuPont could have licensed the foreign manufacturer, DuPont loses royalties.[12] Therefore, the sales of all finished goods containing aramid fiber have an adverse impact on DuPont.

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[10] There is no cause of action for process patents in district court when the process occurs abroad.

[11] In the purely domestic context, there is no cause of action against a party selling an item that contains an input that violates a process patent. However, in the purely domestic context, unlike the instant investigation, jurisdiction can always be obtained over the infringer of the process patent.

[12] See Confidential Exhibit RX1806A for a discussion of plans to license foreign producers of aramid fiber.

Moreover, given the Commission majority's conclusion that imports of "basic" aramid fiber have a tendency to injure the domestic industry, I do not see how the Commission can escape the conclusion that imports of all aramid fiber and all merchandise containing aramid fiber that infringe the '756 patent have a tendency to injure the domestic industry. It is beyond disagreement that the importation of finished goods made from infringing aramid fiber does not benefit the domestic industry. Therefore, if imports of "basic" aramid fiber have the tendency to injure, then imports of "basic" aramid fiber plus finished goods made from infringing aramid fiber must also satisfy the injury standard.

Furthermore, several Commissioners do not recognize the importation of an infringing item as necessarily injurious to the domestic industry (assuming that a domestic industry exists for the purpose of section 337). In order to establish substantial injury, they require a significant market share be held by the infringing imports.[13] This stringent standard of injury, in conjunction with the disaggregation of infringing imports, would permit the importation of a certain amount of the infringing goods. If the threshold is high enough and the disaggregation of imports detailed enough, then it is possible that no injury will be found even if there are massive imports

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[13] See, e.g., Certain Optical Waveguide Fibers, Investigation No. 337-TA-189, USITC Pub. 1754, Views of Chairwoman Stern, Commissioner Eckes, Commissioner Lodwick, and Commissioner Rohr (Sept. 1985).

of infringing items. The appropriate solution is to consider all imports of infringing merchandise, both the basic product and final products embodying the basic product. together for the purpose of determining injury.

Most importantly, the decision is not in accord with the statute. Section 337 directs the Commission to consider whether unfair acts in the importation or sale of articles have the effect or tendency to destroy or substantially injure a domestic industry. The statute is aimed at unfair practices. In the instant investigation, the unfair practice is the importation or sale of aramid fiber made using a process that infringes claim 13 of the '756 patent. The statute makes no distinction on the basis of the form in which the fiber enters the United States for the purpose of determining injury. [14]

My second problem with the majority's opinion comes from the notion that the Commission has the authority to fashion a remedy that will prevent or remedy the injury. There is no such statutory grant of discretion. Rather the statute is explicit: the Commission must exclude all of the offending merchandise unless public interest considerations suggest that a different remedy would be appropriate. I reject the notion that the Commission can carve out a portion of the imported

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[14] Such an inquiry might be relevant for the purpose of determining whether the public interest requires a different remedy.

products bearing the infringing goods because they themselves do not injure the domestic industry. I base this conclusion on the statutory language, which requires exclusion unless public interest considerations dictate otherwise.

I also disagree with the notion that an order covering "basic" forms of aramid fiber can prevent substantial injury to the domestic industry. As mentioned above, finished products embodying the infringing fiber injure the domestic aramid fiber industry by reducing the demand for its fiber and the royalties it could earn from licensing others to produce the fiber for sale in the United States. The right of the domestic industry to all sales is recognized by the United States patent laws.[15] Moreover, if a more stringent standard of injury is used, then one can always design subsets of merchandise that would not injure the domestic industry, in which case it is possible that no items will be excluded, even without examining the public interest factors. For all of these reasons, I reject the notion that the Commiksion can design a remedy on the basis of disaggregated injury, and refuse to exclude articles on a basis other than the public interest factors. Once the Commission has determined that a violation of section 337 exists, and that exclusion is the appropriate remedy, the Commission must exclude all of the offending merchandise unless considerations of public interest dictate a different

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[15] See I. Kayton, Patents at 1-25-27 (1985 *ed.).*

result.[16]

My third disagreement with the Commission majority is over the public interest. DuPont has requested that the Commission issue a Limited exclusion order in this investigation covering the basic forms of aramid fiber manufactured by Azko and articles fabricated from aramid fiber.[17] Although I concur with the majority's determination that a limited rather than a general exclusion order is appropriate,[18] I disagree with their conclusion that a broader remedy would not be in the public interest.

This case raises a number of interesting and difficult public interest questions. The difficulty of these questions,

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[16] The Commission has previously recognized that public interest factors are the only basis for not excluding articles that have the effect or tendency to destroy or substantially injure the domestic industry. For example, in <u>Certain Airless Paint Spray Pumps and Components Thereof ("Spray Pumps").</u> Investigation No. 337-TA-90, USITC Pub. No. 1199 (November 1981). the Commission issued a limited exclusion order for the first time. In deciding to issue a limited rather than a general exclusion order, the Commission balanced "complainant's interest in obtaining complete protection from all potential foreign infringers" against the public interest in unencumbered trade, specifically "the inherent potential of a general exclusion order to disrupt legitimate trade." Id. at 18. See also the decision in this investigation to issue a limited exclusion order.

[17] DuPont's memorandum on Remedy and Bonding, at 2.

[18] According to DuPont, there is only one commercially feasible process for producing aramid fiber, and only Azko and DuPont make this fiber commercially. DuPont's memorandum on Remedy and Bonding at 17. Consequently, DuPont contends that a

(Footnote continued to page 10)

however, is no basis for declining to address them.[19] Aramid fiber is a basic product that is incorporated *in* varying amounts into a wide range of products. Depending on the nature of the finished products, there are substitutes of varying degrees for aramid fiber. Also, in some of these finished products, the infringing aramid fiber can be easily detected, whereas in others the infringing fiber can be detected only by destroying the merchandise. Today, there is no clear line that can be drawn between those finished products which could be excluded without an adverse impact on the public interest and those which would have an adverse impact if they were excluded. The Commission, however, had the opportunity to ask for more information and could have made its best estimate where to draw the line.[20]

Moreover, there is no obvious public interest justification for excluding only "basic" forms of aramid fiber. For the near future, until the '756 patent expires in 1990, there is both the potential, and, if relief is not granted, the expectation, that millions of dollars of aramid fiber in basic forms and in

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(Footnote continued from page 9)
limited rather than a general exclusion order is appropriate. The criteria set forth in Spray Pumps for a general exclusion order are not met. Thus, I agree that a limited exclusion order is appropriate.

[19] The Commission does not have all the information before it because the ALJ does not take evidence on the question of remedy.

[20] See footnote 1, supra.

finished products will be imported into the United States.[21] Thus, it is clear that an exclusion order covering only "basic" forms of aramid fiber will not give DuPont effective relief. Furthermore, although an order covering all articles containing aramid fiber could be a burden on legitimate trade and impossible to enforce, some articles could be included without burdening trade or the enforcement mechanism.

There is also a strong public interest in protecting patents. A complainant with a valid United States patent has the exclusive right to make and sell the product protected by the patent, or in the case of a process patent to use the process, in the United States. This right is recognized in the Constitution, which states "The Congress shall have power . . .to promote the progress of . . . [the] useful arts, by securing for limited times to . . . inventors the exclusive right to their . . . discoveries."[22] It is generally recognized that patents allow successful innovators to earn a return for the expense and risk they incurred. It is this return which provides the incentive to invent. " The United States patent laws implicitly recognize the trade-off between innovation and competition. Thus, there are strong public interest factors that support exclusion.

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[21] all Henry Affidavit, submitted in conjunction with DuPont's Brief on Remedy, at 2.

[22] U.S. Constitution, Art. I, Section 8.

[23] see I. Kayton, Patents chapter 1 (1985 ed.).

There may be cases where the public interest will not favor excluding all items that embody infringing components because of the burden on trade. Specifically, the public interest may permit entry of goods in those cases where the infringing component represents a relatively small share of the total value. Also, exclusion may be inappropriate when it is very difficult to separate the infringing component from the finished product. This is not to suggest that would-be infringers have a "license" to sell infringing components because of the high value of the finished product. In such cases, the value of the infringing component should also be insubstantial. Time would also appear to be a critical element. Finished goods made before the Commission has issued its determination are more likely to be admitted than those produced afterwards. Because the Commission declined to seek additional information, the appropriate limits of the exclusion order cannot be determined. The Commission should have taken evidence on these and all other relevant factors before deciding not to exclude any finished articles containing aramid fiber. Therefore, I dissent.

Certificate Of Service

I, Kenneth R. Mason, hereby certify that the attached NOTICE OF ISSUANCE OF LIMITED EXCLUSION ORDER, was served upon Victoria L. Partner, Esq., and upon the following parties via first class mail, and air mail where necessary, on November 26, 1985.

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U.S. International Trade Commission
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Washington, D.C. 20436

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PUBLIC VERSION

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Public comments due
Comm. decision due ,D40-s
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UNITED STATES INTERNATIONAL TRADE COMMTstION
Washington, D.C.

In the Matter of

CERTAIN ARAMID FIBERS

Investigation Nu. 337-TA-194

INITIAL DETERMINATION

Pursuant to the Notice of Investigation in this matter (49 Fed. Reg. 21,806, May 23, 1984), this is the Administrative Law Judge's initial determination under Rule 210.53 of the Rules of Practice and Procedure-of this Commission, 19 C.F.R. S 210.53. The Administrative Law Judge hereby determines, after a review of the briefs of the parties and of the reard developed at the hearing, that there is a violation of Section 337 of the Tariff Act of 1930, as amended (19 U.S.C. S 1337, hereinafter S 337), in the unauthorized importation into the United States, and in the sale of..certain aramid fibers by reason of infringement of claim 13 of U.S. Letters Patent-No. 3,767,756, with the effect or tendency to destroy or substantially injure an industry efficiently and economically operated in the United States.

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CPX Complaint's Physical Exhibit

CX Complaint's Exhibit

RPFF : Respondents' Proposed Findings of Fact

RPFFIt: Respondents' Proposed Rebuttal Findings of Fact

RPH : Respondents' Post-Hearing Brief

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PROCEDURAL HISTORY

On April 18, 1984, E.I. du Pont de Nemours and Company (Du Pont) filed a complaint with the U.S. International Trade Commission under 5337 of the Tariff Act of 1930, as amended (19 U.S.C. S1337, hereafter 5337). The complaint alleged unfair methods of competition and unfair acts which included (a) the importation, sale and marketing in the United States of certain aramid fiber produced in The Netherlands by a process allegedly covered by the claims of U.S. Letters Patent No. 3,767,756 (the '756 patent) and (b) active efforts to exploit applications of and markets DuPont has created for aramid fibers. The complaint also alleged that the effector tendency of the unfair methods of competition and unfair acts is to destroy or substantially injure an industry, efficiently and economically operated in the United States. Du Pont requested the Commission institute an investigation and, after full investigation, issue a permanent exclusion order and a permanent cease and desist order.

Upon consideration of the complaint on May 16, 1984, the Commission ordered that an investigation be instituted pursuant to subsection (b) of 5337 to determine whether there is a violation of subsection (a) of 5337, as alleged by Du Pont. The Notice of Investigation was published in the Federal Register on May 23, 1984 (49 Fed. Reg. 21806)

The respondents named in the Notice of Investigation were the following:

AKZO N.V.
ENKA B.V.
Velperweg 76
Post Bus 186
6800 LS Arnhem
The Netherlands

Velperweg 76
6824 BM Arnhem
The Netherlands

Aramide Maatschappij VoF
Velperweg 76
Post Bus 60
6800 AB Arnhem
The Netherlands

Akzona, Inc.
P.O. Box 1
Enka, North Carolina 28728

See FF 2-10 for a description of the parties.

Victoria L. Partner, Esq., Office of Unfair Import Investigation, U.S. International Trade Commission, was named as Commission investigative attorney, also a party to the investigation. Robert D. Litowitz, Esq. staff attorney participated at the hearing.

By Order No. 1, issued May 18, 1984, the chief administrative law judge Donald K. Duvall designated Paul J. Luckern as administrative law judge in the investigation.

In a response to the Notice of Investigation, dated June 19, 1984, respondents AKZO N.V., ENKA B.V. (Enka), ARAMIDE MAATSCHAPPIJ v.o.f.(Aramide) and AKZONA Incorporated (Akzona) (respondents or Akzo) denied that there is any violation of S337 and denied that they have engaged in the unlawful importation of aramid fiber into the United States or in the unlawful sale of such fiber by reason of the overseas production of aramid fiber by a process covered by a valid and enforceable United States patent. The respondents further denied that they have engaged in any acts or methods of competition the effect or tendency of which is to destroy or substantially injure an industry, efficiently and economically operated, in the United States. They also denied that the Commission has or can obtain jurisdiction over respondent Akzo N.V. Ten affirmative defenses were pleaded in the response.

On June 22, 1984, pursuant to Order No. 3 issued June 1, 1984 a preliminary conference was held before the administrative law judge. Order No. 6 issued June 28, 1984, set forth a schedule for the investigation and hearing.

At the preliminary conference on June 22, 1984, respondents orally moved to modify the Protective Order that had issued in the investigation on May 21, 1984. Respondents argued that there was a substantial overlap between the investigation and an action in the United States District Court, District of Delaware, commenced by respondents Enka, Aramide and Akzona against complainant Du Pont (Delaware action). The respondents contended that because a protective order had issued in the Delaware action, it made no sense to have the very same documents under two different protective orders, and that it would facilitate things to align the protective orders' so that there is essentially the same protective order in this proceeding as was agreed by both sides and so ordered by the Delaware court. (Hearing Tr. of June 22, 1984, p. 45). In Order No. 7 issued July 6, the administrative law judge denied the motion.

On June 19, 1984 the respondents moved for an order to stay this investigation because of the pending Delaware action. The administrative law judge denied the motion in Order No. 8 issued July 13, 1984.

On July 17, 1984 Du Pont moved for an order dismissing the second, third and fifth affirmative defenses and to limit discovery. The administrative law judge in Order No. 9 issued August 31, 1984, denied the motion. The order stated in part that under 5337 all legal and equitable defenses may be raised in a 5337 proceeding.

On September 20, 1984, respondents moved for an order designating the investigation as a "more complicated" investigation. Respondents requested a four month extension of the discovery cutoff date from October 26, 1984 to February 28, 1985 and further requested that the hearing then scheduled to commence on December 3, 1984 be rescheduled to commence on April 1, 1985. The administrative law judge in Order No. 13 which issued October 31, 1984, granted in part respondents' motion. The judge set aside for hearing February 11 (ten weeks from the then scheduled hearing date), 12, 13, 14, 15, 18, 19, 20, 21 and 22, 1985 and stated that the Initial Determination would be due on May 6, 1985, which was ten weeks from the then scheduled due date of February 25, 1985.

In a Notice of the Commission, dated November 19, 1984, the Commission, referring to the circumstances of the delay in discovery, the substantial expansion in the scope and complexity of discovery and the short period for discovery on these issues, decided not to review the Initial Determination declaring the investigation more complicated.

On January 24, 1985 the Commission investigative staff requested that the Commission permit the administrative law judge take evidence at the hearing which was scheduled to commence on February 11, 1985, concerning the effects which entry of an exclusion order in the investigation may have upon the .public health and welfare, competitive conditions in the United States economy, the production of like or directly competitive articles in the United States, and United States consumers. Since Commission Rule 210.58(b) provides that the judge may not take evidence or hear arguments on such matters "[uInless otherwise ordered by the Commission," the staff requested that the administrative law judge certify the request to the Commission. In Order No. 34 issued February 6, 1985, the administrative law judge certified the staff's request to the Commission but recommended that the staff's motion be denied based upon the following: (1) the time constraint as to evidence the administrative law judge has to consider relating to an injury determination and the May 6, 1985 due date for the Initial Determination; (2) the matter of due process; and (3) Commission Rule 210.58 which provides that submissions as to the public interest can be made to the Commission. During the hearing on February 14, 1985, Ms. Field from the Office of General Counsel of the Commission was introduced to counsel for the parties. *Ms.* Fields represented to the administrative law judge that the Commission had denied the staff's motion but that the Commission is interested in developing the record in remedy and public interest issues in the investigation. Accordingly, it was represented that on June 20, 1985, when the Commission decides whether to review the initial determination on the violation issues, it will notify the parties regarding the taking of evidence on remedy and public interest. (Tr. pp. 744-745).

On February 15, 1985 the Commission issued a notice in which it denied the staff's motion to permit the administrative law judge to take evidence on the remedy and public interest issues. The Commission stated that the staff had not shown that the circumstances of the investigation are so different that the Commission should invoke the extraordinary alternative procedure available under Rule 210.58(b).

On February 8, 1985 respondents moved to modify the Protective Order in the investigation to permit an in-house counsel *and-a* management representative of respondents limited access under the Protective Order to certain Du Pont material subject to the Protective Order. It was argued that without such limited access, respondents cannot properly and adequately assist in their own defense. Order No. 40 issued February 21, 1985, denied the motion because on the record before the administrative law judge respondents had not demonstrated a need for a key management official of respondents and respondents' in-house counsel to have the requested access to Du Pont's confidential material.

The hearing in this investigation commenced on February 11, 1985. It continued on February 12, 13, 14 ,15, 16, 18, 19, 20, 21, 22 and 23. Pursuant to Commission Rule 210.53(g) the record was reopened on February 28, and March 5, 1985 for additional rebuttal testimony of Du Pont's economic witness Professor Jerry A. Hausman. Closing arguments were heard on March 19, 1985.

On February 13, 1985, during the hearing, the administrative law judge put on the record that the Notice of Investigation made no reference to any specific claims of the '756 patent. Rather, it merely stated 'production overseas *by a* process allegedly covered by the claims of U.S. Letters Patent 3,767,756% There are thirteen method claims in the '756 patent. During opening arguments on February 11, Du Pont's counsel handed to the bench a document entitled 'EXEMPLARY CLAIM 13 OF BLADES '756 PATENT." The document duplicated dependent claim 13, claim 12, which claim 13 depended, and claim 10, which claim 12 depended. Du Pont's counsel stated that Du Pont has designated claim 13 as "an exemplary claim." (Tr. p. 405). Respondents' counsel pointed to V 6.2 of the complaint which read that Du Pont had concluded from publicly available information that the AKZO Semiworks plant is using the process covered by all the claims in the '756 patent. (Tr. pp. 406-407). Du Pont's counsel confirmed that the complaint did not state any specific claims but said that Du Pont stands or falls on claim 13. (Tr. pp. 405-407).

Respondents' counsel did not want the administrative law judge to consider only claims 10, 12 and 13 of the '756 patent. He stated that while respondents will prove that claims 10, 12 and 13 are anticipated by the prior art, all the claims are in issue, that the reason Du Pont backed off to claim 13 is that the other "claims are clearly anticipated". Respondents' counsel argued that in their pretrial submissions respondents submitted arguments on claim 1 and that "certainly a look at what the distinctions are between Claim 13 and Claim 1, for example, is a very relevant part of your determination of what is valid or invalid". *(Tr.* p. 409). Du Pont's counsel responded by stating that when Du Pont filed the complaint, Du Pont included the broader claims; that it had discovery

and that Du Pont thought it would simplify the issues to designate this single exemplary claim. Du Pont then was not asking the administrative law judge to ignore any of the claims of the '756 patent. (Tr. p. 410).

Respondents' counsel argued that respondents were charged with infringement of all the claims of the '756 patent and that they are all invalid. It was said that in the course of respondents' defense, respondents will show by looking first at the broader claims that they are totally anticipated and that then respondents will show that the differences between claim 13 and claim 1 are minimal and, as a matter of fact, are not differences at all. Respondents had no problem with Du Pont's accusation of respondents infringing only claim 13. (Tr. pp. 411-412). Du Pont's counsel however stated that the domestic industry covers the broader claims of the '756 patent as well and would not take the position that respondents are only infringing claim 13 of the '756 patent but would be willing to limit everything to claim 13 and stand or fall on claim 13. (Tr. pp. 412-413). Respondents' counsel indicated that respondents intended to address themselves not only to claim 13, but would demonstrate that there are no differences between the narrow and broad claims insofar as the prior art is concerned. (Tr. pp. 412-413).

The Commission investigative attorney acknowledged that the staff has not taken a position on the patent issues but that it is typical in cases such as this case for complainants to designate an exemplary claim which will result in certain economies and efficiencies. The staff was sympathetic with respondents' contentions that they should not be precluded from introducing evidence respecting the claims that are not specifically asserted by Du Pont as being infringed, iE that will be relevant to determining the validity or invalidity of Claim 13. (Tr. pp. 414-415).

On February 20, 1985 respondents' counsel asked its patent expert witness whether he had an opinion as to whether claim 13 of the '756 patent is patentably distinct from claim 1 of the '756 patent. Du Pont's counsel . objected to the question on the ground that the question of patentable . distinction between the claims of the '756 patent is not an issue. (Tr. p. 2338). Thereupon Du Pont's counsel orally moved to limit Du Pont's charge of infringement in this investigation to respondents' infringement of claim 13 with the patent issues then limited to the validity and infringement of claim 13. Respondents' counsel argued that if there then should be any limitation of claims, the claims to be ruled on should at least include claim 1 of the '756 patent. Du Pont's counsel argued that there was simply no reason for a consideration of claim 1; that respondents wanted to have an academic attack on the broadest claim in the case, and that the real test of infringement and validity is the most specific claim of the '756 patent where Du Pont submitted "infringement is clear and validity is clear". (Tr. pp. 2343-2344).

In opposing Du Pont's oral motion to limit the patent issues to a consideration of claim 13 of the '756 patent, respondents' counsel argued that whether Du Pont's motion is granted or not, consideration will have to be given as to whether or not claim 13 is valid 'in the sequence of alleged patentability;' that it has to be decided "whether the broad process claim 1, which isn't that different from Claim 13, is patentable over the art.' (Tr. p. 2345). In view of the development of the issues by the respondents on discovery and in their prehearing filings, Du Pont's oral motion made on the ninth day of the hearing to limit the patent issues to a consideration of only claim 13 was denied. (Tr. p. 2353).

The issues have been briefed and proposed findings of fact submitted by the participating parties. The Commission investigative staff takes no position on the questions of respondents' infringement and validity of the '756 patent. (SPH p. 13). The staff however has taken the position that respondents have not carried their burden of establishing their affirmative defenses with respect to the enforceability of the '756 patent. (SPH pp. 47-50).

This initial determination is based on the entire record of this proceeding including the evidentiary record compiled at the final hearing, and the proposed findings of fact and conclusions of law and supporting memoranda filed by the parties. The administrative law judge has also taken into account his observation of the witnesses who appeared before him and their demeanor. proposed findings, not herein adopted, either in the form submitted or in substance, are rejected either as not supported by the evidence, involving immaterial matters or as cumulative.

The findings of fact include references to supporting evidentiary items in the record. Such references are intended to serve as guides to the testimony and exhibits supporting the findings of fact. They do not necessarily represent complete summaries of the evidence supporting each finding.

JURISDICTION

The Commission has in rem and subject matter jurisdiction in this investigation, under Section 337, since the alleged unfair methods of competition and unfair acts involved the importation into, and sale in, the United States of aramid fibers, the alleged effect or tendency of which is to destroy or substantially injure an industry, alleged to be efficiently and economically operated in the United States. (FF 1).

Although all parties have appeared and litigated the issues in this investigation, respondents, since the investigation was initiated, have maintained that the Commission lacks jurisdiction over respondent Akzo N.V. (Response, Tenth Affirmative Defense). They argue that Akzo N.V. does not do business in the United States, does not control the day-to-day operations of any of the other respondents, and does not make or sell aramid fibers or import such fibers into the United States. It is submitted that Judge Longobardi's decision in the Delaware action, Akzona Incorporated v. E.I. DuPont de Nemours & Company, Civil Action No. 84-10 LON (D. Del. October 2, 1984) (RX 1799), granting Akzo N.V.'s motion to dismiss Du Pont's counter-claim against Akzo N.V. for lack of personal jurisdiction, despite Du Pont's vigorous opposition, precludes Du Pont from relitigating that issue, including an alter ego theory, in this investigation. (RPH 1).

However, as the staff correctly pointed out, the Commission has made it clear that in personam jurisdiction is not a prerequisite to a party being included as a respondent in a Section 337 investigation or to the issuance of an exclusion order by the Commission. Certain Composite Diamond Coated Textile Machinery, Inv. No. 337-TA-160, Commission Memorandum Opinion in Support of Denial of Motion for Termination of Respondent, February 1, 19b4;

Certain Steel Rod Treating Apparatus and Components, Thereof, Inv. No. 337-TA-97, Commission Memorandum Opinion, pp. 14-20 (1982) (SPH pp. 4-5).

In the *Steel Rod Treating Apparatus* case the grounds asserted for dismissal by certain respondents included, as here, an alleged lack of in *personam* jurisdiction. The Commission, in affirming a denial by the administrative law judge of respondents' motion for dismissal of certain respondents referred to the holding of the Court of Customs and Patent Appeals in Sealed Air v. U.S. International. Trade *Commission,* App. Nos. 79-35 and 89-04, that the Commission's section 337 jurisdiction to issue exclusion orders is in rem and not *in personam,* that the Commission's jurisdiction over the goods established, "without more, sufficient 'minimum contacts' as to a foreign respondent." (Id. pp. 5, 11).

Respondents argue that on the basis of the same facts found by the Delaware court, there is simply no basis for connecting Akzo N.V. to aramid fiber imports (EPH 1). While there may be some merit in respondents' argument that on the basis of the "same" facts found by the Delaware court, there is in this investigation, a lack of *in personam* jurisdiction over Akzo N.V., there are facts in this record before the administrative law judge connecting Akzo N.V. to aramid fiber imports.

It is not denied by the respondents that respondents Enka B.V. and Akzona, Inc. are involved in the day-to-day production of aramid fiber and any importation of the fiber into the United States. Respondents Enka B.V. and Akzona, Inc. are wholly owned subsidiaries of Akzo W.V. (FF 3(b)(c)). Respondent Aramide Maatschappy v.o.f. is a partnership in which Enka Aramide B.V., a wholly-owned subsidiary of Enka B.V. is a partner with NOM. Approval by Akzo N.V. was necessary for Enka's entry into the joint venture agreement with NOM (FF 4(d). While Akzo N.V. is not involved in the day-to-day business operations of its subsidiaries (FF 4(h), Akzo N.V. must approve the subsidiaries' three-year operational plans and strategic plans. Without Akzo N.V.'s approval, no investment over $700,000 may be made by a subsidiary and no loan nor equity capital may be raised. (FT 4(h)). Akzo N.V.'s research laboratories have been closely involved in the adoption of the process which process is said by Du Pont to infringe the claims of the '756 patent in Issue. (FF 4(c)). Mr. Loudon, who is president of Akzo N.V., and who holds no position with Enka, initiated and directed the licensing discussions between Akzo N.V. and Du Pont. (FF 4(g)).

The administrative law judge concludes, from the foregoing, that Akzo V.V. has been an indispensable entity in the adoption and production by respondents of the imported aramid fiber allegedly produced by the claimed process of the '756 patent. Accordingly, the administrative law judge *finds* that there are facts in the record before him connecting Akzo W.V. to aramid fiber imports such that he can find Akzo N.V. in violation of Section 337, if the record supports a violation by the other respondents.

OPINION

I. THE '756 PATENT IN ISSUE

This investigation involves allegations of infringement of the '756 patent. (FT 1). The '756 patent entitled "Dry-Jet Wet Spinning Process" issued October 23, 1973, to inventor Herbert Blades. It is assigned to Du Pont. The patent will expire in October 1990. *(FF* 32).

The '756 patent is based on application Ser. No. 268,052 filed June 30, 1972. Ser. No. 268,052 was a continuation-in-part application of abandoned

Ser. No. 239 377 filed March 29, 1972, which in turn was a continuation-in-part application of abandoned Ser. No. 172,515 filed August 10, 1971, which in turn was a continuation-in-part application of abandoned Ser. No. 138,210 filed April 28, 1971. (FF 32).

The claimed process of the '756 patent relates to a process that produces a high strength fiber which is said to be claimed in U.S. Letters Patent 3,869,429. That patent issued on March 4, 1975, and the named inventor is Herbert Blades. The patent, on its face, is assigned to Du Pont. (FF 34).

The '756 patent contains thirteen method claims. It has no composition of matter claims. (FF 33). It contains two independent method claims 1 and 10. These two method claims relate to a method comprising extruding a spinning dope from an orifice through a layer of non-coagulating fluid into a coagulating bath. The dope comprises a polyamide and a solvent consisting essentially of sulfuric acid of at least 98% concentration, chlorosulfuric acid or fluorosulfuric acid and mixtures thereof. (FF 33).

The independent method claims 1 and In further require that the concentration of the polyamide in the acid dope be at least 30 grams of said polyamide per 100 ml. of the acid solvent. This amounts to about 14.1 weight percent of polymer in the acid dopes. (FF 33).

Independent method claims 1 and 10 also require that the polyamide have an inherent viscosity of at least 2.0 but no less than 12.8-.05 (C-30)1 where C is defined as the concentration of the dope in grams of polyamide per 100 ml. of solvent at 25°C. (FF 33). The preferred dopes, according to the '756 patent specification employ between 40 and 56 grams of poly (p-phenylene terephthalamide), as the polyamide, having an inherent viscosity of at least 3.0 per 100 ml. of acid. This amounts to between 18 and 23.4 weight percent of polymer in the acid dopes. (FF 33).

Independent method claim 1 (FF 33) recites that the polyamide consists

> "essentially of recurring units selected from the group:
>
> wherein units I and II, if present in the polyamide, are present in substantially equimolar amounts, R, R' and R" which may be the same or different, are divalent radicals, n may be zero or the integer one, and at least about 95 mol percent of the total R, R' and R" radicals in t he polyamide consist of single rigid radicals with extended bonds or a series of such rigid radicals which are linked together directly by extended bonds with the proviso that rigid ring radicals may be linked by azo or axozy groups."

This recitation reads on the polyamide poly -4, 4'- diamanobenzanilide terephthalamide which has been referred to in the record as 4, 4'-DABT. (FF 61). The preferred polyamide, poly (p-phenylene terephthalamide) of the '756 patent specification (FF 43), and specifically recited in claims 4 and 13 of the '756 patent (FF 33), is referred to in the '756 patent as PPD-T. (FF 43, 59).

Independent claim 10 (FF 33) recites that the polyamide consists

> ..essentially of recurring units selected from the group:
>
> wherein units I and II, if present in the polyamide, are present in substantially equimolar amounts, R, R' and R" may be the same or different divalent radicals, n may be zsero or the integer one, and at least about 95 mol percent of the total R, R' and R" radicals in the polyamide are selected from the group of trans-1, 4-cyclohexylene, 1,4-phenylene, 1, 5-naphtylene, 2, 6-naphthylene, 2,6-naphthylene, 2,5-pyridylene, 4,4'-biphenylene, trans,trans-4,4'-bicyclohezylene radicals and 1,4-phenylene groups linked by trans-vinylene, ethynylene, azo or azoxy with the proviso

> that R may also be selected from trams-vinylene,
> ethynylene, trans, trans-1,4-butadienylene and
> 2 41-
> , trans-vinylenephenylene."

Claim 2, dependent on claim 1, recites that the acid is sulfuric acid of at least 1P2 concentration. (FF 33). Claim ^{1}, dependent on claim 2, recites that the polyamide has an inherent viscosity of at least 3 and is present at a concentration of at least An grams per lOn ml. of solvent. (FF 11). At a minimum inherent viscosity of 2,3, at least 4n grams of polymer per Inn ml of 98 percent sulfuric acid would amount to at least 1.\$^{1} weight percent polymer. (FF 43).

Claim 3, dependent on claim 2, recites that the polyamide has an inherent viscosity of at least 3 and is present. et concentration of at least 40 grams per 100 ml. of solvent. (FF 33). Claim 4, dependent on claim 2, recites that the polyamide is the preferred poly-(p-phenylene terephthalamide). (FF 33). Claim 5, dependent on claim 1, recites that the layer of inert non-coagulating fluid is between 0.1 and 10 cm. thick. (FF 33). Claim 6, dependent on claim 1, recites that the layer of inert non-coagulating fluid is a gas. (FF 33). Claim 7, dependent on claim 1, recites that the coagulating bath is at a temperature of under 50°C. (FF 33). Claim 8, dependent on claim 7, recites that the layer of inert non-coagulating fluid is air and the coagulating bath is aqueous and at a temperature of 28 °C lower. (FF 33). Claim 9, dependent on claim 1, recites that the rigid radicals are single ring or fused multi-ring aromatic carbocyclic or heterocylic radicals, trans-1,4-cyclohexylene, 1,4-f2,2,21-bicyclo-octylene, vinylene or +-thynyiene. (f.7 33).

,:illendent on claim 10, recites that at least 95 mole percent of the total R, R' and R" radicals are 1,4-phenylene radicals. (FF 33). Claim

12, dependent on claim 10, recites that the spinning dope passes from the orifice through a layer of gas and into an aqueous bath at a temperature of under 50°C and wherein the polyamide has an inherent viscosity of at least 3.0 and is present at a concentration of at least 40 grams per 100 ml. of solvent. (FF 33). Claim 13, dependent on claim 12, recites that the polyamide is poly(p-phenyleneterephthalamide) and the solvent is sulfuric acid of at least 98% concentration. (FF 33). Because claim 13 is dependent on claim 12, the grams of polymer per 100 ml. 98% sulfuric acid in claim 13 would be at least 18 weight percent polymer. (FF 43).

The '756 patent specification states that the spinning dopes used in the '756 claimed process are unusual; that at room temperatures most are solid; that as the temperature is raised, they melt, becoming less viscous and translucent to transparent. It is disclosed that the spinning dopes are optically anisotropic, i.e., microscopic regions of a given dope are birefringent. It is said that a bulk dope sample depolarizes plane polarized light because the light transmission properties of the microscopic areas of the dope vary with direction, and that this characteristic is associated with the existence of at least part of the dope in the liquid crystalline state. The dopes are said to exhibit anisotropy while in the relaxed state. (FF 47).

It is disclosed in the '756 patent specification that as the temperature of a molten anisotropic dope increases, a temperature is reached at which the anount of anisotropic phase begins to decrease. That temperature is higher as the concentration of polymer in acid solvent increases. For example, for PPD-T/sulfuric acid dopes of 32, 40 and 46 grams per 100 ml. concentration, said temperature values are found to be about 80-100 degrees C., 82-135 degrees C. and 110 to 122 degrees C., respectively. (FF 48).

The preferred polymeric polyamide of the '756 patent specification, viz., poly(p-phenylene terephthalamide) (FF 43) has a para-positioned aromatic ring. Nearly all synthetic polymers (including nylon polyamide) have flexible claims. However, the introduction of aromatic rings in the polymer backbone serves to decrease the flexibility of the claims. (FF 61(a)). When these rings are introduced in the meta or ortho position, the claims are still substantially flexible. However, when the aromatic rings are introduced in the polymer backbone in the pare position, the result is a marked decrease in chain flexibility. When the polymer consists entirely of para-positioned aromatic rings, as in poly(p-phenyleneterephthalamide) the chains can be regarded as almost ideally rigid. If the backbone contains other moieties besides aromatic ring structures, such as the amide linkages in the preferred poly(p-phenyleneterephthalamide) (PPD-T) of the '756 patent specification, the chains while much more rigid than their meta-positioned analogues, retain some modest degree of flexibility. In appropriate solvents, they act as considerably rigid molecules. (FF 61(a)).

Du Pont's technical expect Prof. Donald R. Uhlmann (FF 384) testified that besides affecting chain stiffness, the change from meta-positioned to para-positioned aromatic rings has a profound effect on solubility; that for example, while the meta-positioned poly(m-phenylene isophthalamide) is highly soluble in dimethylacetamide $CaCl_2$, and is spun commercially from such solutions containing about 18% polymer, the para-positioned PPD-T of comparable molecular weight is effectively insoluble in this solvent; that the change from meta-positioned to pare-positioned aromatic polyamides, and its accompanying effect on chain stiffness, has another dramatic effect on solution behavior; that the meta-positioned polymers form isotropic solutions at all concentrations of polymer; that in contrast, with the pare-positioned PPD-7, anisotropic solutions can be formed only above a critical concentration; that anisotropic solutions contain liquid crystalline domains, while isotropic solutions do not; that within each liquid crystalline domain, the molecules are aligned in a given direction, but the direction of alignment is different in different domains; and that such anisotropic solutions exhibit pronounced optical birefringence. (FF 61(b)).

The '756 patent specification contains nine examples. Example I mixes the preferred polymer PPD-T of 4.4 I.V. (inherent viscosity) with 100.2% sulfuric acid in the ratio of 46 grams of polymer per 100 ml. of acid (20% by weight) and heats the mix in a 95 degrees centrigrade water bath. Thereafter, the dope is extruded from a spinneret at a jet velocity of 240 feet minute through air into a coagulating bath. The resulting filaments have a tenacity of 18 g.p.d. In another embodiment of example I a solution of 46 grams of PPD-T of 5.4 I.V. per 100 ml. of 99.7% sulfuric acid (20% by weight) is utilized. Yarn tenacity of as-spun fiber is 26 gpd. (FF 59, 60).

Example II of the '756 patent specification adds the preferred polymer PPD-T of 6.0 I.V. to 99.72 sulfuric acid to give a ratio of 46 grams of polymer per 100 mi. of acid. Under a partial vacuum the mixture is heated to 77-85 °C. which affords a temperature in the solution of between 79-82 °C. Therefore the dope is extruded from a spinneret into cold water. In this embodiment depending on the spinning tube the yarn tenacity went from 21.2 to 22.8 to 24.3 gpd. FF 61).

In another embodiment of example II the preferred polymer PPD-T of 5.9 I.V. Is mixed with 99.7% sulfuric acid to give on heating a dope with a ratio of 45.8 grams of polymer per 100 ml. of 100% sulfuric acid. The dope was extruded from a spinneret to give a yarn having a tenacity of 24 gpd. (FF 61).

In a third embodiment of example II 46 grams PPD-T per 100 mi. of above 99% sulfuric acid is made by mixing the polymer of 4.8 I.V. with acid and stirring at 80-95 °C. The dope is extruded through a spinneret to give fiber having a tenacity of 15 gpd. (FF 61). A fourth embodiment of Example II forms a dope containing 46 grams of PPD-T (I.V. 5.91 per 100 mi. of above 99% sulfuric acid, extruded from a spinneret to give a film of a tenacity of 18 gpd. (FF 61).

In example III of the '756 patent specification dopes from PPD-T of 5.4 I.V. and 4.6 I.V. and various acids and acids containing additives are prepared in the mixing device of example I. The percent polymer ranges from 16 to 222 with the concentration of the spinning dope ranging from 34 to 47 grams of polymer per 100 mi. of solvent and additives. After extruding through a spinneret into cold water, the resultant filaments *yielded* a tenacity of 14 to 27 gpd. (FF 61).

Example IV of the '756 specification prepares dopes of polyamides made from diamines and diacid halides. The dopes are prepared using sulfuric *acid* (99..7 to 100.0 percent) to give 46 grams of polymer per 100 ml. of acid (20 weight percent). The dopes are extruded using a spinneret block. The resultant filament tenacities range from 15 to 24 gpd. (FF 61). Example IV also shows 56 g polymer per 100 ml. of sulfuric acid (23.4 weight percent made from poly-(chloro-p-phenylene terephthalamide) of 4.1 I.V. spun into fibers with filament tenacity of 17 gpd. (FF 61).

Example V utilizes polyamides made from "A-B monomers." Included is the spinning of the ordered copolymer 4,4'-DABT in Example V (a) to produce a fiber having a tenacity of 17 gpd. Also included in Example V is the spinning of random copolymers wherein p-phenylene-diamine, p-aminobenzoyl chloride hydrochloride and terephthaloyl chloride are reacted together simultaneously to give fibers having tenacities of 32 and 23 gpd. (Example V (b) and V (c)). The polymer I.V. ranges from 4.0 to 5.9. Dopes are prepared using 99 to 100% sulfuric acid to give 46 grams of polymer per 100 ml. of acid (20 weight percent). (FF 61).

Example VI of the '756 patent specification shows variables in the spinning process. Dopes of PPD-T in 99.7 - 100% sulfuric acid solvents are made and spun using the apparatus and general techniques of Example 1B. (FF 60). All dopes were said to contain 46 g polymer per 100 ml. solvent (20 weight percent) except one dope which used 38 g polymer per 100 ml. solvent. Tenacities of the resultant filament ran from 16 to 25 gpd. (FF 61).

Example VII of the '756 patent specification shows the effect of extrusion temperature. In this example a dope containing 46 g polymer per 100 ml.. of sulfuric acid made from PPD-T of 5.2 I.V. is extruded using the general procedure of Example II. The resultant tenacities, at extruded temperatures of 36°C, 100°C, 110-115°C and 115-120° were 24, 22, 19 and 11 gpd respectively. (FF 61).

Example VIII of the '756 patent specification employs dopes containing 30 g polirmer per 100 ml. of 99-1002 sulfuric acid made from PPD-T of 5.2 I.V. Using various dope extrusion temperatures, filament tenacities ranged from 15 to 18 gpd. (FF 61).

The final Example IX of the '756 patent specification uses a blend of 30 g of PPD-T (5.4 I.V.) acid, 5g of poly (m-phenylene isophthalamide) (1.16 I.V.) in a 1002 fluorosulfuric acid and 100.12 sulfuric acid. The blend is mixed at 30°C using the general technique of example IB. The dope is extruded from a spinneret. As-spun filaments therefrom have tenacity of 23 gpd. Repetition of the procedure using a dope containing 24 percent by weight of the poly (iso-phenylene isophthalamide) and no PPD-T in the same mixed solvent affored as-spun filaments with a tenacity of only 1.8 gpd. (FF 61).

The '756 patent specification discloses that the water content of the dopes used in the claimed process should be carefully controlled to be less than 2%. Excessive water can interfere with the formulation of dopes suitable for spinning and also *lead* to excessive degradation of the polymer. (FF 42). It is stated that the dopes should be mixed and held during the spinning process at as low a temperature as is practical to keep them liquid in order to reduce degradation of the polymer resulting in low I.V. values; and that exposures to temperatures over 90°C should be minimized. (FF 42). The '756 patent specification discloses that the spin dopes of the claimed process possess unexpected stability; and that it appears that the "acidity" of the sulfuric acid is reduced by the presence of high concentrations of stiff chain polyanides. Thus dopes were made of PPD-T polymer of 4.88 I.V. in 1002 sulfuric acid at concentrations of 46, 21.3 and 3.7 grams per 100 ml. The dopes were heated for 3 hours at 100°C. Polymer isolated from the *heated* solution of 46 grams had on I.V. of 4.2. However, polymer isolated from the heated solution of 21.3 grams had only an I.V. of 2.8 and polymer isolated from the heated solution of 3.7 grams had a I.V. of only 1.9. (FF 44).

The '756 patent specification discloses that dopes containing about 49 grams of PPD-T per 100 ml. of sulfuric acid represent the highest concentration that can be handled in the conventional mixers, transfer lines and spinning equipment due to the extremely high bulk viscosity of mixes. It is said that when the usual technique of lowering the viscosity by raising the temperature is used, excessive degradation of the polymer occurs and that the use of more effective mixes well permit the use of higher concentrations. (FF 45(0). The viscosities at high concentrations are said to be a function of the polymer - solvent system used. For example when poly-(chloro-p- phenylene terephthalamide) of 4.1 I.V. was used, a 23.11 weight percent dope can be employed. (FF 45(a)).

In extrusion of the dopes used in the claimed process, the '756 patent specification discloses that since the amount of degradation is dependent upon tine and temperature, temperatures as low as practical should be used, preferably below 90°C. If higher temperatures are desired, it is said that the equipment should be designed so that the exposure time of the dope to the elevated temperature is kept at a minimum. (FF 46).

II. PROCESS IN ISSUE

The Blades '756 patent in issue contains only process claims.

the aramid fiber manufactured and sold by Akzo under the registered trademark "Twaron" and previously sold as "Akrenka" and "Enka Aramid". Du Pont's competing aramid fiber is sold under the registered trademark "Revlar". (FF 11).

(FF 12).

The "Kevlar" and "Twaron" commerical spinnning precesses are

"<u>Twaron</u>"

<u>Polyamide:</u>
<u>Solvent:</u>
<u>PPD-T Concentration:</u>
<u>PPD-T I.V.:</u>
<u>Air Gap:</u>
<u>Coagulating Bath:</u>

(FF 29).

Respondents admit that Akzo's aramid fibers are prepared by the extrusion of a spinning dope

into an aqueous coagulation bath maintained at a temperature of

The spinning dope comprises

poly(p-phenylene terephthalamide) of

Inherent viscosity between In a sulfuric acid solvent. (FF 30). Thus, Akzo in its process is spinning a PPD-T in sulphuric *acid* dope. The concentration of PPD-T polymer is and Akzo is using an inherent viscosity that is and a coagulation bath temperature that is (FF 31).

Aramid is said to be the strongest commercial synthetic fiber known to man -- about five times as strong as steel on an equal weight basis. It has opened vast new technical horizons. (FF 15).

Du Pont's "Kevlar" aramid fiber has a unique combination of properties never before achieved in a synthetic fiber. In addition to extraordinary as-spun strength, "Kevlar" has a modulus (i.e., its resistance to stretch) equal to glass eight times as high as industrial grade polyester and 25 times as high as industrial grade nylon. (FF 16). "Kevlar" fiber also displays remarkable heat resistance. "KeVlar" will not melt. It retains one-half its room temperature tensile strength at 254 degrees Celsius, which is the melting point of industrial grade nylon and polyester. "Kevlar" only chars at exposure to high temperature. (FF 17).

Because of its unusal properties, "Kevlar" fiber has many diverse applications -- in ropes, spacecraft, airplanes, bullet resistant and other protective clothing, tires, boat hulls, hard armor, gaskets, and other objects. It can be used where high strength and light weight are sought. In some uses, its rustproof character or stability in high or low temperatures contribute to its utility. Depending on the use, "Kevlar" aramid fiber can substitute for steel,aluminum, asbestos, nylon, rayon, polyester, cotton, or carbon fiber. (FF 18).

Du Pont has developed a broad variety of "Kevlar" aramid fiber products to meet the needs of customers and potential customers who have differing uses for the product. "Kevlar" is available as continuous filament yarns and rovings, in a broad range of deniers, ranging from 195 to 15000 denier. (FF 19).

"Kevlar" fiber is also produced as staple and as pulp. Staple consists of short, crimped fibers designed primarily to be spun into yarn and for use as reinforcement in composite material. "Kevlar" pulp is a finely ground fiber used for applications such as the reinforcement of elastomers and for asbestos replacement in friction products. (FF 20). "Revlar" fiber is available at two levels of modulus. The regular modulus Kevlar is sold under the names "Kevlar" and "Kevlar 20." "Kevlar 49" is a continuous filament yarn that has been subjected to heat and high tension to create a higher modulus form of the fiber. It is used primarily as a reinforcement material in high technology composites for such applications as aircraft and space vehicle parts and boat hulls. (FF 21).

Akzo's "Twaron" aramid fiber has substantially the same properties and uses as Du Pont's "Kevlar" fibers. (FF 23). Properties and uses of "Twaron" are described in Akzo's Technical Bullentins for its products. "Twaron" is similarly available at two levels of modulus. (FF 23). "Twaron" fiber is made and sold in various types. (FF 24). Akzo's "Twaron" fiber is currently being produced in The Netherlands in a pilot plant in Arnhem. By October 1985 this fiber will be produced in a commercial plant being constructed in Emmen, The Netherlands. (FF 26).

III. TERMINOLOGY

Polyamides are polymers containing amide linkages:

(FF 103)

Aromatic polymers are polyamides wherein the radicals linking the amide linkages constitute aromatic radicals, e.g. 1,4-phenylene. If all of the radicals linking the amide linkages constitute aromatic radicals, then the aromatic polyamide is termed a wholly aromatic polyamide. If those radicals are also para-oriented, then a wholly aromatic para-oriented polyamide is formed. (FF 104).

Poly(p-benzamide) (1,4B) can be represented graphically as:

(FF 124).

The preferred polymer in the '756 patent specification PPD-T (FF 43) and the polymer recited in claims 4 and 13 of the '756 patent is a wholly aromatic para-positioned polyamide comprising equal parts of

and wherein R and R' are para-phenylene (1,4-phenylene) radicals. It is chemically referred to as poly)p-phenylene terephthalamide).-[1] and can be represented graphically as:

(FF 105).

1/ Du Pont has also used the code PRD-44 to refer to poly(p-phenylene tereplithalamide). (FF 129).

A polymer disclosed in Example V(a) in the '756 patent specification (FF 61) and which is included in the generic coverage of claims 1 and 10 of the '756 patent (FF 33) is the ordered copolymer 4,4' DABT comprising equal parts of

and wherein R, R' and R" are para-phenylene (1,4-phenylene) radicals. It is a para-positioned polyamide. It is chemically referred to as poly-4,4'-diaminohenzanilide terephthalamide and can be represented graphically as:

(FF 106).

The molecular weight of polymeric polyamides is dependent on the number of recurring units and accordingly can vary. It has a considerable effect on the viscosity of the polyamide dissolved in various solvents. Generally for a given polymeric polyamide in a particular solvent, viscosity of the polymer increases with increasing molecular weight of the polymeric polyamide. (FF 112).

IV. DU PONT'S RESEARCH EXCLUDING INVENTOR BLADES

In April 1957 Du Pont's scientist P.W. Morgan prepared high molecular weight PPD-T. On April 17, 1957, its solubility in concentrated sulfuric acid was noted. (FF 117). It was said that polymeric PPD-T could be wet spun from sulfuric acid into aqueous salt baths. On May 20, 1957, Horgan prepared "excellent" solutions of high viscosity PPD-T polymer (about 12% by weight) dissolved in concentrated sulfuric acid. (FF 118). Morgan observed that progress with PPD-T was excellent and work should continue. He felt PPD-T was a candidate for the class of high modulues, high tenacity fibers. (FF 118). Films of PPT-T were cast by Morgan from PPD-T/ sulfuric *acid* in 1957 but were tough but "brittle dry". (FF 118). A Du Pont notebook entry dated November 3, 1958 showed the synthesis bY Du Pont's Morgan of high molecular weight PPD-T using UMPA. This synthesis became example XIX in a Kwolek et al U.S. 3,063,966 which issued on Nov. 13, 1962. (FF 119).

Du Pont's Pioneering Research Laboratory was established in the late 1940's and by, 1964, it had a staff of approximately 100 PH.D.s and 150 support personnel all doing research aimed at new fibers and fibrous products. (FF 122). By 1964, Pioneering Research had discovered many commercial fibers which included "Orion", "Lycra" "Teflon" and "Nomex". (FP 122). In 1964 Dr. Eugene E. Magat, who testified at the hearing, took over as one of Pioneering Research's four research managers with responsibility for *new* polymer and new fiber compositions. (FF 123).

PRD-27 was Du Pont's code for high strength, high modulus fiber made from poly(p-benzamide) (1,48). It was Du Pont's first para-positioned polyamide that could be dissolved and spun into fibers with high modulus. (FF 124).

Research on polymeric poly-1,4-benzamide at Du Pont's Pioneering Research Laboratory was stimulated by the issuance of Belgian and Luxemburg patents in 1964. Du Pont's initial reaction was that this polymer could be a threat to the Nonex products venture. (FF 133).

On April 29, 1964 Du Pont's Morgan agreed to undertake a study of poly-1,4-benzamide. Du Pont's S.L. Kwolek was assigned by Morgan to carry out experiments on the polymer when a search of Du Pont's records showed only scanty data available in its files. (FF 134). According to statements in a Du Pont patent proposal it was thought that the potential of poly-1,4-benzanide to be superior material in the form of strong, durable fibers, films, and fibrids having exceptional thermal resistance, electrical insulating properties, and resistance to hydrolysis. (FF 135).

Experimental work on poly-1,4-benzamide was started by Ms. Kwolek on June 3, 1964 and later in 1964 polymeric poly-1,4-benzamide was prepared. Wet-spinning from sulfuric acid was done on January 15, 1965 with production of "fair fiber". (FF 136). Dry spinning of poly-1,4-benzamide in May 1965 yielded excellent, bright filaments. It was considered that an extraordinary organic fiber had been discovered which property-wise was patentably superior to glass as a reinforcing material for plastics and rubber. (FF 137).

_Prior to Us. Kwolek's work in the mid-sixties, para-positioned polyamides were regarded as essentially intractable and incapable of being formed into fibers. (FF 141). Kwolek discovered that under certain conditions, solutions or dopes of these para-positioned polyamides were in a liquid crystalline state, i.e. anisotropic state, and when properly wet or dry spun, fibers retained the high degree of orientation imparted by the spinneret prior to coagulation into fibers. (FF 141). The fibers "as-spun" were oriented and had high modulus (stiffness) and relatively high tenacity (tensile strength) without subsequent drawing. (FF 141). When given a heat treatment the fibers underwent recrystallization which raised those properties still higher. (FF 141). In previous high strength synthesis fibers such as industrial nylon, any orientation imparted on the spinning solution by the spinneret was lost by relaxation of the polymer melt or solution. As a result fibers were unoriented upon solidification or coagulation and the as-spun fiber ha49to be subsequently drawn to achieve acceptable orientation and crystallinity. (FF 141).

Du Pont's Morgan suggested in 1966 extruding viscous sulfuric acid solutions of PRD-27 and "kindred polymers" from fine-hole spinnerets into air and then before the stream of solution had time to relax and disorient, passing the stream into a coagulating bath. Nothing was said by Morgan about the concentration of polymer. (FF 150). Moreover Du Pont's Antal reported from work he did from Oct. 1965 to Feb. 1967 that PRD-27 in sulfuric acid forms isotropic solution and that while special low temperature disolution techniques can yield structured solutions of this polymer in sulfuric *acid,* the structure is easily destroyed on warming even to room temperature. (FF 151). Sulfuric acid dopes of PRD-27 were said to be poorly oriented on extrusion through a spinneret and the dopes were said to relax so fast that the resulting fiber is appreciably oriented in the skin while the interior of the fiber is a poorly oriented spherulitic arrangement. (FF 151). A 1967 Du Pont report however noted that 100% sulfuric acid was an excellent solvent for obtaining anisotropic dopes of p-aromatic polyamides, including PRD-27. (FF 153).

Pioneering Research was wet spinning PPD-T from concentrated sulfuric acid into a water bath in 1966 and 1967. A 1966 Du Pont report indicated that the low solubility of PPD-T in existing solvent systems however had precluded dry-spinning of PPD-T. (FF 145). A 1967 Du Pont report disclosed that while prip-7 gave spinnable solutions in concentrated sulfuric acid, extruded filaments from concentrated sulfuric acid were somewhat weaker than those spun from other solvents and only high inherent viscosity PPD-T had given good spins. (FF 147). All of the work in the 1967 report was with PPD-T viscosities which were in the range of 2.5. (FF 149). In 1967 it was noted

at Du Pont that the patent literature disclosed anistoropic PPD-T sulfuric acid dopes. It was observed that high as-spun properties and very high modulus fibers appear to be related to the ability of the polymer to give an anisotropic dope. (FF 154).

DU Pont's Bair in an August 1968 report reported that anisotropic dopes could be obtained with many p-aromatic polyamides but only in around 100% sulfuric acid. This discovery was said to provide a lead to a new inexpensive process for spinning which could be applied to a wide range of polymeric compositions as well as a greatly extended range of molecular weights. (FF 155-164). Bair however had a concern for degradation of p-aromatic polyamides in around 100% sulfuric acid. Thus he observed that very little, if any "degradation" of poly(p-phenylene terephthalamide) was found to occur during his spinning-coagulation of the sulfuric acid dopes. (FF 156).

Bair in his August 1968 repoit reported that earlier work at Du Pont with sulfuric acid dopes of all pare aromatic polyamides had dealt with concentrated (95-98%) sulfuric acid; that these solutions were isotropic and had short relaxation times when sheared. Commenting on what Du Pont's Antal had earlier reported, (FF 158) Bair noted that a consequence of the short relaxation times is that orientation is imparted only to the outer porition of the fiber during extrusion and coagulation gave a fiber with a thin, tough, highly **oriented skin and an unoriented core. (FF 158). Bair pointed out that an advantage of around 100% sulfuric acid as a solvent for the dopes of all para aromatic polyamides is the ability to dissolve high molecular weight polymers at relatively high solids content to form an inherent viscosity of 3. Only 10 % solids content however was considered by Bair to be a high solids content. (FF 158). Bair commented further on the difference in solution viscosity of sulfuric acid isotropic and anistropic dopes; that the**

extremely high viscosity of the isotropic dopes at high solids limited to some extent the range of solids which could be spun conveniently and as a consequence most spins of isotropic dopes were considered with around 5-7 % solids. (FF 159).

In the experimental section of Bair's August 1968 report relating to the spins of poly(p-phenylene terephthalamide) from sulfuric acid, the temperature was varied over a range of 30-40°C with a maximum temperature of 60 °C. Bair found it convenient to operate in a middle bath temperature of 30-40 °C. (FF 161). While a Table XI in his report showed 15% concentration <u>inter alia</u> of the polymer in at least 99% sulfuric acid, (FF 161) there is no disclosure of what the spin bath temperature was for that concentration. Furthermore Bair reported in his August 30, 1968 report that the best fiber properties were at 10% PPD-T concentration with as-spun tenacity up to 7 gpd. (FF 163). The tenacity reported for the 15% PPD-T concentration was only 3.83 gpd; the tenacities reported for the 13% PPD-T concentrations were at least below six. (FF 164). In deposition Bair has denied heating any dopes of this report because he was certain the polymers would degrade. (FF 169).

Du Pont's Bair in a Dec. 1968 report reported that poly(p-phenylene terephthalamide) no longer gave anisotropic dopes in acid strengths much under 99-100% sulfuric acid. (FF 166). However copolymers of PRD-27/PRD-44 were said to form anisotropic dopes in 95.5% sulfuric acid. (FF 167).

Du Pont's Mukamal in a Aug. 1968 report indicated that PPD-T /H_2SO_4 solution anisotropy, considered a prerequisite to high as-spun tensile properties, was sensitive to heat development (FF 171) and that the usual range for spinning anisotropic dopes is limited to solute concentrations of 9.5 to 12t. (FF 172). Research at Du Pont in a July 1969 report disclosed critical concentration levels of PPD-T polymer in 100.3% sulfuric acid at only about 8% solids for polymer with inherent viscosity from 4-6. (FF 178). While it was said that anisotropic dopes of PDD-T in concentrated sulfuric acid can be prepared in the region of from about 8-10% solids, such a dope with high viscosity is more like a "dough". (FF 178).

V. THE BLADES INVENTION

Herbert Blades, inventor on the '756 patent, is employed at Du Pont's Pioneering Research Laboratory (FF 198, 199). About January 1969 he joined Dr. Magat's group. (FF 200). His first assignement was the measurement of the compresive strength of PRD-27. PRD-27 was then the leading candidate for development as a high tenacity, high modulus industrial fiber. (FF 200, 201). PPD-T polymer was a back-up candidate. (FF 200). Around mid-1969 he was assigned the broad task of examining wet spinning of PRD-27 and PPD-T liquid crystalline amide dopes into water. (FF 200, 202). Inventor Blades presented the results of his studies at a Du Pont Research Review in November 1969. After the review discussions, Du Pont's Dr. Peter Boettcher suggested that an air gap betwen the spinneret and the bath would be one way of influencing the early stage of coagulation. (FF 204). Other than through the suggestion by Dr. Boethcher, inventor Blades had no independent knowledge of the concept of the air-gap. (FF 205). Dr. Boettcher received the concept of the air-gap from a Monsanto Morgan '645 U.S. patent. (FF 206, 260).

At the hearing inventor Blades testified that he remembered the Morgan '645 patent being given to him sometime after he made his first spin with an air gap using amide solvents and before he did any work with sulphuric acid. (FF 207). On November 7, 1969 Blades experimented with an air gap using PRD-44(PPD-T) amide dopes and succeeded in making fiber. Blade found tint using the PRD-44 dopes and spinning through an air gap into a coagulating bath produced higher windup speeds and spin stretch. (FF 208).

Spinning polymeric solutions through an air gap to improve the properties of the polymeric fiber therefrom is notoriously old in the polymer art. (FF 370-380). However the properties that are improved can vary from system to system. For example U.S. Patent No. 3,080,210, which issued in March 1963 discloses that the use of an air gap with a preferred solvent and bath composition at a critical temperature range are all necessary to produce acrylonitrile polymer fibers with advantageous physical properties. (FF 370).

It is noteworthy, in connection with issues raised in this investigation, that inventor Blades Nov. 7, 1969 air gap experiment did not improve the tenacities of the fiber spun. Thus he wrote in his notebook that the tenacity of filaments from PPD-T with an air gap was very poor. (FF 208). Blades did think the use of an air gap was a good Idea because it gave orientation produced by shear in the spinneret orifice time to relax and hence fiber could then be stretched as a solution first before it entered the bath. In this way he noted that it would be possible to separate the orientating effects of shear in the orifice with spin stretch. (FF 209).

At the time Blades conducted his air gap experiment on Nov. 7, 1969 anisotropic spinning dopes of PPD-T in sulfuric acid of at least 98% concentration or more were well-known within Du Pont. (FF 178). Also it was the concensus within Du Pont, that the preferred concentration of sulfuric acid when used as a solvent for PPD-T, was around 100 percent sulfuric acid. (FF 178). Blades testified at the hearing that it was then common knowledge at Du Pont's Pioneering Research Laboratory that PPD-T polymer reacted with sulfuric acid and was degraded at high temperatures; that scientists in prior research efforts with PPD-T had been careful to carry out the mixing of PPD-T and sulfuric acid and spinning procedures at about room temperature. (FF 214).

It was Dr. Ilagat who suggested to inventor Blades that Blades include sulfuric acid dopes in his work. (FF 215). Because the preparation of spin dopes proved very difficult a twin cylinder mixing device was designed and constructed by Blades. Blades waited from mid-December 1969 into March 1970 for Du Pont's shop to make some parts he needed to assemble the mixer. (FF 217).

Inventor Blades used sulfuric acid of about 1002 concentration in his first air-gap spins of PPD-T/H_2SO_4 dopes at 10% polymer concentration in March 1970 with his twin cylinder mixer. (FF 219-221). While results showed an air gap provided higher spinning speeds, consistent with teachings in the prior art, the as-spun properties of the fibers were not good - the tenacities being only 3.5-5.4 gpd. (FF 221). Prior research at Du Pont with 10% PPD-T in 100% sulfuric acid, without an air gap had given a tenacity as high ss 12 gpd, (FF 221). Blades then made a 10.2% PPD-T sulfuric acid dope and spun it with acid without an air gap. The fiber properties with no air gap were comparable to the air gap experiments. (FF 222). The mixing and spinning Blades had done up to this time were at about room temperature. In April 1970 Blades experimented with a 12.3% PPD-T sulfuric and dope (FF 223) and applied heat at 55 °C and 85 °C through a water bath. Thereafter he cooled the dopes to room temperature and spun immediately using air gap spinning. Blades found that heating the dope during mixing greately facilitated the mixing (FF 223). He became convinced that 12.3% PPD-T was not the maximum concentration possible in sulfuric acid dopes. (FF 223).

Blades next worked with 14.52 PPD-T sulfuric acid (100%) dopes, heating them to facilitate mixing. As-spun tenacity went to 14.5 gpd. (FF 224). At the hearing Blades testified, he was the first at Du Pont to heat PTD-T/sulfuric acid at polymer concentration greater than 12%.

(FF 214). Blades did experience difficulty with the 14.5% dope because after heating the 14.5% dope, he cooled it before spinning and consequently the spinneret holes would plug repeatedly. Blades concluded that the trouble was that all the polymer was not in solution. (FF 226). He recognized that to spin higher concentrations of PPD-T/sulfuric and solutions, spinning temperatures far greater than room temperature were required to keep the system above its melting point and fluid at the spinneret. Thus modifications had to be made by Blades to the mixing equipment so that the hot water bath could be kept in place around the mixing vessel during spinning. (FF 228). In separate experiments in April 1970 Blades found that the melting point of a dope increased as its PPD-T concentration increased. (FF 229).

As soon as the equipment was modified Blades, as recorded by him on April 16, 1970, ran an experiment using PPD-T of 4.4 inherent viscosity at a concentration of 20% by weight in 100.2% sulfuric acid. The mix was heated to about 95°C and spinning carried out at about 100°C. Spinning was trouble free. The as-spun tenacity of filaments therefrom was about 18 gpd. Blades recognized that the tenacity was an extraordinary value. (FF 230). In a notebook entry dated April 20, 1970 Blades noted "little or no degradation" of PPD-T. (FF 231). The administrative law judge finds this notation consistent with the feeling at the time at Du Pont that heating of PPD-T in concentrated sulfuric acid would expose the PPD-T to degradation. Certainly Blades ,when he made that notation in his notebook, was not thinking of filing a patent application nor creating a myth for patentability, as Akzo centends.

Example 1 of the '756 patent records the experiment using 20% PPD-T/H_2SO_4 which Blades performed in April 1970. (FF 233). Blades believed that at the high concentration of PPD-T, the sulfuric acid is bound to the polymer and is essentially deactivated in a chemical sense. Hence the absence of degradation. (FF 236).

Inventor Blades presented his work with illustrative charts to a Du Pont Research Review on April 16, 1970. (FF 238). One chart illustrated how as-spun tenacity of Blades' fibers was roughly twice what had been obtained in Du Pont Killian's experiments using PPD-T/sulfuric and at 10% polymer concentration. (FF 238). Another chart showed the relationship between polymer concentration in sulfuric acid solution and the melting point which Blades had discovered. (FF 239). Another chart showed the significant advantages gained from Blade's novel process with PPD-T. (FF 241).

VI. VALIDITY OF THE '756 PATENT

35 U.S.C. § 282 creates a presumption that a patent is valid.

The patent challenger must establish invalidity by clear and convincing evidence. As the Court of Appeal's for the Federal Circuit emphasized:

> "The statute places the burden of proving facts establishing invalidity on the person asserting invalidity. The patent challenger must establish those facts by clear and convincing evidence, and the ultimate burden of persuasion never shifts from the patent challenger." Jones v. Hardy, 727 F.2d 1524, 1528, 220 U.S.P.Q. 1021, 1024 TFe : cii717F4).

In the present case, Akzo relies primarily on two references, Monsanto's Morgan '645 patent (FF 260) and Du Pont's Kwolek '542 patent (FF 299-329), which were both of record during the prosecution of the Blades '756 patent, and were extensively considered by the Examiner during the prosecution. (FF 63-102). Under these circumstances, the patent challenger's burden to overcome the presumption of validity by clear and convincing evidence is made even heavier:

> "When no prior art other than that which was considered by the PTO examiner is relied on by the attacker, he has the added burden of overcoming the deference that is due to a qualified government agency presumed to have properly done its job, which includes one or more examiners who are assumed to have some expertise in interpreting the references and to be familiar from their work with the level of skill in the art and whose duty it is to issue only valid patents."

American Hoist & Derrick Co. v. Soya & Sons, Inc., 725 F.2d 1350, 1359, 220 U.S.P.Q. 763, 770 (Fed. Cir. 1984). See also Fromson v. Advance Offset Plate, Inc. No. 84-1542, 84-1553 (Fed. Cir., Feb. 21, 1985).

Claim 13 Is Not Anticipated Under 35 U.S.C. § 102

Anticipation under 35 U.S.C. § 102 requires, in a single prior art reference, disclosue of each and every element of the claimed invention. Connell v. Sears, Roebuck & Co., 722 F.2d 1542, 220 U.S.P.Q. 193 (Fed. Cir. 1983); SSIH Equip. S.A. v. U.S.I.T.C., 718 F.2d 365, 218 U.S.P.Q. 678 (Fed. Cir. 1983). W.L. Gore 6 Associates, Inc. v. Garlock, Inc. 721 F.2d 1540, 1554, 220 U.S.P.Q. 303,313 (Fed. Cir. 1983), cert denied 105 S. Ct. 709(1984) Scott v. Inflatable Systems, Inc., 222 U.S.P.Q. 460, 461 (9th Cir. 1983); In re Certain Automatic Crankpin Grinders, 205 U.S.P.Q. 71, 76 (ITC 1979); Structural Rubber Products Co. v. Park Rubber Co., 749 F.2d 707, 715, 223 U.S.P.Q. 1264, 1270 (Fed Cir. 1984). Also to anticiapte, the reference must in an "enabling" disclosure, In re Brown, 329 F.2d 1006, 141 U.S.P.Q. 245, (C.C.P.A. 1964), i.e., a "direct teaching." As Judge I. Jack Nartin stated in the Brown case, the "true test of any prior art" is whether the prior art is such as to place the allegedly disclosed matter "in the possession of the public." Id. at 1011, 141 U.S.P.Q. at 249.

Respondents argue the identity of claim 1 of the '756 patent, as to the polymer with the Morgan '645 patent by referring to 4,4'-DABT at col. 2, ls.

44-4S of the Morgan '645 patent and the disclosure of 4,4'DABT in the '756 patent which disclosure is within the generic concept of claim 1 of the '756 patent.

Claim 13 of the '756 patent discloses a process involving PPD-T. Respondents argue that PPD-T is disclosed in the Morgan '645 patent by virtue of a Hill et al '899 patent and a Hill et al '511 patent (FF 295) which are referred to in column 1 of the Morgan '645 patent and which are said to disclose aromatic polyamides to be used in the Morgan '645 process. (FF 281, 282). (RPH p. 21). Respondents argue that the "slightly higher" polymer concentrations of claim 13 (at least 18 wt. percent in claim 13 as against at least 14.1 wt. percent in claim 1) are clearly disclosed in the Morgan '645 patent and therefore claim 13 cannot avoid anticipation. (RPH pp. 20-21).

The '756 patent specification teaches that what is involved in the '756 patent are optically anisotropic dopes.. (FF 47). There is no teaching in the Hill patents that all of the suggested polymers would.inherently form optically anisotropic dopes as is the dope with PPD-T in claim 13. (FF 33, 47). The fact that, in the Hill patents the substituents on the aromatic ring can be meta or para oriented (FF 245) is to the contrary. Hence to obtain the PPD-T of claim 13 would involve random "picking and choosing" on the happenstance that PPD-T will be selected. Moreover there is nothing in the Morgan '645 patent that teaches that the minimum polymer range of about 10% should be adjusted to at least the 14.1% range of claim 1 or at least 182 of clpim 13 to obtain the anisotropic dopes of claim 1 and claim 13, even assuming the Morgan '645 patent taught a sulfuric acid concentration of at least 982.

Respondents have not disputed the fact that a fiber of poly (m-(meta-oriented] phenylene isophthalamide) wet spun as an 18% solution in dimethylacetamide-calium chloride (polymer inherent viscosity 1.91 had a tenacity of only 6.8 grams per denier. (FF 71). Moreover they do not take issue with the fact that when a dope containing 24% by weight of the poly (m [meta-oriented phenylene isophthalamide] of 1.16 I.V. is as spun from an acid solution through an air gap filaments with a tenacity of only 1.8 gpd. are obtained. (FF 61). Respondents also have not disputed that a spinning dope made of 15.8% by weight of poly(meta-oriented) phenylene isophthalamide of inherent viscosity of 2.18 in an acid mixture when as spun through an air gap resulted in fibers with a tenacity of only 0.46 gpd. (FF 73).

Respondents do not dispurte the fact that all of the examples of the Morgan '645 patent are directed to the use of meta-oriented aromatic polyamides (FF 262) and that there is only one para-oriented aromatic polyamide named in the Morgan '645 patent, excluding the '645 patent *reference* to other patents. Respondents cannot dispute the fact that the Morgan '645 patent does not disclose liquid crystallinity on the part of para-oriented aromatic polyamides (PPD-T), which is not found in meta-oriented aromatic polyamides, because in 1964 when the Monsanto '645 patent application was filed even the manifestation of liquid crystallinity on the part of para-oriented polyamides had not been demonstrated. (FF 276).

The Morgan '645 patent is further deficient as an anticipating reference under 35 U.S.C. § 102 bacause it does not disclose a process involving sulfuric acid of "at least 98%" concentration as a solvent for the polymer. This is a limitation not only in claim 13 but in each of the claims of the '756 patent. (FF 33). Respondents argue that the use of sulfuric acid of at least 98% concentration for PPD-T is disclosed in the Morgan '645 patent by virtue of a Smith '125 patent (FF 296-298) referred to in col. 1 of the Morgan '645 patent and the recitation *in the* Morgan '645 patent of concentrated sulfuric acid (FF 283). Concentrated sulfuric acid is not inherently sulfuric acid of at least 98%. For example the term concentrated sulfuric acid' was used at Du Pont to refer to sulfuric acid having a concentration as low as 952. (FF 158, 167). Also there Is frequent reference in the literature to concentrated sulfuric acid with a concentration as low as 952. (FF 389, 390). Concentrated sulfuric acid of at least 98% concentration is critical for the formation of the anisotropic dopes used in the processes of the Blades claims. (FF 37, 41). In neither the Morgan '645 patent nor Smith '125 patent is there a teaching of the use of sulfuric *acid* of at least 982 concentration for obtaining anisotropic dopes. A mere reference to concentrated sulfuric acid in the Morgan '645 patent is not a teaching of an acid of at least 982 concentration, as claimed in the '756 patent, found "in exactly the same situation ... to perform the identical function" in the Morgan '645 patent, Scott v. Inflatable Systems, Inc. 222 U.S.P.Q. 460.461 (9th Cir. 1983). Respondents have not established where in the four corners of the Morgan '645 patent, even with its disclosure of 4,4' DART and its reference to other patents, there is a teaching to adjust the concentration of the sulfuric acid to at least 98% and to adjust the weight percentage of polymer to obtain the anisotropic dopes used in the claims of the '756 patent.

Respondents' argument that those within Du Pont would have understood "concentrated sulfuric acid" as that expression is used in Morgan '645 to mean a concentration of at least 982 suitable for making anisotropic dopes of 4,4'—DABT is unpersuasive. (RPH p. 23). This argument assumes that the Morgan '645 patent has, as its object, the preparation of ansotropic dopes. This assumption is unwarranted in view of the wide variety of polymers disclosed in the Morgan '645 patent as useful in the Morgan '645 invention. (FF 280).

Respondents argue that the recitation, in the Morgan '645 patent, that the temperature resistant[4] wholly aromatic polyamides are conveniently spun from about 10 percent to about 30 percent solutions, preferably 12 to 20 percent solutions by weight (col. 4, ls. 24-27) (RX-2, chart) discloses the limitation of claim 13 of the '756 patent as regards PPD-T "at a concentration of at least 40 grams per 100 ml. of solvent [18% PPD-T]" (at least 18 wt. percent). However, as Du Pont argued, there is a failure in the Horgan '645 patent to connect any percentage range of polymer with any specific polymer, let alone PPD-T, and there is not an enablement, as required for §102, to teach one skilled in the art how to achieve an 182 concentration of PPD-T in sulfuric acid. (CM, p. 22). There is no disclosure in the Morgan patent of development of orientation and desirable mechanical properties in as-spun fibers. (FF 209). The specification and all of the examples of.the Morgan '645 patent call for post-coagulation drawing of the fibers to produce orientation and the desired mechanical properties. Morgan discloses as an integral part of his process following coagulation an orientation stretch in a hot bath (FF 265) and thereafter another hot drawing step. (FF 265, 266).

Thus the examples in the Morgan '645 patent use total post-coagulation draws of 1.7x to 5.62x, with most of the examples using total post-coagulation draws of about 3.6x. (FF 266). Such post coagulation draws are in the range of those conventionally employed in the processing of textile fibers such as nylon, polyacrylonitrile and polyethylene terephthalate. In such processing, the achievement of a high degree of orientation and crystallinity in the as-spun fibers is not a desiratum of the process since they would render difficult the subsequent drawing operation and lead to filament breakage in the drawing. The combination of properties in the fibers produced by Morgan, even after the extensive post-coagulation drawing, is very different from the properties of the <u>as-spun</u> fibers from the process of claim 13 of the '756 patent. Morgan reported the highest tenacity as 7 gpd and an elongation of 332, compared to fibers from the claim 13 process which can be as high as 20 gpd and have 3-4% elongation. (FF 267).[21] The highest tenacity of any fiber described by Morgan *in* the '645 patent is notably inferior to the tenacity of drawn nylon filaments available at the time (about 10 gpd). (FF 268). Nowhere does the Morgan '645 patent disclose a specific example where he makes a fiber of PPD-T. All the examples refer to meta-positioned polymers. (FF 269). Meta-positioned polymers form isotropic solutions at all concentrations of polymer and do not form liquid crystalline solutions. Nowhere does the Morgan '645 patent disclose the spinning of fibers using liquid crystalline (i.e. anisotropic) solutions or dopes. (FF 269, 274).

The Morgan '645 patent has no example disclosing how spin dopes containing 4,4'-DABT might be prepared, how fibers of this polymer might be spun or what the resultant properties may be. 4,4'-DART is the only para-positioned polymer named in Morgan excluding the reference to other patents in col. 1. (FF 270-273). All the examples in the Morgan '645 patent dissolve the meta-positioned aromatic polyamides in amide/salt solvents. Moreover, according to Morgan, "it is desirable and convenient to use the same solvent for polymerization and spinning" and dlmethylformamide and dimethylacetamide containing up to 102 by weight of dissolved metal salts are

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2/ The unique fiber properties produced by the claim 13 process cannot be divorced from the novel process even though each is separately patented. W.L. Gore *Si* <u>Associates</u> Inc. v. <u>Garlock, Inc.,</u> supra. 721 F.2d 1540,220 U.S.P.Q. 303. <u>See also Congoleum Industries,</u> Inc. v. <u>Armstrong Cork Co.,</u> 339 F. Supp. 1036, 1053, 173 U.S.P.Q. 769 (3d Cir.), <u>cert. denied,</u> 421 U.S. 988 (1975); <u>Ralston Purina Co.</u> v. <u>Far-Mar-Co.,</u> 586 F. Supp. 1176, 1224, 222 U.S.P.Q. 863, 900 (D. Kan. 1934).

regarded as "especially useful." (F 274). Consistent with Morgan's focus on amide/salt solvent systems is Morgan's concern about eliminating salts from the fibers and his selection of specific solvent extraction agents - both of which are specifically *directed to amide/salt* solvents and not the sulfuric acid dopes of claim 13. (FF 275).

Morgan's 10-307. polymer concentration range Is consistent also with his focus on meta-positioned polyamides in amide-salt solvents which are typically dissolved in such concentrations. Para-positioned polyamides, and particularyly PPD-T, are much less soluble than meta-positioned polyamides. (FF 276). Morgan does not disclose forming concentrations of 12-20% (Morgan's preferred range) for any para-positioned polyamide, and there is no teaching as to how they could be achieved for the highly Intractable PPD-T. (FF 277). Morgan's reference at column 4, lines 5-6 to a broad range of elevated tempeatures of 30 to 120°C. refeis to the extrusion temperature. Since it was well known to adjust the temperature of extrusion as a means of varying the viscosity of the solution for spinning, this is a teaching of adjusting spinning conditions. It is not a disclosure that mixing and extrusion operations are carried out separately with different apparatus and conditions. Nowhere in the Morgan '645 patent is there any specific disclosure as to how his spin dope solutions are prepared. (FF 278).

There is also no disclosure in the Morgan '645 patent that the "as-spun"--[3] tenacity of dry jet wet spun fibers is higher than that of wet

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[3] The mere use of an air gap is not a guarantee that good as spun fibers can be obtained. Following inventor Blades' initial use of an air gap in the spinning of PPD-T amide solutions in 1969, J. McBride, another Du Pont researcher at Du Pont's Pioneering Research Laboratory, reporting to Blades,

(Footnote continued to page 0)

spun fibers. The tensile strengths reported in the Morgan '645 patent refers to fibers which were drawn extensively after spinning. (FF 270).

For application of the Morgan '645 patent under § 102, to the claimed subject matter one would have to pick and choose among (1) a large number of polymers, (2) a plurality of solvents which in view of the recitation "concentrated sulfruic acid" only in Morgan '645 patent would also involve a particular type of solvent, (3) a range of inherent viscosities. As Judge Rich stated in In re Arldey, 455 F.2d 586, 587, 172 U.S.P.Q. 524,526 (CCPA 1972) for anticipation under 35 U.S.C. S 102 a reference must clearly and unequivocally disclose the claimed subject matter or direct those skilled in the art to said matter without any need for picking, choosing and combining various diclosures not directly related to each other by the teachings of the cited art. See also General Battery v. Gould, Inc. 545 F. Supp 731, 744,215 U.S.P.Q. 1007,1017 (D.Del. 1982), Structural Rubber Products Co. v Park Rubber Co. supra 749 F.2d at 716, 723 U.S.P.Q. at 1271.

For the foregoing reasons respondents have not sustained their burden in proving that claim 13 of the '756 patent is invalid under 35 U.S.C. S 102.

(Footnote continued from page 44)
undertook a program aimed at assessing the use of an air gap in the spinning of amide dopes of 1,4B, C1PPD-T and PPD-T. Fiber B (1,4B) wet spun had consistently produced fibers with as-spun properties T/E/11 = 12/6/500. McBride using an air gap with the same 1,4B amide dopes (PRD-27) was unable to get better properties -- his best properties as-spun for these amide dopes were T/E/M/ - 11.0/8.1/371. McBride could not get any better as-spun properties using an air gap with PPD-T amide solutions (PRD-44) - his best properties as-spun for these amide dopes were T/E/M - 7.7/4,3/380. McBr44e's work with an air gap and C1PPD-T-amide dopes resulted in lower tenacities than PRD-27 (1,4B). (T/E/M = 8.5/6.4/300). (FF 279).

Claims 13 In Not Obvious Under 35 U.S.C. § 103

Under 35 U.S.0 § 103, a patent may not *be* obtained if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. In Graham v. John Deere Co., 383 U.S.. 1, 148 U.S.P.Q. 459 (1966), the Supreme Court detailed the factual considerations which courts must apply in determining the question of obviousness. The Court stated:

> "Under § 103, the scope and content of the prior art are to be determined; differences between the prior art and the claims at issue are to be ascertained; and the level of ordinary skill in the pertinent art resolved. Against this background, the obviousness or nonobviousness of the subject matter is determined. SuCh secondary considerations as commercial success, long felt but unsolved needs, failures of others, etc., might be utilized to give light to the circumstances surrounding the origin of the subject matter sought to be patented. As indicia of obviousness. or nonobviousness, these inquiries may have relevancy." (Footnote omitted).

(383 U.S. at 17-18, 148 U.SP.Q. at 467).

In United States v. Adams, 333 U.S. 39, 148 U.S.P.Q. 479 (1966), the Supreme Court again treated the question of obviousness under § 103. The Adams patent in issue covered a nonrechargeable electric battery which could be stored indefinitely without any fluid in its cells and could be activated merely by adding water. The patent called for battery electrodes of magnesium and cuprous chloride, both battery elements being old in the art though not previously combined in a single battery. The government had argued that wet batteries comprising a zinc anode and silver cloride cathode were old in the art; and that the prior art showed that magnesium may be substituted for zinc and cuprous chloride for silver chloride. In rejecting this contention, the46

Court stated:

> "It begs the question . . . to state merely that magnesium and cuprous chloride were individually known battery components. If such a combination is novel, the issue is whether bringing them together as taught by Adams was obvious in light of the prior art." (Emphasis added).

(383 U.S. 49, 148 U.S.P.Q. 483).

The Court also mentioned the tremendous commercial success of the Adams battery and identified this as a factor bearing on the question of obviousness.

"[S]econdary considerations" referenced by the Supreme Court in the Graham case are considered for whatever probative value they have. In Jones v. Hardy, 727 F.2d 1524, 220 U.S.P.Q. 1021 (Fed. Cir. 1984) Chief Judge Markey stated:

> "Objective indicia of nonobvousness, when present, must always be considered before a legal conslusion under § 103 is reached. Stratoflex, Inc. v. eroquip Corp., 713 F.2d 1530, 1538, 218 U.S.P.Q. 871, 879 (Fed. Cir. 1983). [Patentee] Jones introduced evidence of long—felt need and commercial success. Hardy's admitted infringement constitutes some evidence of the merits of the claimed invention over the prior art praised but avoided by Hardy.

(220 U.S.P.Q. at 1026).

Evidence of commercial success in "extremely strong and is entitled to great weight". Simonds Fastener Corporation v. illinois Tool Works, Inc., 222 U.S.P.Q. 744, 747 (Fed. Cir. 1984).

35 U.S.C. § 103 further requires that the mind be cast back to when the invention was made" and requires a determination of whether the ivention "would have been obvious" at that time. Moreover, the question which always has to be answered in a § 103 situation is whether the subject matter of the invention "as a whole" would have been obvious. Rosemount, Inc. v. Beckman Insts., Inc., 727 F.2d 1540, 221 U.S.P.Q. 1 (Fed. Cir. 1934).

Respondents argue that the process cltrimed in each of the thirteen claims of the '756 patent would have been obvious to one of ordinary skill in the art under Section 103 by reason of Morgan '645 when considered with the Kwolek '542, Bair et al '941, and Cipriani '793, patents, the other air-gap spinning art and Du Pont's internal prior work which preceded Blades' invention (RPH pp. 24-25). Respondents presented two witnesses who testified on the obviousness of the Blades invention. One of these witnesses, Dr.Uilliam J. Baily, is not an expert in the spinning of fibers in liquid crystals. Respondents' other expert Dr. Robert B. Davis has no experience with anisotropic or liquid crystalline solutions or the handling of anisotropic PPD-T solutions. (FF 338). Spinning of fibers and anisotropic PPD-T solutions are critical to the claim 13 process. (FF 47). Neither of respondents' technical witnesses showed how the teachings of the.references, for example the Morgan process which uses the traditional fiber making approach (FF 250-252) and the Kwolek and Bair et al processes which use the liquid crystalline approach for making fibers (FF 253-255) could properly be brought together or combined without reconstructing the teaching of these patents nor did they show where there is a direction in these patents for any proposed combinations. (FF 339, 341, 342). In contrast Du Pont's expert Dr. Uhlmann an expert in the field of spinning polymer solutions, (FF 384) particularly para-amides, testified at the hearing that one skilled in the art would be directed by the teachings of the Morgan '645, Kwolek '542 and Bair et al '941 patents not to combine them. Dr. Uhlmann pointed out that Kwolek wanted to produce highly oriented fibers as-spun and that Morgan '645 wanted the opposite, namely isotropic, largely unoriented fibers as spun. (FF 340).

A simple examination of each of the cited art further teaches away from combining the references in the absence of the benefit of the '756 patent.

Thus the the largest PPD-T concentration used in Examples 1, 2 and 72 of-Kwolek '542 (FF 311-313) was about 12%. Tenacities of the polymer ranged from 5.7 to 7 gpd. (FF 314). The PPD-T concentration of the claim 13 process which is the preferred concentration of the '756 patent, is at least 18 present. Kwolek '542 patent spins dopes by conventional wet and dry spinning techniques. (FF 319). In the Morgan '645, patent, although Morgan '645 suggests a vast number of polymers there was only one polyamide that is encompassed by the formula of the claims, 1 and 10 of the '756 patent viz. poly-4,4'-diaminobenzamide terephthalamide (4,4'DABT). However no example showed that polymer being spun or even in a spinning solution. All of the other polymers disclosed in the Morgan '645 patent contain radicals with nonextended bonds, e.g., meta-oriented segments, which are not encompassed by the claims of the '756 patent. (FF 269-273).

The largest PPD-T concentration in the Bair et al '941 patented examples is about 10%. (FF 313). The Bair et al patent does not disclose heating PPD-T and sulfuric acid to form a spin dope. (FF 314). Dopes in the Bair et al '941 patent are spun by conventional wet and dry spinning. (FF 315). There is no suggestion in the Cipriani '793 patent that dry jet wet spinning could be used to any advantage in the spinning of polyamides from sulfuric acid solutions. (FF 354). Post-coagulation stretches are essential to obtaining attractive mechanical properties in the '793 patent. No such stretches are used with Blades' fiber. (FF 356).

Respondents' effort to pick and choose among the prior art disclosures is an approach disapproved by the Federal Circuit for a Section 103 analysis. The patent challenger may not use the claims of a patent as a frame, and employ individual parts of separate prior art references "as a mosaic to recreate a facsimile of the claimed invention." U.L. Gore & Associates, Inc. v. Garlock, supra, 721 F.2d at 1552, 220 U.S.P.Q. at 312.

In contrast to respondents' attempt to pick and choose, the examples of the '756 patent specification clearly support the patentability of the use of preferred dope of claims 13, viz. between 40 and 56 grams of poly(p-phenylene terephthalamide) (PPD-T) having an I.V. of at least 3.0 per 100 ml. of at least 98% sulfuric acid with the amount of polymer being between 18 *and* 23.4 weight percent. (FF 33). A study of the examples show the following: (FF 59, 60, 61).

Ex.	Conc. of Polymer	Tenacity
I	20	18
I B	20	26
II	20	15-24
II C	20	18
III (d)	20	27
VI	20	16-25
VII	20	24, 22, 19

In addition to the non-disclosure of claim 13 in the prior art, the record establishes objective indicia or secondary considerations that supports non-obviousness. Inventor Blades solved a problem at Du Pont which Du researchers had been working on for five years. (FF 117-190). Respondents in their manufacture of aramid fiber

Du Pont uses the steps of the Blades process in manufacturing its "Kevlar" which has achieved widespread commercial success by supplmenting prior art fibers. (FF 11-22, 29).

With respect to the patent aspects of this investigation respondents alleged two "myths" that Du Pont is said to have sought to perpetrate in this investigation. Myth No. 1 is that inventor Blades did something contrary to conventional wisdom when he warmed the semi-solid dope to make it spinnable.

Akzo asserts that Du Pont's Magat conceived this argument sometime in late 1971- and put it in his "NP-9 History"; and that Du Pont's witnesses at the hearing attempted to establish it. Respondents argue that there is no evidence showing that prior to December 1969 researchers within Du Pont were reluctant to heat PPD-T/sulfuric acid dopes because of a fear of degrading the polymer and that, to the contrary, a number of researchers within Du Pont had, in fact, heated dopes before the Blades' invention. They further argued that prior art patents, disclose heating PPD-T/sulfuric acid dopes. (RPII p. 2).

Alleged Myth No. 2, asserted by respondents, is that inventor Blades was the inventor of the '756 process. It is argued that Blades was investigating spinning of PPD-T in aramide solvents at the time the Morgan '645 patent came to Du Pont',s Boettcher's attention; that Dr. Boettcher suggested that inventor Blades try the Monsanto Morgan '645 air gap process; that Blades did so and immediately confirmed the spin stretch factor and wind-up speed improvements predicted by the prior art. It is further argued that in December 1969 Dr. Nagat of Du Pont directed inventor Blades to try the Monsanto Morgan '645 air gap process with PPD-T dope dissolved in concentrated sulfuric acid; that inventor Blades' initial dopes were at 10% polymer concentration; that Du Pont's Dr. Antal suggested to inventor Blades that higher concentrations would be possible if the dopes were heated; and that inventor Blades merely confirmed the benefits suggested by the prior art as he adopted each of the suggestions of Du Pont's Boettcher, Magat and Antal. (RPH pp. 2-3).

4/ Du Pont's Magat attached a "VP-History" to his memo dated September 2, 1971 to J.M. Criffing of Du Pont. In the memo in referring to the history, Magat stated that he had emphasized the development of PPD-T fiber from its early discovery to the final PRD-58 product. (CX-803).

(FF 410-427). Moreover internal Du Pont reports, prior to the Blades' invention favored spinning PPD-T/sulfuirc acid dopes at a polymer content considerably less than 13%. (FF 178). They also show a concern about degradation of PPD-T in sulfuric acid. (FF 151, 156, 171). Also a concern about polymer degradation is disclosed in the '756 patent specification (FF 41, 56). A notebook entry by inventor Blades in April 1970 when he carried out his first experiment with 20% PPD-T/sulfuric acid shows a concern about degradation of PPD-T by sulfuric acid. (FF 231). Thus the administrative law judge finds support in the record, unrelated to any patent controversy, for a concern about degratation of PPD-T.in sulfuric acid when inventor Blades made his '756 invention in April 1970 (FF 230)

5/ Respondents argue that the prior art indicated that aromatic polyamides can be heated without significant degradation and refer to such prior art as British patent 1,006,673 to Celanese published on October 6, 1965 (RPFF-250). Reference is made to FF 368 for the disclosure of this patent. Significantly although there is mentioned a large, almost limitless, number of synthetic linear polymers containing repeating -CO NR- groups, the two examples in the Celanese British patent are limited polyhexamethylene terephthalamide. (FF 369). The administrative law judge has been unable to find in any of said prior art even an attempt to form and heat a PPD-T/ sulfuric acid solution wherein the PPD-T is at least 18 weight percent, and the sulfuric acid is at least 93% concentration. The judge believes Du

(Footnote continued to page 553

Regarding Myth No. 2, Du Pont admits to the suggestions of Drs. Boettcher and Magat (Tr. p. 4030). The record supports the suggestions. (FF 209, 215). The testimony as to whether Dr. Antal suggested to Blades higher concentrations of PPD-T if sulfuric *acid* dopes were heated is unclear. (FF 185, 187). There is an indication that inventor Blades had started design of the mixer device used to prepare the dopes of his '756 invention before Antal started working for Blades. (FF 185, 217). In any event claim 13 of the '756 patent is not directed to what merely Dr. Boettcher or Dr. Magat or possibly Dr. Antal suggested to inventor Blades. Rather claim 13 is directed to a process comprising a combination of elements involving extruding spinning dopes containing at least 13% PPD-T by weight, having an inherent viscosity of at least 3, dissolved in sulfuric *acid* of at least 982 concentration from an orifice though an air gap into an aqueous coagulation bath at a temperature under 50 °C. (FF 33). The record establishes that this combination, which can produce an aramide fiber with tenacity of about 20 gpd (FF 59, 60, 61), originated with inventor Blades.

Respondents argue that if one plots tenacity of fiber against concentration, of PPD-T *in* concentrated sulfuric acid dope, tenacity goes up proportionately and hence better fibers would be expected with an increase concentration and that that is what the prior art teaches (Tr. p. 4071), that "all we are talking about here, and all that the contemporaneous records show with respect to Blades' activities is that as you increase the concentration, which you are permitted to do after you go to an air gap system, you increase

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(Footnote continued from page 52)
Pont's own internal research records adequately demonstrate a concern for degradation of this solution on the application of heat.

proportionately and in a straight line the fiber properties" (Tr. p. 4150); that while the air gap doesn't give you inherently a better tenacity, "it is the increased concentrations that does that, and it is in the air gap and the ability to use a hot dope to get more polymer into solvent that is responsible ultimately for having a higher concentration and a higher viscosity "(Tr. p. 4157); that a prior art Ucci patent (FF 370) discloses that "an advantage of the present inventions is the fact that spinning solutions having much higher temperatures can be employed than ordinarily used in wet spinning. Hence a greater percentage of polymer in the solutions can be used with success "(Tr. p. 4164); that as one increases the concentration of PPD-T, the tenacity increases in a straight line function as "Dr. Blades in RX-188 the very, within a day or two whatever it was after he first made his so-called high tenacity breakthrough, he got his people together and one of the.things he did was show them a plot of tenacity against concentration"; that "it was well known in the art that as you increased concentrations up to some point .... either the concentration of the polymer or the inherent viscosity of the polymer or both, you improve the tenacity of the resulting fiber" (Tr. p. 4168); and that the Du Pont reports of Killian, Mukamal and Bair disclose spinning of PPD-T sulfuric and dopes with the sulfuric acid of at least 98% concentration. (Tr. p. 4149).

The administrative law judge is not persuaded by respondents' arguments. Respondents with their reference to RX-188 concede that it was Blades who first showed a straight line function in a PPD-T/sulfuric acid system increasing to a concentration of 202. Respondents have not provided any prior art which discloses a straight line function in a PPD-T/sulfuric acid system with respect to increased PPD-T concentration and increased tenacity. References, such as the Ucci patent (FF 370), are not to a PPD-T/sulfuric acid anisotropic *dope* system. Moreover respondents in their arguments have admitted that the air gap does not inherently result in a better tenacity. Futhermore in none of the patents which describe dry jet *wet* spinning is the air gap method taught as an approach to make as-spun fibers with high tenacity, nor to use with liquid crystalline solutions nor to use dry jet spinning for the production of highly crystalline as-spun fibers. (FF 385-388).

Respondents' reference to the Du Pont reports of Killian, Mukamal and Bair supports the patentability of the claimed subject matter. These scientists have at least ordinary skill in the art and had been working with PPD-T before inventor Blades entered the scene in Jan. 1969. (FF 200). Bair started such work at least in Ilov. 1965. (FF 145). Mukamal was involved with PRD-27 research at least in early 1968. (FF 171). Killian also was involved with PPD-T in 1968. Most of the dopes prepared by Killian from the period of August 1968 to March 1969 were only at the 102 solids of PPD-T with a few at 9% solids level (FF 178) and Killian encountered very significant processing problems because of the high viscosity of the spinning solutions. Hence his work was stopped. (FF 181). The Mukamal and Bair reports do not show the scientists working with PPD-T/sulfuric acid dopes where the concentration of polymer went to 20%. It was not until inventor Blades started work with aromatic polyanides in early 1969 that in April 1970 he and Du Pont obtained spinnable PPD-T/sulfuric acid anisotropic dopes that consistently produced "as spun" fibers of high tenacity.

Respondents' arguments assume that the prior art teaches increasing the concentration of PPD-T in sulfuric acid of at least 982 concentration as inventor Blades *did* in April 1970. (FF 231).

For the foregoing reasons responents have not sustained their burden in proving that claim 13 of the '756 patent is invalid under 35 U.S.C. § 103.

Claim 13 Is Not Invalid Under 35 U.S.C. 112

35 U.S.C. § 112 sets the standards by which to gauge the propriety and sufficiency of the disclosure and claims of a United States patent. Pertinent to the issues in the case, are the following first and second paiagraphs of 35 U.S.C. § 112"

> 112. Specification
>
> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.
>
> This specifiction shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

The presumption of validity of 35 U.S.C. § 282 applies equally to a $_5$ 112 challenge and thus may be overcome only by clear and convincing evidence. Radio Steel & Mfg. Co. v. MTD Products, Inc., 731 F.2d 840, 845, 221 U.S.P.Q. 657, 661 (Fed. Cir. 1984); Jones v. Hardy, 727 F.2d 1524, 1528, " [4] 220 U.S.P.Q. 1021, 1024 (Fed. Cir. 1984).

Akzo argues that the claimed subject matter fails to satisfy the requirements of the first and second paragraphs of § 112. In support, Akzo argues that the '756 patent states (col. 6, lines 73-75):

> It has been found advantageous in some instances to deaerate the liquid dope at reduced pressure prior to spinning. (Emphasis added).

When that statement (and the absence of any further instructions in the patent) is considered in the light of what Du Pont actually believed and did with respect to deaeration or degasification of the dopes processed in its MDF-I, MDF-II and commercial plants, it is argued that it is apparent that the Blades' patent specification is defective and is grossly misleading on the subject. (RPH pp. 30-31).

Akzo also argues that claim 13 is not directed just to producing 18 gpd, or even 15 gpd tensile strength fibers; that such a claim would require far more critical limits than are present in claim 13; that the Examiner in applicant's Serial No. 172,515 rejected the claims on the basis that the "wet spinning steps are not clearly defined" (Office Action of April 12, 1972); that he further stated in applicant's Serial No. 239,377 that "process steps should define spin draw factor" and (Office Action of December 19, 1972); that in the last application, Serial No. 268, 052 which resulted in the '756 patent the examiner again required that the spin stretch factor (SSF) be utilized in the claims (Office Action of January 2, 1973); that for a given bath temperature some minimum spin stretch factor (SSF) was needed in Blades' process to achieve desired properties, and the minimum SSF is in the range of

2.5 to 3 for "most systems"; that even at a bath temperature of 40°C -- well below the 50°C limit of claim 13 for bath temerature - fibers of 18 gpd tensile strength required a minimum SSF of 4.0; that Du Pont was fully aware of the criticality of a number of variables, including bath temperature, inherent viscosity, spin stretch factor and hole sizing; that this necessity for a minimum SSF to achieve a given level of tensile strength is evident from a study of Blades' own notebooks, which also show that a bath temperature of 20°C or less is needed to "reasonably" ensure 18 gpd and from Blades' progess report PR-70-131; and that Blades knew spin stretch factor, specific bath temperature, inherent viscosity, capillary hole sizes were all critical variables in a dope system of 202 PPD-T in 1002 sulfuric acid. Hence it is argued that Blades overclaimed the subject matter by omitting critical limitations. (RPH p. 32).

Akzo further argues that only 64.62 of Blades' claim 13 experimental runs resulted in fiber possessing tensile strength over 15 gpd. (MPH 307; FF 243).

Du Pont argues that inventor Blades did not regard deaeration as necessary in all cases and that in any event Blades sets forth one method of deaeration in Example II of his '756 patent; that inventor Blades did not consider any particular spin stretch factor to be part of the subject matter which he regarded as his invention and therefore properly did not claim one; that Blades claimed clearly and distinctly sets forth in his claim what he regarded as his invention. (CPHR pp. 17-18).

The administrative law judge finds that Akzo has not overcome by clear and convincing evidence the presumption of validity of claim 13 with respect to 35 U.S.C. § 112. Inventor Blades testified that he did not regard deaeration as necessary in all cases. (FF 195).

Moreover deaeration of spinning dopes prior to the Blades invention was an old and standard technque. (FF 195).

As to spin stretch factor, inventor Blades did not consider any particular spin stetch (or spin draw) factor to be part of the subject matter which he regarded as his invention as supported by col. 8, Is. 33-49 of the '756 patent. (CX-6, RX-57). Thus when the Patent Examiner in the last Official Action prior to allowance and issuance of the Blades '756 patent, stated (CX-843 at p.. 66, 4 3):

> "Instant process should define spin draw factor. Process steps should be distinct from dry spinning, interfacial spinning, pleximentary spinning, semi melt spinning, etc."

Du Pont's sttorney disagreed (CX 843 at p. 74, second full para.):

> "It is believed that the instant process claims adequately define the present invention and are distinct from dry spinning and the other spinning techniques enumerated in the outstanding Office Action. While Applicant is prepared to insert a range of spin stretch factors, nevertheless it is velieved that his is unnecessary and would merely confuse the issue." (emphasis added)

Moreover the '756 specification provides detail and guidance as to extrusion conditions, viz. spinnerets, jet velocity, spin stretch factor, fluid layer, spin tubes and guide, coagulating bath, working drying and heat treatment. (FF 49-56). With respect to Akzo's argument that only 64.6% of Blades claim 13 experimental runs resulted in fibers processing-tensile strength over 15 gpd, while Akzo states that the experiments "conforms with the limitation by Blades '756 patent claim 13" (RPFFR 806), Akzo has not shown the precise experimental conditions for each of the numerous experimental runs it has referred to (FF 243). Inventor Blades teaches in his '756 patent specification that even with the limitations of claim 13 if, for example, the extrusion temperature for a spin is 115-120°, the resultant tenacity can be as low as 11. (FF 61, Ex. VII).

Akzo argues that the conditions used in the scale up of the Blades' claim 13 process (FF 191-193) should be a part of claim 13 and/or '756 patent specification. However claim 13 is based on the examples (experimental runs) set forth in the '756 patent specification which show increased• tenacity of resultant fiber. It was not based on a scale up of the examples. It is not the purpose of a patent claim or patent specification to be a "cookbook" recipie where every instance of a development of a claimed process is detailed in minutiae. A claim does not have to include solutions to problems which would be routinely investigated, such as in an scale up of a claimed process, by one of ordinary skill in the art. See Mineral Separation, Ltd. v. Hyde 242 U.S. 251,270-71 (1916).

For the foregoing reasons Akzo has not sustained its burden in proving that claim 13 is invalid under 35 U.S.C. § 112.

The '756 Patent Is Not Unenforceable Because There Was No Misconduct In Its Prosecution

Akzo argues that Du Pont must be denied the relief it seeks in this investigation because its "hands are unclean"; that it has been guilty of inequitable conduct because Du Pont's patent attorney who prosecuted the applications leading to the '756 patent withheld the following information he knew or should have known should have been supplied to the Examiner:

> 1) Du Pont's substantial experience, which included a Cellura Report PR-71-40, with spinning sulfuric acid dopes of 4,4'-DABT and the quality of fibers produced

> while arguing that it would not be obvious to use the dopes of Kwolek '542 and the Morgan '645 processes when both patents explicitly disclosed spinning concentrated sulfuric acid dopes of 4,4'DABT;
>
> 2) the Boettcher suggestion and the fact that it was prompted by the Morgan '645 patent; and
>
> 3) the Magat and Antal suggestions which led Blades directly to high polymer concentration, 100% H_2SO_4 dopes to spin in the Morgan '645 process.

Akzo argues that the three unrequested affidavits -- the affidavits of McBride, DeDominicis and Hatchard -- in the prosecution of the Blades patent application which led to the issuance of the '756 patent were submitted with the intent to show purported patentability over the prior art; that they were deceptive in that counsel knew or should have known that comparative testing directed to air-gap spinning of 4,4'-DABT in concentrated sulfuric acid or at least air-gap spinning of Examples 21, 23B, 69, 71 and 81 of Kwolek '542 would have been far more useful to the Examiner in deciding the issue of patentability; that instead Du Pont formulated a series of experiments, which are reported in the three affidavits, calculated to lead the Examiner astray; that the three affidavits were submitted together with a list of prior art, without explanation, after a "premature" interview; that no affidavit showing the prepiration or spinning of a sulfuric acid/4,4'-DABT dope was volunteered and that if it had been, there could have been no allowance. (RPH p. 34).

Du Pont argues that Akzo's instances of allegedly withheld material information simply are straw men. Thus it states that Cellura testified that the work in his report PR-71-40 was done by him after he was aware of Blades' "major invention", with "a tremendous amount of day-to-day contact with Herb (Blades]", and that Cellura had used Blades technology and his twin cylinder device to heat and mix the spin dopes; that Boettcher's suggestion was not a material part of Blades' invention and was not prior art; that the Morgan '445 patent *was* cited to the Patent Office and it disclosed the air gap; that Magat's suggestion was never reduced to practice by him and not prior art; and that Antal simply did not make material suggestions to Blades. (CPMK p. 19).

With respect to the three affidavits submitted during the prosecution of the application which resulted in the '756 patent, Du Pont argues that Akzo does not contend that there was anything false or misleading in the affidavits themselves; that Akzo cites no authority in support of its novel theory that the truthful submission of experimental data could be the basis of inequitable conduct because the patent challenger asserts that a different experiment which the Examiner did not ask for would have been "more useful" to him. (CPHR, p. 20).

The prosecution which led to the issuance of the '756 patent was fairly exhaustive. (FF 63-102). It involved examination of four applications on the subject matter by the same patent examiner, Jay H. Woo. The Morgan '645 patent was specifically referred to by Du Pont in the applications as filed as teaching a dry-jet water spinning process of extruding a solution of wholly aromatic polyamides through a gaseous medium into a coagulating bath. (FF 36). The Examiner repeatedly relied on the Morgan '645 and Kwolek '542 patents in his rejections. For example he pointed out that the '645 patent is *directed to the* "same polyamides" as involved in the '756 process claim and acknowledged the dry-wet spinning process taught by the Morgan '645 patent and which was suggested by Du Pont's Boettcher. The Examiner also pointed out that the Kwolek '542 patent teaches applicant's claimed spin dope composition and the fibers from the Kwolek '542 patent have a high tenacity. (FF 80). The Examiner further cited additional art to show air-gap spinning and jet spinning processes. (FF 64). Du Pont brought to the attention of the

Examiner art, for example Ike' U.S:.3,080,210 and Cipriani U.S. 3,227,793, relied on by Akzo. (FF 68). Du Pont in the prosecution specifically admitted that Morgan '645 encompassed 4,4'DABT (which Akzo now argues should have been the subject of the three affidavits submitted in the prosecution of the applications which led to the '756 patent) but correctly pointed out that there is no example showing 4,4'DABT being spun or even in a spinning solution. (FF 70). Significantly Du Pont argued that all the other polymers disclosed in Morgan '645 contained radicals with nonextended bonds, e.g. meta-oriented segments. (FF 70). Du Pont also admitted to the Examiner that Morgan '645 disclosed "concentrated sulfuric acid" which Magat had called to Blades' attention. (FF 71).

The Examiner was fully aware that the Kwolek '542 patent taught spinning in 982 concentrated sulfuric acid. (FF 80). Moreover many of the references relied on by Akzo were even discussed by Du Pont at an interview with the Examiner. (FF 90). Also the Examiner not only relied on the Kwolek '542 patent but specifically referred to example 23 (FF 92) and Du Pont's attorney admitted to the Examiner that the spin dope of Example 23B of the Kwolek '542 patent, referred to by Akzo, meets the requirements of the spin dopes of certain of the Blades claims before the Examiner. (FF 6/ In addition, the Examinier was aware that the art recognized the advantage of the air-gap wet spinning technique to promote "spin-stretch" effect for wholly aromatic polyamide fibers. (FF 38).

Based on the foregoing, Akzo, has not sustained its burden in proving that the '756 patent is unenforceable because it was produced by inequitable

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6/ Akzo contends that the spinning dopes of _Examples 21, 23B, 69 and 81 of Kwolek are literally encompassed by the Blades '756 patent claims. (RPPF 165).

conduct before the United States Patent and TrademaPk Office.

VII. AFFIRMATIVE DEFENSES

As affirmative defenses Akzo argues that Du Pont's '756 patent is unenforceable bacause of antitrust violations, patent misuse, and other inequitable conduct. Akzo's position is that Du Pont's overall scheme has been to "prevent -- delay -- limit" Akzo's entry into the aramid fiber market by a "whole complex of acts" that together constitute a serious antitrust violation of Section 2 of the Sherman Act, that Du Pont's anticompetitive and inequitable conduct constitutes patent misuse even if it does not give rise to the level of a Section 2 violation (RPH pp. 36-52; Prehearing Tr. p. 252).

Akzo also argues that, in addition to the alleged overall scheme of Du Pont to "prevent -- delay -- limit Akzo's market entry" into the aramid fiber market, Du Pont's pricing practices, including value-in-use pricing, violate Sections 1 and 2 of the Sherman Art and also the Robinson Patman Act and constitute patent misuse. (RPH pp. 52-59).

Akzo argues further that Du Pont has misappropriated an Akzo patent on the only commercially feasible, non-carcinogenic solvent for the manufacture of aramid fiber . (RPH pp. 59-61).

Some fifty years ago the Supreme court stated in <u>United States v. Dubilier Condenser Corp.</u> 187 U.S. 178, 179 (1933) stated:

> By Article I, § 8, clause 8 of the Constitution, Congress is given power to promote the progress of science and the useful arts by securing for limited times to inventors the exclusive rights to their respective discoveries. R.S. 4886 as amended (U.S. Code, Title 35, § 31) is the last of a series of statutes which since 1793 have implemented the constitutional provision.

> Though often so characterized, a patent is not, accurately speaking, a monopoly, for it is not created by the executive authority at the expense and to the prejudice of all the community except the grantee of the patent. Seymour v. Osborne, 11 Wall. 516, 533. The term monopoly connotes the giving of an exclusive privilege for buying, selling working or using a thing which the public freely enjoyed prior to the grant. Thus a monopoly takes something from the people. An inventor deprives the public of nothing which it enjoyed before his discovery, but gives something of value to the community by adding to the sum of human knowledge. United States v. Deli Telephone Co., 167 U.S. 224, 239; Paper Bag Patent Case, 210 U.S. 405, 424; Brooks v. Jenkins, 3 McLean 432, 437; Parker v. Haworth, 4 McLean 370, 372; Allen v. Hunter, 6 McLean 303, 305-306; Attorney General v. Rumford Chemical Works, 2 Bann. & Ard. 298, 302. He may keep his invention secret and reap its fruits indefinitely. In condsideration of its disclosure and the consequent benefit to the community, the patent is granted. An exlcusive enjoyment is guaranteed him for seventeen years, but upon the expiration of that period, the knowledge of the invention enures to the people, who are thus enabled without restriction to practice it and profit by its use. kendall v. insor, 21 How. 322, 327; United States v. Bell Telephone Co., supra, p. 239. To this end the law requires such disclosure to be made in the application for patent that others skilled in the art may understand the invention and how to put it to use. [footnote omitted] [Emphasis added].

The limited exclusionary right granted by the patent laws encourages the investment of risk capital which in turn promotes the development of new technology

The administrative law judge has found that claim 13 of the '756 patent is valid and that there was no inequitable conduct in the procurement of the '756 patent. Du Pont has invested considerable capital in the claim 13 process of the '756 patent. (FF 593, 594).

(FF 29-31). The '756 patent will expire in October 1990.

7/ Report of the Attorney General's National Committee to Study the Antitrust Laws pp. 224-25 (1955); J. Von Kalinowiki, Business Organizations; Antitrust Law and Trade Regulations § 59.02 [21 (1981).

When a patent holder exercise his "right to exclude others from making, using or selling the invention", by refusing unilaterally to license the patent, his conduct is expressly permitted by the patent laws *SCN Corp.* v. *Xerox Corp.* 645 F.2d 1195 1204 (Fed. Cir. 1981) cert. *denied* 455 U.S. 1016 (March 22, 1982). Hence the fact that Du Pont is not licensing the '756 patent is not indicative of any patent misuse.

Use of a patent, lawfully acquired, to foreclose competition, to gain competitive advantage, or to destroy competition is unlawful Id. 645. F.2d at 1205. However the Supreme Court has stated the following general priniciple in the context of the application of equitable defenses in patent infringement actions:

> [C]ourts of equity do not make the quality of suitors the test. They apply the maxim requiring clean hands only where some unconscionable act of one coming for relief has immediate and necessary relation to the equity that he seeks in respect of the matter in litigation. They do not close their doors because of plaintiff's misconduct, whatever its character, that has no relation to anything involved in the suit, but only for such violations of conscience as in some measure affect the equitable relations between the parties in respect of something brought before the court for adjudication.

Keystone *Driller Co. v. General Excavator Co.,* 290 U.S. 240, 245 (1933). Thus, "[njot every allegation of misconduct on the part of a plaintiff, even if true, constitutes a bar to suit under the clean hands doctrine. The misconduct must be in relation to or in all events connected with the matter in litigation *Carter-Wallace, Inc. v. United States,* 449 F.2d 1374, 1384 (CT. Cl. 1971). The patent misuse defense must stem from allegedly illegal or inequitable conduct under the suit patent. The Commission has concurred in the principle that "there must be a direct connection or nexus between the activity of the patentee in the exercise of the patent ... and the acts of misconduct which improperly and wrongfuly attempt to extend the patent monopoly." Certain Automatic Crankpin Crinders, Inv. No. 337-TA-60, RD at 38-39 and cases cited therein, adopted CD at 14 (1979).

Akzo argues that the law is clear that where there are strong interconnections between patents, misconduct with respect to any one of them will be sufficient to bar enforcement of other patents as well,' citing Keystone Driller Co. v. General Excavator Co. supra. However as Akzo recoginzes in its comment on the Keystone Driller Co. case, in that case a patent applicant bribed another inventor to suppress the prior art which was relevant to one of five related patents. The Supreme Court then held that all five patents were unenforceable by reason of the inequitable conduct with respect to one of them, inasmuch as the devices covered by the five patents were "important, if not essential, parts of the same machine." (RPUR p. 50). In this investigation the administrative law judge has found no misconduct by Du Pont in its procurement of the '756 patent in issue nor has he found any misconduct by Du Pont with respect to Du Pont's procurement of any other U.S. patent said to be interconnected with the '756 patent.

Foreign Prosecutions

Respondents allege that the evidence shows inter alia fraudulent conduct on the part of Du Pont in submitting certain Morgan and Cellura affidavits to the Dutch patent office in Du Pont's course of prosecuting the Dutch equivalent of the Kwolek application which corresponded to the disclosure of the '542 patent. Under Mannington Mills, Inc. v. Congoleum Corp., 595 2d 1287 (3rd Cir. 1979), it is urged that an antitrust claim under Walker Process

Equipment, Inc. v. Food Machinery & Chemical Corp., 382 U.S. 172, 177 (1965) may be based on allegations that a competitor obtained foreign patents by fraudulent conduct on foreign patent offices even if that conduct would not invalidate the foreign patents. (RPH p. 40). Akzo also relies on Du Pont's prosecution of a German patent application which corresponds to the combination of two United States Blades patents not in issue and on prosecution of the Blades '756 counterparts in the United Kingdom, Italy and Israel.

Contrary to Akzo's interpretation of the Mannington Mills case, the case holds only that a district court may have jurisdication to hear such a claim when raised by an American company foreclosed from export markets. Also in that case the substantive standards to be applied were not addressed, and neither was the jurisdictional issue where the claim is raised by a foreign firm complaining about patent foreclosure from its home markets.

In addition because the equitable defense of fraud is available only where there has been fraud in processing the '756 patent,-[8] which this record is lacking, the evidence as to Du Pont's activities before the Dutch and other foreign Patent Offices is irrelevant to a claim that the enforcement of the '756 patent should be denied for fraud. Moreover it is not seen how

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[8] E.g., SSIH Equip,S.A. v. ITC, 718 F.2d 365, 378 (Fed. Cir. 1983) (rejecting "as a matter of law" that inequitable conduct as to one patent can render another unenforceable); Beckman Instruments, Inc. v. Technical Dev. Corp., 433 F.2d 55, 62 (7th Cir. 1970), cert. denied, 401 U.S. 976 (1971) Trriudulent procurement of a second patent so closely related to the patent in suit as to be included in the *same* licensing agreemtn does not affect the enforceability of the patent in suit); S.H. Kress & Co. v. Aghnides, 246 F.2d 718, 725 (4th Cir.), cert. denied, 355 U.S. 889 (1957) (fraud in the procurement of a foreign patent does not affect the enforceability of U.S. counterpart patent); Slimfold Mfg. Co. v. Kinkead Indus., Inc., Civ. Act. No. C-78-118A (N.D. Ca. Nov. 20, 1984) (slip op.) (same); Plantronics, Inc. v. Roanwell Corp., 185 U.S.P.Q. 505 (S.D.N.Y. 1975) (same).

alleged inequitable conduct before the Dutch patent office relates to a monopoly of a relevant market in the United States, nor, where no Dutch patent has issued to Du Pont, even in Europe.

The administrative law judge has considered the facts put before him regarding the alleged inequitable conduct by Du Pont before the Dutch patent office. (FF 452 to 471). As to what proceeded before the Dutch patent office, the judge finds no inequitable conduct by Du Pont. Thus the Dutch patent office was aware of what is said to be withheld information (FF 468) by respondents. Moreover, significantly, no Dutch patent ever issued to Du Pont (FF 470) and the "withheld" information was before the United States Patent Office. (FF 452).

With respect to Du Pont's prosecution of other foreign patent application the administrative law judge finds the record (FF 472-473) lacking any proof of inequitable conduct, assuming the evidence was relevant to issues in this investigation.

The Dutch Government

Akzo argues that Du Pont relying upon its entire patent estate, including the Blades '756 patent in suit, sought to convince the Dutch Government, through threats and misrepresentation, to withdraw financial support from the Arami project; that while Du Pont now claims its efforts were totally unsuccessful, its internal documents proclaim that the Arami project was in fact delayed for years and that Du Pont's efforts were instrumental In achieving this desirable result; and that such attempts by a monopolist to delay or hinder a competitor through abusive appeals to governmental bodies violate the antitrust laws. (RPH p. 29).

The evidence shows that Du Pont has conducted business in The Netherlands through a Dutch subsidiary for about 25 years. The Dutch subsideary owns a major chemical complex at Dordrecht, The Netherlands which is among Du Pont's largest investments in Europe. (FF 479-482). Because of its longstanding, strategic investments in The Netherlands, Du Pont executives have communicated frequently with the Dutch Government over a long period of time. (FF 483). In the late 1970's Du Pont learned that Akzo had opened communications with the Dutch Ministry of Economic Affairs for the purpose of persuading the Government of The Netherlands to provide financial support to Akzo's contemplated aramid fiber venture. (FF 434). Du Pont hence found itself faced with the uncomfortable position of having a proper relationship between it and the Dutch Government, through Du Pont's establishment at Dordrecht, being shifted such that Du Pont, as a private enterprise would be competing with a company which was not just a private enterprise but was a private enterprise plus the Dutch Government. (FF 497).

On January 23, 1979 Du Pont met with Dutch government officials and made a presentation about "Kevlar" and explained Du Pont's patent position. (FF 486, 487). Du Pont also was making an alternate study to determine if it should install some "Kevlar" capacity in Europe. The Dutch government showed positve interest in the possibility of Du Pont installing a facility at Dordsecht. (FF 488). On August 5, 1980 Du Pont told the Dutch Government that it was planning to build a "Kevlar" spinning plant in Europe. (FF 489). Du Pont did eventually select a site in Maydown, Northern Ireland for a spinning and finishing facility which plant expects to be operation in 1987. (FF 492).

In October 1980 Akzo requested that the Dutch government suspend consideration of support for any Akzo contemplated aramid fiber venture because of a clear deterioration in a number of sectors of the synthetic fiber industry. (FF 493). Akzo communicated to the Dutch government its renewed interest in the aramid project with the Dutch government around the middle of 1982. A July 14, 1982 telex from the government set forth terms of a "Enka-NOH" partnership between Akzo and the Dutch government. (FF 499). On July 20, 1982 the Dutch government issued a public statement announcing the commitment of the Government and NOM to support and participate• in construction of Akzo's aramid fiber plants in The Netherlands. (FF 500, 501).

Du Pont continued to have periodic contacts with the Dutch government during the period 1982-84 and used the ocasion of those contacts to express its concerns, that the government support of Akzo's aramide venture would involve the Dutch government in patent infringement actions and adversely affect its relations with Du Pont. (FF 495).

In 1982 a Du Pont official used the expression "collision course". He explained that with Du Pont's dispute with Akzo becoming more intense, as Du Pont *defended its* patents, Du Pont could find itself on a collision course between its allegiance as a private entrepreneur with the Dutch government and its relationship with the Dutch Government which was a stockholder and substantial owner in a business which Du Pont had a conflict with. (FF 497).

In November 1982 the Dutch election resulted in a government change. (FF 503). With the change in administration in The Netherlands, Du Pont thought It important to restate its position in the matter to the new government. It indicated to the new government that it did not understand the basis for government support to Akzo because the new venture would appear not only to involve infringement of Du Pont's patents in numerous countries thru out the world but also to be economically unattractive because there did not appear to be sufficient demand for high performance fiber product during the 1980's to sustain Du Pont's recently expanded plant and the one contemplated by AKZO. With respect to any patent conflict, Du Pont stated to the new government that it believed Akzo's "Arenda" fiber infringes Du Pont's basic patents in "Kevlar" and that it must and will take all legal and commercial steps necessary to protect its investment in "Kevlar" and its property rights. (FF 502). It also expressed concern because while it was filing lawsuits around the world to enjoin the sale of "Arenka" fiber, it would at the same time have a desire to work closely with the Dutch government in investments in Holland. Du Pont concluded in a Dec. 3, 1982 letter to the new government that although it felt uncomfortable with a potential conflict, it would have no alternative but to defend its patent position to the fullest extent. (FF 502).

On March 4, 1983, Akzo and the Dutch government entered into a formal 15 year agreement establising a partnership. Physical construction activities promptly began in the spring of 1983 on the Akzo—Dutch government facility. (FF 504).

A Du Pont letter dated September 28, 1983 to the Dutch government stated that it appeared that Akzo had estimated the 1982 market size for "Kevlar" to be twice the actual size; that in order for the market to reach Akzo's estimate for 1990, the growth rate between now and then must average 30% per year for eight years; that this is unlikely and hence a conclusion that Akzo and the Dutch government have based a joint venture decision on a misconception of market size and growth rates. (FF 505). Du Pont also expressed to the Dutch government that it found it extremely disturbing that, while it was making large investments and establishing high quality workplaces in Holland in a high technology business, it faced competition that was

Ignoring Du Pont's property rights and attempting to deny Du Pont its rewards of its innovation in aramid fibers. (FF 505).

On January 5, 1984, a meeting was held between Dutch government officials and Du Pont. Two basic issues were discussed, viz. Kevlar market size and growth and patent validity. Du Pont believed Akzo's expectation of 30% compounded growth unrealistic because the development of end-uses took 3-5 years. The Dutch government responded that Du Pont should have no concern that relations with the government will deteriorate; that Akzo has no joint venture with the Dutch government but only with NOM (Northern Development Company); that NOM acts independently even though the capital is provided by the Government; that once the contract with NOM is signed, the Dutch government "can withdraw from it". (FF 507).

On March 30, 1984 a meeting was held among Akzo, Du Pont EOM and the Dutch government. (FF 511, 512). Du Pont repeated its concerns about the importance of good relations with the Dutch government; the risk that such relations would be harmed by differences between Du Pont and the Akzo venture, and the unfairness of the Dutch government entering into a partnership that would violate Du Pont's patents. (FF 512). On April 3, 1984 memo of the meeting by a Dutch government official did not reflect any "threats" by Du Pont to reconsider investments or take other action or any urging by Du Pont that Akzo delay entry into the "Kevlar" market, or any prediction that there would be effects on U.S.-Dutch relations. The memo does reflect that both Akzo and Du Pont representatives agreed that then through around 1990 there is a certain overcapacity In the market for aramide. (FF 513).

The administrative law judge finds that the record does not establish that the "Arami project" was in fact delayed for years, or that Du Pont sought to convince the Dutch government, through threats and misrepresentations, to withdraw financial support from the Arami project.

To the contrary the facts show that Du Pont had legitmate reasons for meeting with the Dutch government, viz. its patent rights, its heavy investment in Dordrecht, and its proposal to establish "Kevlar" facilities in Europe which, since its early discussions with Dutch government officials, Du Pont has committed itself to do in Northern Ireland. Moreover the evidence shows that it was Akzo in October 1980 who suspended discussions witht the Dutch government. (FF 493). When discussions were resumed in mid-July 1982 the Dutch government did announce an agreement with Akzo in July 1982 (FF 500, 501) and a 15 year formal agreement was finalized in March 1933. (FF 504).

The April 3, 1984 a memorandum by a Dutch Government official on a meeting between Du Pont, Akzo and the Dutch Government on March 30, 1984 did not reflect any "threats" by Du Pont to reconsider investments or take other action but did report that both Du Pont and Akzo representatives.agreed that through to around 1990 there is a certain aramid overcapacity. (FF 513). There is independent Du Pont documentation to the same effect. (FF 507). Hendrick Wiseman, the President of NOM and who attended the March 30, 1984 meeting testified that the Dutch government official who prepared the April 3, 1984 memorandum was "a lower level employee" and that the memorandum was not a full account of the meeting since the meeting was set for a discussion between Akzo-Enka and Du Pont and the Dutch Goverment was not taking part in that discussion. (FF 515, 516). However the "lower level employee" was the person dealing with the Enka aramid file and had contact with Akzo prior to the March 30, 1984 meeting. (FF 518). Although Hr. Wiseman testified that in the meeting Du Pont brought up the fact that it might reconsider further investment plans in Holland (FF 514) he could not remember any details of what was said at the March 30, 1984 meeting and further changed his written testimony. (FF 518). Also when Du Pont met with government officials in

March 1984, the joint Akzzo-Dutch government venture was well underway, a 15-year formal agreement with Akzo and the alich government having been finalized in March 1933. (FF 504).

The April 3, 1934 memo by the Dutch government official presented a "direct point-by-point summary" of the discussion that took place at the March 30, 1984 meeting. (CX-653). He was reporting what happened at the meeting. If Du Pont had threatened the Dutch government with respect to Investment plans in Holland, it certainly would have been be of interest to "higher" Dutch government officials. Akzo has offered no testimony from the Dutch government official who authored the April 3, 1984 memo. The administrative law judge *finds* the April 3, 1984 memo corroborates Du Pont's contention as to discussions at the March 30, 1984 meeting, viz. over capacity. Du Pont in discussions with the Dutch Government had some concern with respect to its patent rights. However the concern was a legitmate concern.

Accordingly the administrative law judge finds that Du Pont's discussions with the Dutch government has not affected the enforceabililty of the '756 patent.

Du Pont's License Negotiations With Akzo

Akzo argues that "The fact that a patentee has the power to refuse a license does not mean that he has the power to grant a license on such conditions as he may choose." Transparent-Wrap Machine Corp. v. Stokes 6 Smith Co., 329 U.S. 637, 643 (1947); that the evidence shows that during licensing negotiations in 1983, Du Pont offered Akzo a license under "Du Pont's aramid fiber technology, including the Blades process patent" conditioned on Du Pont's supply of the primary ingredients required for the manufacture of para-oriented aramid fibers; that Du.Pont "demanded" this Condition in order to enable it to control Akzo's production and prices for aramid fiber, which would obviously restrict Akzo's ability to compete in the U.S.; that this attempt to tie the supply of raw materials to the issuance of a patent license is a hornbook case of patent misuse. (RPH p. 48).

Contrary to Akzo's arguments the record does not establish that any Du Pont-Akzo discussions involved a proposed license under any U.S. patent. Therefore the license negotiations lacked a sufficient nexus with '756 patent to establish a defense in this proceeding. Akzo's 2empelin testified that it was his recollection that any license was to be restricted to Europe. (FF 44(a)). This is confirmed by Du Pont contemporaneous documentation. (FF 437). Moreover the June 9, 1983 meeting between Du Pont and Akzo, involved only proposals and Akzo was invited to make suggestions and there were later communications. (FF 441(a), 443; 449). Also the record shows that no agreement was even reached between Du Pont and Akzo involving the supply of the primary ingredients.

Akzo argues that Du Pont conditioned any patent license on Du Pont's supply of the primary ingredients. Yet the evidence shows that it was Akzo's Mr. Loudon in a letter of February 21, 1983 to Du Pont's Mr. Jefferson who stated:

> In addition, we are prepared if this would be of interest to you - to negotiate an agreement on exchange of knowledge on e.g. raw material aspects" (FF 434).

The administrative law judge finds the enforceability of the '756 patent unaffected by any license negotiations of Du Pont with Akzo.

Du Pont's "Kevlar" Pricing Practices

Akzo argues that Du Pont's so-called "value-in-use" pricing system has two elements: price discrimination and enforcement; that Du Pont sells identical fiber at some 18 different prices for some 19 different end uses with the highest price being more than five times the lowest price, thereby discriminating in price between customers; that Du Pont also has an elaborate enforcement system of formal customer agreements and market surveillance to ensure that the "Kevlar" it sells is in fact applied to the end use for which it is sold and does not find its way into a secondary market where price could be determined by competition; that that enforcement system constitutes a "contract, combination or conspiracy in restraint of trade" in violation of Section 1 of the Sherman Act; and that because Du Pont is an aramid fiber monompolist, the enforecment system violates Section 2 of the Sherman Act as well; that these violations also constitute misuse barring enfocement of the patent in suit. (RPH p. 52).

Du Pont argues that "[Als a general rule and absent any overriding unlawful conduct, patentees can charge for their patented products and licenses whatever the market will bear." It cites *Carter-Wallace,* Inc. v. *United States,* 449 F.2d 1374, 1383 (Ct. Cl. 1971), *Brulotte* v. *Thys Co.,* 379 U.S. 29, 23 (1964); *United States* v. *Studiengesellschaft Kohle,* m.b.H., 670 F.2d 1122, 1128 (D.C. Cir. 1981); *W.L. Core &* Assocs. v. *Carlisle* Corp., 529 F.2d 614, 622-23 (3d Cir. 1976). Du Pont urges that "there is not antitrust prohibition against a patent owner's using price discrimination to maximize his income from the patent", citing *USH Corp..* v. *SPS Technologies, Inc.,* 694 F. 2d 505, 512 (7th Cir. 1982), *cert. denied,* 103 S. Cr. 2455 (1983). It is argued that differential pricing by a patent holder is entirely lawful, absent some unlawful purpose and absent a showing that the discrimination brought serious anticompetitive results as between competitive purchasers in the same line of business., citing *USN Corp.* v. *SPS* Technologies, Inc., *supra;* Bela *Seating* Co. v. Poloron *Prods., Inc.* 438 F.2d 733, 738 (7th Cir.), cert. denied, 403 U.S. 922 (1971); *LaPeyre* v. FFTC, 366 F.2d 17, 19-20 (5th Cir. 1966). Du Pont concludes that Akzo has not even attempted any such showing. (CPU pp. 54-55).

With respect to Akzo's attack on Du Pont's pricing structurem Du Pont argues that there is no evidence that Du Pont restrained any "Kevlar" resale prices, the uses to which "Kevlar" could be put, or the category of customers to whom a "Kevlar" purchaser could resell.

The administrative law judge finds that Akzo has not established an unlawful purpose by Du Pont nor has it showed that Du Pont's pricing practices have brought serious anticompetitive results as between competitive purchasers in the same line of business. To the contrary the '756 patent is valid and the record shows that Du Pont's "Kevlar" pricing has been an important and reasonable means by which the market for "Kevlar" has been developed.

"Kevlar" is not a single product. Du Pont's price lists illustrate the many combinations of denier, finish and modulus that are sold. Du Pont has developed a broad variety of "Kevlar" products with a variation in prices to meet the needs of different end uses of the fiber. For example, the price is for a 1500 denier regular modulus fiber while the price is for a 195 denier high modulus "Kevlar 49" fiber. In addition, both the fine denier and the high modulus add to the cost of manufacturing 195 Denier "Kevlar 49." The time required to produce a pound of 195 denier yarn is 7 1/2 times longer than the time required to produce a pound of 1500 denier yarn. (FF 541). As of December 31, 1983, "Kevlar" yarn was offered by Du Pont in 30 combinations of modulus, finish and denier. Both wet and dry pulp are sold. There is high and low modulus staple, and that the staple is available with eight differnt cut lengths of fiber. (Fr 542).

By selling "Kevlar" aramide fiber at different prices for different end-uses, Du Pont has been able to maximize the uses to which "Kevlar" can he put and accordingly enlarge the volume of "Kevlar" that is sold. Du Pont cannot sell "Kevlar" only at $5 per pound if it locks to recover its captical investment. If, however, Du Pont were to sell "Kevlar" only at' a substantially higher price, it could never obtain the high volume business it has in the tire market, so that it could not achieve the economics of scale and other cost reductions that come from producing greater quantitites of Kevlar. (FF 544). Moreover Du Pont has even priced "Kevlar" at less than the amount that would produce the greatest short-term profits. Thus, the price of "Kevlar" cable used in offshore drilling applications is $8.00 per pound, even though the value of "Kevlar",in this end use is $16.00 per pound. (FF 545).

As to Du Pont's pricing structure, customers deposed by Akzo explicitly stated that Du Pont never made any effort to control the resale price of "Kevlar" or of the products incroporating "Kevlar". (FF 546). Du Pont does have a requirement that it be reimbursed if a purchaser elects to use or resell "Kevlar" for a higher-price application than the use for which it was sold. (FF 547, 548). However in the absence of such a requirement, Du Pont would risk disadvantaging their customers in their ability to compete. (FF 531). Akzo has not made the showing that Du Pont's reimbursement policy is something other than a reasonable means for achieving the legtimate objective of value-in-use pricing.

Akzo has alleged that Du Pont violated section 2(a) of the Robinson-Patman Act by allowing Goodyear to produce mechanical rubber goods, in competition with Gates Rubber, using "Kevlar" purchased for use in tires. (RPH p. 57). The evidence is to the contrary. (FF 556).

Akzo has also alleged that a further section 2(a) violation of the Robinson Patman Act is established by a pricing allowance granted by Du Pont to (RPH p. 56). The allowance however was granted to promote the use *of* "Kevlar" in new product lines because of increasing pricing competition from polyester for certain hose applications. (FF 549, 550). Hence the Robinson - Patman meeting competition defenses Is available.

The administrative law judge finds the enforceability of the '756 patent unaffected by any of Du Pont's present "Kevlar" pricing practices.

Misappropriation

Akzo argues that Du Pont has misappropriated Akzo's patent in the only commercially feasible, non-carcinogenic solvent for the manufacture of aramid fiber. (RPH p. 59). It is argued that Du Pont admits it received a copy of Akzo's patent application in confidence after Du Pont expressed an interest in obtaining a license from Akzo; that Du Pont admits that it began to employ the process disclosed in the patent application and a Dutch court has so held. (RPH p. 60).

The evidence is to the contrary. It shows that Du Pont developed a solvent *system* prior to receipt of any Akzo application. (FT 563). Also the Akzo application was not misappropriated by Du Pont but was voluntarily given to Du Pont by Akzo. (FF 598, 582). Finally while *a* Dutch court may have held that Du Pont is using the Akzo solvent as claimed in a Dutch patent the record in absent a finding that a United States court has found that Du Pont is infringing any Akzo U.S. patent to said solvent.

VIII. IMPORTATIM AND SALE

To invoke the subject matter jurisdiction of the Commission and to support a S 337 violation, Du Pont must establish that aramid fiber made by the accused process has been imported into or sold in the United States. The administrative law judge finds the the evidence supports such a "finding. (FF 665).

IX. DOMESTIC INDUSTRY

Du Pont manufactures "Kevlar" by the process of claim 13 of the '756 patent at its Spruance facility near Richmond, Virginia. The principal starting ingredients p-phenylenedianine (PPD) and terephthaloyl chloride (TCL) are manufactured at Du Pont plants in Lousiana and New Jersey. (FF 587).

When "Kevlar" was first offered for sale, potential customers were unfamiliar with the product and ready markets did not exist. Du Pont has had to create markets for "Kevlar" and continues to do so. (FF 583). Du Pont's marketing efforts over the last dozen year have developed some-twenty major end uses falling into three general categories: (1) tires, (2) mechanical rubber goods including hoses and belts, and (3) special products which covers non-rubber goods such as armor (hard and soft), ropes and cables, asbestos replacement, aerospace and aircraft, and marine. (FF 590).

In the period 1972 -1984, Du Pont's worldwide sales of "Kevlar" amounted to about million. About million pounds of "Kevlar" were sold worldwide during this period, of which about million pounds were sold In the United Staes. (FF 591). Since 1972, except for the recession of 1981-82, sales of "Kevlar" have grown steadily worldwide and in the United States. (FF 592).

X. EFFICIENT AND ECONOMIC OPERATION

In order to prevail under section 337, Du Pont must establish that the domestic industry, as defined, is efficiently and economically operated. The criteria established by the Commission to be indicative of efficient and 82
economic operation include: (1) substantial investment in research and

development; (2) substantial expenditures in advertising, promotion and development of consumer goodwill; (3) use of modern production equipment; (4) separate facilities designed specifically for production of the articles at issue; (5) highly trained work force; (6) employee benefit programs; (7) effective quality control programs; and (3) profitable operations. *Certain Foam Earplugs,* Inv. No. 337-TA-184, USITC Pub. No. 1671, at 111-112 (1935); *Certain Minutiae-Based Automated Fingerprint* Identification Systems, Inv. No. 337-TA-156, ID at 77 (1983); *Certain Methods for Extruding Plastic Tubing,* Inv. No. 33-TA-110, 218 U.S.P.Q. 384 (1982); *Certain Coin-Operated* Audiovisual. *Games and Components Thereof,* Inv. No. 337-TA-105, 214 U.S.P.Q. 217 (1982).

Akzo contends that Du Pont's domestic industry is not efficiently and economically operated. In support of this contention, Akzo refers to criteria which it argues are routinely used by economists for judging the.operations of a company. These criteria include profitability, capacity utilization and costs. In short, Akzo argues that Du Pont's lack of profit in its Kevlar production precludes a finding of efficient and economic operation. (RPM, pp. 72-73).

The record establishes that Du Pont has made substantial investment in research and development, in particular for product and process development, for "Kevlar". (FF 593). There also has been a substantial expenditures in advertising, promotion *in* advertising, promotion and development of cnosumer goodwill with respect to"Kevlar". (FF 594-603). Du Pont uses modern production equipment for "Kevlar" (FF 604-614), has built separate facilities designed specifically for production of "Kevlar" (FF 604-614), has improved its production facilities or "Kevlar" (FF 615-613), has an employee benefit program (FF 619-624), and has an effective quality control program. (FF 625).

As of the close of 1984, Du Pont's "Kevlar" business had not made a profit although in 1984 Du Pont generated its first full year positive cash flow. (FF 626-631). Du Pont estimates that it will have positive net operating earnings for 1985. (FT 631).

The Commission has never accepted profitability as the sole criterion on which a determination of efficient and economic operation depends. Profitability is only one of the factors considered by the Commission. Even in cases when the Commission focused on an industry's profitability as a basis . for finding efficient and economic operations, other factors were considered. See, e.g., Certain Heavy-Duty Staple Gun Tackers, Inv. No. 337-TA-137, ID at 69 (1984) (other factors included substantial research and development investment; use of modern equipment; effective quality control programs; and incentive compensation and fringe benefit programs for employees); Certain Steel Rod Treating Apparatus and Components Thereof, Inv. No. 337-TA-97, at 59 (in addition to profit, Commission looked at investment in capital improvements, and research and development); and Certain Apparatus for the Continuous .Production of Copper Rod„337-TA-52, ID at 97 (1979) (volume of sales; increase in labor force; investment in research and development and machinery were considered in addition to profitability).

Considering the "realities of the market place" in which the complaining industry functions (Certain Limited-Charge Cell Culture Microcarriers, Inv. No. 337-TA-129, ID at 246 (1983)), the Commission has found efficient and economic operations in the absence of profitability. In some cases, the Commission has found that the nature of the industry prevents instant or short-term profitability. Fingerprint Identification Systems, supra, at 81. As stated in Amorphous Metals, "filnstant profitability should not be the measure of efficiency in a company that is looking towards the future and is ready to spend the necessary money to create a significant product and then a demand for it." Certain Amorphous Metal Articles, Inv. No. 337-TA-143, ID at 126

(1984). (See also, Certain Centrifugal Trash Pumps, Inv. No. 337—TA-43, RD at 53 (1979) and Certain Automatic Crankpin Grinders, Inv. No. 337—TA-60, RD at 56 (1979) for proposition that efficient and economic operation may be found by focusing on other activities of industry ir the absence of one or more of the traditional indicia of efficient and economic operation).

"Kevlar" is a recent high technology venture and the evidence shows that extended developmental periods have been experienced by Du Pont in other ultimately successful high technology ventures, such as neoprene, Tedlar" polyfluorocarbon film, "Delria" acetal resin and "Kapton" polyimide film. (FF 632).

Accordingly the administrative law judge finds that Du Pont satisfies the statutory requirement that its "Kevlar" domestic industry business be "efficiently and economically operated".

XI. INJURY

In order to prevail under §337, Du Pont must demonstrate that the importation and sale of allegedly infringing aramid fiber has the effect or tendency to destroy or substantially injure the domestic industry. 19 U.S.C. §1337(a). This element requires proof separate from, and independent of proof of an unfair act.

Substantial Injury

Factors the Commission has considered in reaching a determination on injury include: (1) lost sales; (2) declining sales; (3) decrease in domestic production and profitability; (4) volume of imports and their degree of market penetration; (5) underselling; and (6) reduction in complainant's prices. Certain Optical Waveguide Fibers, Inv. No. 337-TA-189, ID at 102 (1984)(Optical Waveguide Fibers); Certain Drill Point Screws for Drywall Construction, Inv. No. 337-TA-116 at 18 (1982) (Drill Point Screws); In re Certain Vacuum Bottles and Components Thereof, Inv. No. 337-TA-108, RD at 72, 219 U.S.P.Q. 637 (U.S.I.T.C. 1982); In re Certain Spring Assemblies and Components Thereof and Methods of Their Manufacture, Inv. No. 337-TA-88 at 42-49, 216 U.S.P.Q. 225 (U.S.I.T.C. 1981) (Spring Assemblies); In re Certain Flexible Foam Sandals, Inv. No. 337-TA-47, RD at 4, 207 U.S.P.Q. 541 (U.S.I.T.C. 1979); In re Certain Roller Units, Inv. No. 337-TA-44 at 10, 208 U.S.P.Q. 141 (U.S.I.T.C. 1979); In re Certain Reclosable Plastic Bags, Inv. No. 337-TA-22, 192 U.S.P.Q. 674 (U.S.I.T.C. 1977). The determination of injury must be based upon the peculiar facts of each case. Drill Point Screws, RD at 144.

Du Pont contends that the domestic industry has been substantially injured in the form of lost sales and deferred customer purchases. Du Pontalso proposes that the following be recognized as indicia of injury: the acquisition by Akzo of valuable technical and market information as a result of its activities in the U.S. market, the attainment by Akzo of a "headstart" in its commercial sales of fiber and finally, the committment by Du Pont of additional expenditures for product development and marketing for 1985 - 1990, as a result of Akzo's penetration of the U.S. market. (CPH, pp. 37-38).

Du Pont's development of "Kevlar" began in 1971 and the fiber's first commercial production occured in 1982. With a current actual production capacity of more than   million pounds per year, Du Pont, at this time, is the only company in the world capable of manufacturing aramid fiber in commercial quantities. (FF 633, 634).

Du Pont's marketing efforts over the years have developed some 20 major end-uses for aramid fiber falling into three general categories: (1) tires; (2) mechanical rubber goods; and (3) special products encompassing non-rubber goods such as armor, ropes and cables, asbestos replacement, aerospace and aircraft, and marine products. Within these end-uses there are nearly 500 different applications for "Kevlar". (FF 639). For the years 1982 - 1984, Du Pont spent approximately   on marketing, advertising and publicity, and end-use research to develop the market for aramid fiber. (FF 646).

Du Pont's expenditures for the development of the aramid fiber market have had beneficial results as "Kevlar" is now entering a growth phase of development characterized by a sharp increase in sales in recent years as demonstrated below:

	MM LBS.	MM $

1980

1981

1982

1983

1984

(FF 635, 636).

Akzo made its first shipment of 4.5 lbs. of "Twaron" to the U.S. in 1980 and did not begin marketing activities here until sometime after 1982. (FF 654, 666). All of Akzo's U.S. aramid fiber shipments are from its pilot plant that has a design capacity of approximately 100 metric tons or 220,460 lbs. and a production output of approximately 50 metric tons or 110,230 lbs. (FF 647, 648).[9/] --To date, all of the "Twaron" distribution in the U.S. has been in sample quantities to enable potential customers to test the technical properties of the product, to adVise those in the market of Akzo's intended entry with commercial quantities, to learn of the market's requirements and to receive approval of "Twaron" so that Akzo will be ready to supply "Twaron" in commercial quantities when Akzo begins commercial production at the end of 1985 in its Emmen and Delfzijl facilities, currently under construction. (FF 648, 652, 656 - 659).

The record shows that from 1980 to 1984 Akzo imported approximately lbs. of sample quantities of "Twaron" into the U.S. (FF 666, 675, 677) While there *is* evidence that Akzo had "booked" an additional lbs. of "Twaron as of February, 1984, for shipment to the U.S. market, there is no indication that these "booked" quantities were in fact shipped. (FF

[9/] One metric ton equals 2,204.6 lbs. (FF 676)

669). Akzo's importation of aramid fiber to the U.S. for the years. 1980 - 1984 represent approximately of Du Pont's sales of "Kevlar" for the same period. (FF 678). Though there is evidence that Akzo has been increasing its U.S. shipments of sample quantities of aramid fiber and its U.S. marketing efforts in recent years, the degree of market penetration *achieved* by Akzo to date is considered de *minimis.* (FF 660, 663, 666). To establish present or past substantial injury the domestic industry must normally show that the alleged infringer holds a significant share of the domestic market of the goods at issue or has made a significant amount of sales of the articles. Textron, *Inc. v U.S. International Trade Commission,* No. 84-1261, slip op. at 20 (C.A.F.C. January 24, 1985); *Spring* Assemblies, 216 U.S.P.Q. at 243. The evidence of record fails to meet that standard.

Many of the companies for whom Akzo has shipped or "booked" sample quantities of "Twaron" are Du Pont customers. (FF 667, 668, 670, 671, 673, 674). Nontheless, the record shows that these samples are obtained for the purpose of testing and evaluation and in consideration of future purchases from Akzo. Du Pont has failed to show that any of the "Twaron" obtained by its customers was intended to supplant those customers' purchases of commercial quantities of "Kevlar". In short, there has been no showing that even the relatively minimal shipments or bookings of "Twaron" have resulted in any lost commercial sales of aramid fiber to Du Pont.

Du Pont argues that as a result of Akzo's marketing activity in the U.S., Du Pont's customers have deferred for at least one year 10% of the purchases of "Kevlar" they otherwise would have made. (CPU, p. 37). This claim is based upon the testimony of one of Du Pont's expert witnesses, Professor Robert J. Thomas, a professor at Georgetown University, who *speculated* that the presence of two potential suppliers of aramid fiber would tend to generate lengthy negotiations prior to purchase. (FF 685). Professor Thomas testified that he was not aware of any specific Du Pont customer which had in fact deferred a purchase of "Kevlar" as a result of Akzo's presence in the U.S. market nor is there any evidence of record to that effect. (FF 686, See FF 687). Accordingly, Du Pont has failed to prove by a preponderance of the evidence that it has been substantially injured in the form of deferred purchases.

Akzo's presence in the U.S. market has provided it with ready access to such information as the structure and needs of the market and the aramid fiber products required to satisfy those needs. (FF 682). Du Pont asserts that Akzo's acquisition of this information is at Du Pont's expense in that much of its effort in developing the market for aramid fiber has redounded to Akzo'sbenefit, resulting in cost savings to Akzo, which in turn provides Akzo with a competitive advantage over Du Pont. (Closing Argument, Tr. p. 4216-17; FF 683). Du Pont has failed to show that the mere acquisition of market information by Akzo constitutes an element of past or present injury and there is no evidence of record that Akzo has obtained any form of competitive advantage over Du Pont, thereby. Whether, for example, Akzo has been able to reduce its prices for "Twaron" as a result of any cost savings it has experienced by virtue of its access to market information, and consequently successfully compete with Du Pont for sales, is not indicated in the record.

Du Pont avers that it has committed an additional million to product development and marketing for the period 1985 - 1990 as a result of Akzo's current activities in the U.S. (CPH, p. 38). While the committment to such expenditures may have in fact been accelerated by Akzo's marketing activities, there is *evidence* of record that Du Pont would have increased its research and development outlays and marketing resources whether Akzo entered the U.S.

market or not. (FF 689, 690). Therefore, the record is inconclusive as to whether increases in expenditures to meet market competition in itself constitutes an element of injury. In any event, the million expense has merely been <u>committed,</u> the cost has not yet been incurred. (FF 689).

Du Pont proposes as another element of injury that

> [title diversion of management attention occasioned by AKZO's entry into the United States market also may result in the loss of opportunities that Du Pont's "Kevlar" management team would otherwise be able to exploit.

(CPFF 9.20)

Mere speculation that Du Pont <u>may</u> have lost "opportunities" as a result of Akzo's presence in the U.S. market cannot be considered a cognizable element of present or past substantial injury.

Du Pont further contends that Akzo's current sampling activities give it a "headstart" of approximately 14 months in commercial sales so that when Akzois able to begin commercial gales of aramid fiber from its Emmen and Delfzijl facilities, "it will be in a position to take 4X of the market immediately". (CPH, p. 38). This argument postulates an alleged injury to Du Pont in the future, and as such may not be considered as an element of present injury.

Finally, the record fails to show such traditional indicia of injury as an idling of production facilities, declining sales or underselling by the alleged infringer. Several of Du Pont's employees have testified that they are unaware of any adverse effects upon Du Pont's "Kevlar" business to date as a result of Akzo's presence in the U.S. aramid fiber market. (FF 691 - 695).

Based upon the foregoing, Du Pont has failed to prove by a preponderance of the evidence that the domestic industry has been substantially injured by Akzo's importation and sale in the United States of aramid fiber.

Tendency to Substantially Injure

To show a tendency to substantially injure the domestic industry, an assessment of the market in the presence of the accused imported product should demonstrate relevant conditions or circumstances from which probable future injury can be inferred. Certain Combination Locks, inv. No. 337-TA-45, 205 U.S.P.Q. 1124 (U.S.I.T.C. 1979). Relevant conditions or circumstances may include substantial manufacturing capacity combined with the intention to penetrate the United States market, foreign cost advantage or an ability of the imported product to undersell complainant's product. Optical Waveguide Fibers; Certain Methods for Extruding Plastic Tubing, Inv. No. 337-TA-110, 218 U.S.P.Q. 348 (U.S.I.T.C. 1982); Certain Reclosable Plastic Bags, Inv. No. 337-TA-22, 192 U.S.P.Q. 674 (U.S.I.T.C. 1977). The legislative history of §337 indicates that "[wihere unfair methods and acts have resulted inconceivable loss of sales, a tendency to substantially injure such industry has been established." Trade Reform Act of 1973, Report of the House Committee On Ways And Means, H. Rep. No. 93-571, 93 Cong., 1st Sess. at 78 (1973), citing, In re Von Clemm, 108 U.S.P.Q. 371 (C.C.P.A. 1955). Although it has been recognized by the Federal Circuit and the Commission that the quantum of proof of injury is less in the context of patent, trademark or copyright infringement than in other types of unfair trade practices, the domestic industry, to establish a tendency to substantially injure, must show that the infringer threatens to hold a significant share of the domestic market in the covered articles or threatens to make a significant amount of sales of the articles. See Textron, slip op. at 10; Spring Assemblies, 216 U.S.P.Q. at 243. The injury contemplated under the "tendency to substantially injure" provision of §337 has to be one of a substantive and clearly foreseen threat to the future of the industry, not based on allegation, conjecture or mere possibility. *Optical Waveguide Fibers,* ID at 113-14; *In the Matter of Certain Braiding Machines*, Inv. No. 337-TA-130 (1983).

Du Pont contends that the importation and sale in the U.S. by Akzo of aramid fibers has the tendency to substantially injure the domestic industry in the form of lost sales and reduced prices. (CPU, pp. 40, 43).

Akzo's Intent and Capacity

There is evidence of record of Akzo's intent to further penetrate the U.S. aramid fiber market, as well as the capacity to do so. Aramid fiber is considered a "high learning" innovation, that is, substantial time and knowledge are required by both the innovator and its customers before end uses are developed and purchases are made. Also, before an aramid sale is completed, the fiber must qualify or meet the customer's specifications, a process which, depending on the end use and the customer, may take from a few months up to more than one year. (FF 637, 656, 733, 734). As discussed supra, Akzo has been distributing sample quantities of "Twaron" in the U.S. market since 1980 for the express purpose of obtaining approval of its product from potential customers so that it will be able to supply those customers with commercial quantities of "Twaron" once Akzo begins its commercial production of aramid fiber in October, 1985. (FF 648, 652, 656 - 659). As a result of Akzo's marketing and sampling activities in the U.S. to date, it has advanced the time when it can sell fiber on a commercial scale in the U.S. (FF 735). See *Certain Amorphous Metal Alloys And Amorphous Metal Articles,* Inv. No. 337-TA-143, ID at 129 (1984).

The record is clear that in the future Akzo intends to increase its efforts in the U.S. market for the sale of "Twaron". Akzo considers [9]0hat the technological edge of the markets for aramid fiber is in the U.S., that the U.S. is the world's largest single Industriel market and that its demand for aramid fiber is in a growth stage. For these reasons, Akzo considers the U.S. aramid fiber market an especially Important one with the greatest potential for future sales. Indeed, in its June, 1983 "Marketing Plan U.S.A.", Akzo expressed its committment to a "long-term engagement" for the supply of aramid fiber to the U.S. (FF 725, 727, 728, 729, 741).

The evidence of record is compelling that to a significant extent Akzo intends to become a second source of supply to existing Du Pont customers. Many of the companies to whom Akzo has shipped sample quantities of "Twaron" and for whom Akzo has booked sample quantities of "Twaron" are Du Pont customers and Akzo has indicated that its estimated sales to the U.S. in 1985 - 1987 are based on actual potential customer contacts it has already made. Furthermore, Akzo considers any -"Kevlar" customer a potential customer for Twaron and .one of its marketing objectives is to persuade existing purchasers of "Kevlar" to substitute "Twaron" for all or part of their aramid fiber needs. (FF 667, 668, 670, 671, 673, 674, 736 - 740). In short, the record demonstrates Akzo's intent to enter the U.S. aramid fiber market and the likelihood that it will direct its sales efforts, to a significant extent, toward current Du Pont customers.

With respect to foreign production capacity, Akzo currently has a spinning plant under construction in the Dutch city of Emmen that will initially have a design capacity of approximately 11 million lbs., though it is not expected to produce at design capacity until the second half of

Its design capacity will be increased to approximately 13.2 million lbs. by

and expansion to a 22 million lb. design capacity may occur but not before unless market demand dictates otherwise. (FF 699, 701, 704 - 706, 708). The raw materials for the production of "Twaron" will be produced by Akzo at its three plants currently under construction in Delfzijl. These facilities will have a design capacity of approximately 11 million lbs., but that capacity could be expanded to 22 million lbs. much sooner than a comparable expansion of the Emmen plant and with much less of an investment. (FF 702 - 704, 707). Production of "Twaron" at the Emmen and Delfzijl facilities will commence in October, 1985. (FF 652).

The evidence of record indicates that Akzo's capacity and estimated production the extent to which Akzo intends to direct its sales of "Twaron" to the Western European and Japanese markets, at least for the years 1985 - 1987. Akzo currently plans to sell approximately lbs. of aramid fiber in 1985, lbs. in 1986 and lbs. in 1987 to the European market and lbs., lbs. and lbs. in the same years, respectively, to the Japanese market. (FF 722, 725). Considering that Akzo estimates a production of and lbs. for each of years 1985-1987, respectively, a significant quantity of "Twaron" will be available for sales in the U.S. market. (FF 718, 719) Akzo, in its most recent planning document, estimates that it will ship the following quantities of "Twaron" to the U.S. in 1985 - 1987:

	Lbs.
1985	
1986	
1987	

(FF 743).

In addition to these specific estimated U.S. shipments, Akzo anticipates that It will ship an additional lbs. of "Twaron" in 1986 and lbs. in 1987, to markets as yet undesignated. Akzo has testified that shOeld the demand arise, some of these undesignated shipments could be made to the U.S. (FF 757, 758). In light of Akzo's forecasted production for 1985-1987 and a design capacity which exceeds that forecast, and in light of its forecasted shipments to Western Europe and Japan, its estimated U.S. shipments for 1985 - 1987 must be considered conservative and it is reasonable to conclude that Akzo may in fact sell larger quantities of "Twaron" in the U.S. than it has forecasted for this time period. Akzo has specifically indicated that its anticipated U.S. sales are not considered limitations, but rather targets. (FF 751). For each of years 1988 - 1990, Akzo expects to sell approximately lbs. of "Twaron" in the U.S. (FF 749).

The record contains forecasts by both Du Pont and Akzo as to the size of the U.S. market for aramid fiber in the next several years. While these estimations of the market differ in varying degrees from year to year, one from the other, and none of them can be considered to reflect precise measurements, they are useful to show the approximate size of the U.S. market and in determining the relative significance of Akzo's impact upon that market. Based upon the foregoing estimated sales of "Twaron" in the U.S. for the years 1985 - 1990, the following table presents a range of the estimated percent of the U.S. aramid fiber market those sales will represent for each of those years:

1985
1986
1987
1988
1989
1990
(FF 755)

The extent to which Akzo is likely to penetrate the U.S. market in the years 1985 - 1990 is clearly indicative of a tendency to substantially injurt the domestic industry. See Certain Surveying Devices, Inv. No. 337-TA-68, Commission Determination and Order at 35 (1980) (market penetration of 4.8% not considered insignificant and demonstrates a tendency to substantially injure); In the Matter of Reclosable Plastic Bags, Inv. No. 337-TA-22, Commission Memorandum Opinion at 14 (1977) (tendency to substantially injure found where imported articles never constituted more than 1.5% of total U.S. production). This conclusion is supported by the clear evidence of Akzo's capacity for aramid production as early as October of this year and its increasing capacity potential through 1990 as well as its unambiguously expressed intent to utilize a significant portion of that capacity for the production of fiber bound for the U.S. market.

Assuming that Akzo's anticipated U.S. "Twaron" sales in 1985 - 1990 do not affect the average price of "Kevlar" or the demand for "Kevlar" and assuming that each pound of "Twaron" sold represents a lost sale to Du Pont, Akzo's sales during that period would result in an approximate loss of $96 million in revenue to Du Pont. (FF 756). While the entire $96 million in estimated revenue loss to Du Pont does not represent lost profits, certainly a percentage of that figure is lost profit to Du Pont, and to that extent, it is one of the objective indicia of a tendency to substantially injure Du Pont.

Price Reduction

Du Pont argues further, that the domestic industry will be additionally injured in the form of reduced prices for "Kevlar" as a result of Akzo's entry into the U.S. market. Akzo contends that to the contrary, it intends to

and that if prices for "Kevlar" are lowered in response to the importation of "Twaron", it will be at Du Pont's

Initiation in an effort to maintain its current market share and that such "self-inflicted wounds" do not constitute a cognizable element of injury under §337. (RPH, pp. 65, 68-69).

Akzo believes that it would not gain by cutting its prices for "Twaron" below those for "Keviar" because Du Pont, with 95% or more of the market, would meet any reduction in price Akzo would offer. (FF 781, 784). Although Akzo has expressed an intention to generally follow Du Pont's pricing for aramid, it has also clearly indicated a willingness to adopt flexible pricing strategies for special projects or particular end uses, particularly in the (FF 780, 784, 785, 789, 791). Both aramid fiber customers and Akzo itself recognize that the entrance of a second supplier will have a price-reducing effect on the market, and this would not be attributable to Du Pont. Indeed, some aramid customers reported that they would only purchase "Twaron" if it was priced lower than "Keviar". (FF 783, 794, 795, 798). Such purchasing .poliCies by some in the aramid market could reasonably be expected to provide an incentive to Akzo to offer lower prices for its product.

Thus, Akzo will adopt a flexible pricing policy including price reductions, at least in particular end use markets and Du Pont intends to respond to competition from Akzo's entry by reducing prices to maintain its market share. (FF 796). Thus, even if Du Pont initiates a reduction in price, it would be in response to the competition presented by Akzo's presence in the market and as such would represent one of the objective indicia of injury, caused by Akzo's activities.

Forecasts and Price Reduction

Respondents expect to import well in excess of pounds of "Twaron" for each of years 1986 - 1990. (FF 748, 749). Respondents' expert witness, Dean MacAvoy, testified that sales by Akzo beyond the 500,000 - 1,000,000 lb. range would disrupt the current price structure in the U.S. market. (FF 823, 824). Du Pont's "Focus Case" and "Base Case" forecasts project, inter ells, the price declines of "Keeler" for 1m86 - 1990, due to Akzo's entry into the U.S. market, based on Du Pont marketing representatives' assessment of what the price impact of Akzo's entry would be. (FF 810, 811). Du Pont's "Focus" forecasts are based on the assumption that Du Pont will allocate additional resources into new product invention and market development. Du Pont has, in fact, already adopted this "Focus" strategy in the marketplace and will not abandon it even if Akzo is restricted from the U.S. market. Du Pont's "Base" forecasts are based on the assumption that Du Pont would continue the strategies it has been following to date with "Revlar". (FF 850, 851, 853, 854). Both the "Focus" and the "Base" forecasts include projections of the U.S. zramid market with Akzo out of the market and Akzo in the• market, (FF 852, 855). Respondents argue that the impact of Akzo's entry must be measured by a comparison between the "Base" forecast without Akzo in the market and the "Focus" forecast with Akzo in the market. (RPM, p. 17). Rowever, this is not considered a valid comparison. Because of the <u>differing</u> assumptions underlying each of these forecasts, and also because the Base" forecasts are considered more realistic than the "Focus" forecasts, such a comparison would be in error. (FF 864 - 866, 866(a).

While Du Pont's expert witness, Professor Hausman, relied upon a comparison of the "Focus" forecasts (one assuming Akzo did not enter the U.S. market and one assuming that it did), considering that they would yield a more conservative estimate of injury, Du Pont's Charles L. Henry, Vice President of the Textile Fibers Department, testified that the figures forecasted in the "Base Case" forecasts were more realistic in that the premises upon which they were based more realistically reflected the amount of product development Du Pont would engage in. (FP 807, 808, 864 - 866). It is recognized that neither a "Focus-Focus" nor a "Base-Base" comparison is likely to yield a precise measurement of price decline resulting from Akzo's entry. (See FF 806). Nonetheless, the following range of price reduction, as demonstrated by a comparison of both of these forecast models, provides a reasonable estimate of the percentage of price depression of "Kevlar" for the years 1986 - 1990, due to the entry of Akzo into the U.S. aramid fiber market:

1986	1987	1988	1989	1990
7.3 - 9.8	4.2 - 10.3	5.4 - 10.8	5.3 - 11.9	4.1 - 12.7

(FF 803, 805)

Thus, this range reflects estimations_ arrived at by means of a comparison considered conservative (Hausman's "Focus-Focus" comparison) and a comparison which takes into consideration premises considered more realistic. (a "Base-Base" comparison). For 1986, for example, Professor Hausman's comparison yields a 7.37. reduction in price as a result of Akzo's entry and Mr. Henry's recommended "Base-Base" comparison for that same year yields a price reduction of 9.8% The forecasts in each pair of compared forecasts are based upon the same underlying assumptions and therefore, more likely to yield comparisons which do not measure extraneous factors as would the comparison made by respondents. In sum, the foregoing estimated range of price reduction of "Kevlar" for 1986 - 1990, indicates a tendency to substantially injure the domestic industry, caused by Akzo's entry into the U.S. market.

The Equilibrium Principle

Respondents argue that during the period 1986 to 1990 when the '756 patent expires, Du Pont will be affected by competition from Akzo in Europe whether or not Akzo markets its fiber in the United States. (RPF 472). Hence, if Akzo sold only in Europe, its prices there would drive down prices in the United States. (RPFF 474). This argument is based on what economists have termed "the law of one price" which holds that for some products that are sold worldwide, changes in supply and demand conditions are transmitted from one part of the world to another, and prices will adjust until an equilibrium is established. (FF 934).

However, while Akzo's entry into Europe alone will cause some price erosion in the United States (FF 937, 938), it is not seen how the degree of price erosion will be the same as if Akzo were to compete directly in the United States aramid market. In reality, there may exist different competitive conditions between the United States and other countries. For example, prices have been reported for five metal and steel products for sales in up to six different countries. In 1982, prices for these products in the foreign countries were an average of 18% lower than in the United States. (FF 940). Other products have been sold at different prices in different geographic markets. For example, in the first quarter of 1983, carbon and alloy steel prices in the EEC and in the world were 37% and 40% lower, respectively, than in the United States. (FF 941).

Even accepting the operation of the equilibrium principle, Du Pont still could maintain a price differential between the United States and European markets over the period from 1986 to 1990 when the '756 patent expires. (FF 943, 944).

The administrative law judge concludes that the equilibrium principle does not operate under the present circumstances to nullify any tendency to substantially injure the domestic industry.

Elasticity

Respondents contend that although Akzo will not enter the U.S. market with reduced prices, should there be a reduction in aramid prices upon their entry in the market, the volume of aramid sales will increase as a result, and hence Du Pont will benefit from their entry. (RPHR, p. 30). The expert witnesses for both Du Pont and Akzo used elasticity estimates in their calculations of the effect on the domestic industry of the entry of Akzo into the U.S. aramid market. (FF 897). The demand elasticity is a single number used to summarize the sensitivity of the quantity demanded at a particular price to a small change in that price. (FF 896).

The administrative law judge finds that the record evidence establishes that none of the elasticities estimated by either Du Pont or Akzo can be said to reflect with precise certainty the effect that a reduction in price will have upon the volume of demand. Du Pont's elasticities are however, found to be the more reliable indicators of that relationship. Respondents' expert witness, Dean MacAvoy, estimated the price elasticity for aramid fiber to range between 5 and 15, meaning that if the price of aramid fell by 1%, aramid sales volume would increase by 5 - 15Z. (FF 901). Dean MacAvoy characterized these estimates as "extraordinarily high" and Professor Hausman testified that for an elasticity estimate for one or two years in the future, an elasticity of 2.5 is far larger than anything he had seen in the econometrics or economic literature. (FF 900, 902).

Moreover, while both Du Pont and Akzo believe that elasticities will differ by end use market, Dean MacAvoy estimated only an industry-wide elasticity and did not estimate elasticities for individual end use markets. (FF 914, 915). Dean HacAvoy's estimates cannot be considered applicable in the short term; as Dean MacAvoy testified, his elasticity estimates constitute the long term response of sales to changes in price and elasticity is lower in the short run in this market. (FF 903, 904). Akzo concurred that the benefits of increased quantities resulting from lower prices would occur at some later point in time. (FF 905). Furthermore, although Dean MacAvoy pointed to internal Du Pont documents to support his contention that the demand elasticity for aramid fibers is high, many of these documents provided no clear price sensitivity estimates and some that did, suggested an elasticity significantly lower than Dean MacAvoy's estimates. (FF 916-918). Also, Dean MacAvoy testified that the elasticity estimates he made relied on a "poor amount of data". (FF 909).

Using the same data as did Dean MacAvoy, and also acknowledging that the data sample size was inadequate, Professor Hausman econometrically estimated the aramid price elasticity after correcting for errors he claimed existed in Dean MacAvoy's estimation method, such errors including Dean MacAvoy's assumption that only the price last year affects the demand for "Kevlar" this year. (FF 910, 912, 913, 923,.924). Professor Hausman's estimates ranged from 0.72 to 1.4. (FF 923). Professor Hausman also calculated "implicit elasticities" of demand of 0.0 - 1.2 for each "Kevlar" end use, derived from Du Pont's "Focus" forecasts. (FF 921, 922). These "Focus" forecasts were estimates reached by Du Pont's sales representatives who had no knowledge of Akzo's intentions with respect to some market segments and who made their assessments without any guidelines on the amount of "Twaron" Akzo would have available for sale. (FF 814, 815). Further, these forecasts took into account factors other than price in their projections of demand. (FF 856). Using a range of elasticities from 0.7 - 2.0, Professor Hausman calculated injury to Du Pont for the years 1986 - 1990, resulting from Akzo's entminto the U.S. market. The average annual injury[10/] to Du Pont was estimated by Professor Hausman based upon each of the elasticities that he used. With certain corrections (See FF 929, 930), these estimates are as follows:

Elasticities	Average Annual Injury
m l ›	
0.7	22.2
1.0	18.9
1.4	14.7
1.5	13.8
2.0	8.5

(FF 931, 932)

Professor Hausman's injury calculations are more realistic than Dean HacAvoy's estimations for purposes of an overall assessment of the impact upon Du Pont of Akzo's entry into the U.S. market. Thus, Professor Hausman's elasticity estimates are more in conformance with the elasticity estimates reflected in Du Pont's internal documents and his methodology for econometrically estimating elasticities eliminated Dean MacAvoy's sole reliance on last year's "Kevlar" price. (FF 913, 917, 924). In sum, Professor Hausman's estimations of "incremental profit" loss to Du Pont as a result of Akzo's entry into the U.S. is a further indication that there exists a tendency to substantially injure the domestic industry.

10/ Professor Hausman's injury calculation is in the form of lost "incremental profit." Hausman derived Du Pont's "incremental profit" by substracting Du Pont's unit variable costs from the unit selling price (per lb.) and multiplying that figure by the quantity of Du Pont shipments (in lbs.).

Market Expansion

While economic experts for both Du Pont and Akzo acknowledged that Akzo's entry into the U.S. aramid fiber market will result in an increase in overall demand for aramid fibers (FF 829), they were at variance with respect to the size and the effect of the increase. Dean MacAvoy stated that the increase in Du Pont's marketing and research and development expenditures during the period 1985 — 1988, due to anticipated competition from Akzo, will expand demand by approximately 25%. (FF 830). However, his estimates of market expansion were based on a comparison of Du Pont sales forecasts with Akzo in the market and Akzo out of the market which were made over one year apart from each other and thus, could have been based upon differing views of market conditions. (FF 857, 858).

He further testified that it is possible that an expansion in demand would not occur or would occur slowly, that even for currently developed end uses there is a long lead time between the time a customer decides to test aramid and its use by that customer in commercial quantities and that because of the long lead time involved in developing some new aramid end uses, demand for aramid used in those end uses will not be stimulated until 1988, 1989 or 1990. (FF 828, 834, 845). Professor Hausman on the other hand, believed that the market expansion effect of Akzo's entry into the U.S. market will reach a maximum of 2.9% in 1990, when the '756 patent expires. (FF 831).

Dean MacAvoy testified that a second source of supply of aramid fiber would expand the market because customers are provided a greater assurance of supply reliability. (FF 827). Akzo has estimated that the increase in demand for aramid as a function of the presence of a second source of supply would be only a few percent. (FF 839). There is little evidence of record that the mere presence of a second source of supply would serve to increase demand and

In fact, four aramid customers have testified that the availabiltly of a second source would not cause them to increase their total aramid purchases. (FF 841).

Dean MacAvoy has also testified that Akzo will contribute technical innovations that will create new uses and thereby stimulate demand. (FF 827). Though the record contains evidence of Akzo's efforts toward the development of new uses for aramid fiber, the new uses being developed have either already been developed by Du Pont, and therefore do not represent a market segment in which Du Pont is not already participating or able to participate, or the new use is currently under development by Akzo and its date for completion is uncertain. (FF 872, 876 - 895). The evidence of record is insufficient to demonstrate that the development of new uses for aramid fiber by Akzo will serve to expand the U.S. market.

With respect to expansion of the market and any resulting increase in demand for aramid fiber as a result of Akzo's entry into the U.S., Dean MacAvoy's estimates of market expansion are not considered sufficiently reliable to provide a basis for an estimate of injury. The evidence indicates that if an expansion of the market were to occur at all as a result of Akzo's entrance into the market in 1985, that expansion would likely not occur until shorly before the expiration of the '756 patent in October, 1990. (FF 834, 845 - 847). Although Du Pont concedes that market expansion will occur to a limited degree, that expansion will be insufficient to offset the injury likely to occur to Du Pont as a result of Akzo's entry.

Injury Estimates

For the reasons discussed supra, with respect to respondents' position regarding the impact of Akzo's entry upon the price of "Kevlar", the forecast comparisons made by respondents to demonstrate an increase in Du Pont's average pre-tax earnings over the 1986 - 1990 period are deficient.

Du Pont's Mr. Henry did not view the results set forth in the "Focus" forecasts as presenting the most realistic view of market growth for the years 1986 - 1990, and believes that the base case forecasts are the more realistic because "...the premises are more realistic in terms of the kinds of things we're counting on in that five-year period...". (FF 864 - 866). Mr. Henry's injury estimates compared Du Pont's "Base" case pre-tax earnings forecasts with and without Akzo's entry into the U.S. His estimations of Du Pont's loss of pre-tax earnings for 1986 - 1990, in millions of 1984 dollars, are as follows:

1986	1987	1988	1989	1990	Total
23.9	31.3	44.8	49.5	55.7	205.2

(FF 867)

Based upon an estimated range of elasticities, Professor Hausman calculated an average annual loss of "incremental profit" to Du Pont ranging from $8.5 million to $22.2 million, supra. As both Ur. Henry's and Professor Hausman's calculations of injury to Du Pont are cast in different values (pre-tax earnings and "incremental profit", respectively) they cannot be directly compared. However, both of these estimates further indicate a tendency to substantially injure the domestic industry.

Based upon the foregoing, the administrative law judge concludes that the combination of Akzo's intent to enter the United States aramid fiber market and its capacity to do so, Du Pont's resulting loss of revenue, a price

reduction in "Kevlar" upon Akzo's U.S. entry, as supported by market forecasts, the limited expansion of the market upon Akzo's entry, as supported by Professor Hausman's elasticity estimates and the estimated injury to Du Pont as a result of Akzo's entrance into the U.S. market establish that Du Pont has proven by a preponderance of the evidence that Akzo's importation and sale of the accused aramid fiber has the tendency to substantially injure the domestic industry.

Du Pont's Capacity to Meet Demand

Akzo argues that although the evidence shows that (1) Du Pont **has yet to** achieve its 45 million lbs. per annum nameplate capacity **due to technical** problems at Spruance, (2) **Du Pont's million lbs. per annum proven** capacity will be insufficient to satisfy world demand by 1986, (3) Du Pont's nameplate capacity, if realized, will be insufficient to satisfy world **demand** by 1987, and (4) world demand will rise to 932 of the combined nameplate capacity of **both Akzo and Du Pont** by 1988 and to 1172 by 1990, Du Pont refuses to acknowledge the very real prospect of a capacity shortfall. (RPH p. 71). Akzo argues that DuPont does not presently have the technology needed to achieve nameplate capacity at Spruance and does not know how long it will take to achieve that capacity, nor does it currently have any approved plans to install additional capacity; that it would take at least two years lead time to install additional capacity after approval; and that Du Pont's promise of a "major technological advance" in the near future must be viewed with considerable skepticism because Du Pont has repeatedly promised, and failed, to perfect and implement the same technology since 1979. (RPH p. 71).

Du Pont argues that its capacity **to** produce "Kevlar" exceeds 1984 worldwide demand **by over** 50% and **exceeds** its expected 1985 sales by over 352. It is argued that the uncontradicted evidence shows that Du Pont has **the plans** and the ability to continue to adjust its spinning speeds at Spruance to keep ahead of *demand; that* the evidence also shows that Du Pont is well along in its plans to construct a spinning plant in Europe, which will be operating by and that Du Pont is committed to build spinning facilities in Japan once demand there reaches million pounds per year. (CPHR pp. 29-30). Du Pont asserts that it is an outright misrepresentation of the record to assert that Du Pont requires a "major technological advance" to increase existing capacity within the next few months as it alleges Akzo contends. (CPHR p. 30).

At the outset, it is only Du Pont's capacity to meet United States demand that is relevant to the effect of Akzo's importation. Du Pont's ability to meet a demand for aramid fiber outside the United States is not relevant to whether it has sufficient capacity to meet demand in the United States.

On the evidence before the administrative law judge Du Pont has the capacity to meet demand for aramid fiber in the United States. While Du Pont's Spruance plant has experienced technical problems related to the switch from HHPA to solvent so that actual, present capacity is to million pounds per year (FF 769), on April 1, 1985 Du Pont increased its spinning speeds from yards per minute and the number of ends per spin module from bringing effective annual capacity to million pounds (FF 771) Du Pont intends further to increase effective capacity to million pounds within the next two years and to million pounds by 1987 (FF 771). The Spruance facility was designed to allow expansion of production from million pounds. The facility already has adequate polymerization solvent recovery and ingredients' capacity to produce million pounds of "Kelvar" annually. (FF 773). Horeover space in the Spruance plant has been allocated for additional polymerization and spinning equipment. The addition of two spinning machines of the current type an49one polymerization unit will increase the capacity to the million pounds and that equipment can be installed with a *lead time* of approximately two years (FF 774).

Du Pont plans to construct a spinning plant for aramid fiber in Maydovn, Northern Ireland. Operation is expected to begin in 1987 with a nameplate capacity of million pounds. Du Pont expects to expand the nameplate capacity to million pounds per year in the second quarter of 1987. (FF 775). While construction of the Maydown plant has not yet been authorized, Du Pont has applied for government grants to assist in funding. (FF 776). Moreover Du Pont has entered into a joint venture which includes a proposal to build a spinning plant in Japan and it is expected that construction of a Japanese plant will begin in . **(FF** 777.)

The administrative law judge will not speculate what Du Pont can do in a world market. He has found that Akzo has not sustained its burden in proving that claim-13 of the '756 patent is invalid or unenforceable. Based on the record before him Du Pont will have sufficient capacity to meet projected United States demand.

FINDINGS OF FACT

I. JURISDICTION

1. The Commission has in rem and subject matter jurisdiction in this investigation, under 5 337, since the alleged unfair methods of competition and unfair acts involved the importation into, and sale in, the United States of aramid fiber produced by an alleged infringing process, of the '756 patent the alleged effect or tendency of which is to destroy or substantially injure an industry, alleged to be efficiently and economically operated in the United States.

II. THE PARTIES

2. Complainant E. I du Pont de Nemours and Company (Du Pont) is a Delaware corporation with its principal place of business in Wilmington, Delaware. (Complaint 1 1.2; Response to Complaint, 1 1.2).

3. Respondents in this investigation (Akzo) are (Complaint 1 1.3; Response to Complaint 1 1.3):

a. Akzo N.V., a Netherlands corporation, with its principal place of business at Arnhem, The Netherlands.

b. Enka B.V. (Enka), a Netherlands corporation, which is an indirect, wholly-owned subsidiary of Akzo N.v. with its prinicipal place of business at Arnhem, The Netherlands.

c. Akzona, Inc. (Akzona), now known as Akzo-America (Zempelin, Tr. pp. 1590-91), a Delaware corporation which is an indirect, wholly-owned subsidiary of Akzo N.V with its principal place of business at Asheville, North Carolina.

d. Aramide Maatschappij v.o.f., (Arami), a partnership organized under the laws of the Netherlands in which Enka Aramide B.V., a wholly-owned subsidiary of Enka is a partner. The other partner is Noramide B.V., a subsidiary of N. V. Noordelijke Ontwikkelinqsmaatschappij (NOM), which is a company all of whose shares are held by the Dutch Government. Arami's prinicipal place of business is Arnhem, The Netherlands. (Zempelin, RX-7, p. 3). The NOM is independently responsible for its investments and is a "private, limited enterprise." Its employees are employees of a private company and not civil servants (Wisman, Tr. p. 2584).

4. Akzo N.V. is involved in the activities of the other respondents:

a. The management of the respondent's companies overlaps: Mr. Zempelin is a member of the board of management of Akzo N.V., the President and Chief Executive Officer of the Enka Group which includes Enka as well as Enka's interest in Arami, and a_member of the board of directors of Akzona. (Zempelin,. RX-7 p. 1).

b. Akzo N.V. supervises the operations of Enka and its other subsidiaries and controls their major decisions: Akzo N.V. must approve the subsidiaries' three-year operational plans and strategic plans; without Akzo N.V.'s approval, no investment over 2.5 million guilders ($700,00) [1] may be made by a subsidiary, no loan may be contracted, and no equity capital may be raised. (Zempelin, Tr. pp. 1611-1613, 1618-20). However the responsibility for the day to day business operations of Enka and the other subsidiaries of Akzo N.V. has been delegated from Akzo N.V. to the subsidiary. For example no customer will find a bill from Akzo N.V. The bill for example,will be from Enka or from Akzo salt chemical subsidiary. (Zempelin Tr., p. 1612).

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[1] Basel on current exchange rate of 3.55 guilders per dollars. (Hausman, RX-4021 p. 53).

There is no evidence in the record that Akzo N.V. plays any role in deciding the quantity output of the aramil plants, the site of shipments to a particular geographic region or the prices at which the product is to be sold.

c. Akzo N.V.'s research laboratories have been closely involved in the adoption of respondents' accused process which is alleged to be covered by the claims of the '756 patent and used directly or indirectly by the other respondents. .(volbracht, CX-935 pp. 25-26; CX-928 p. E 412864; CX 976A p. E 473369-70).

d. As with all major projects undertaken by one of its subsidiaries, approval by Akzo N.V. was necessary for Enka's entry into the joint venture agreement with NOM. Akio followed the negotiations very carefully and a representative of Akzo N.V. was present during all negotiations with NOM. (van de Ven, CX-89 pp. 37-38, 55).

e. Akzo N.V. guaranteed loans on behalf of the joint venture totalling 80 million Dutch guilders (S27.6 million?/), in the following amounts; De Nationale Investerings Bank N.V. (50 min. Dfl.), Cooperative Centrale Raiffeinsen Boerenlenbank B.A. (15 min. Dfl.), Nederlands Middenstandsbank N.V. (10 min. DEL.), Bank of Tokyo (Holland) N.V. (5 min. Dfl.). (van de Ven, CX-89 p. 54; CX-546, response to Int. No. 14).

f. Akzo N.V. follows the conflict with Du Pont about patent rights and is interested in the outcome. (van de Ven, CX-89 p. 125).

g. Mr. Loudon, who is president of Akzo N.V., but who holds no position with Enka, initiated and directed licensing discussions between Akzo N.V. and Du Pont. He :signed all important correspondence concerning those negotiations on behalf of respondents. (van de Ven, CX-89 p. 44; Heckert, CX-1 pp. 32-34; CX-30; CX-31: CX-33).

2/ This dollar value, is calculated at the exchange rate of 2.90 guilders per dollar prevailing in 1983 when the Arami partnership was formed. (RX-1805 p. E 700559).

h. After receiving a recommendation from Enka, Akzo, N.V. determined the final position of respondents in the licensing negotiations with DuPont (van de Ven, CX 89 p. 133).

i. Soon after the licensing negotiations with DuPont terminated, the Akzo N.V. board of directors approved the filing of litigation against Du Pont concerning Du Pont's aramid patents in the United States District Court for the western District of North Carolina. (van de lien, CX-89 p. 133; CX-658).

5. The corporations affiliated with Akzo N.V. are together Europe's largest producers of textile fibers. The Enka Group, of which Enka is a part, is the world's largest producer of industrial yarns. Akzo N.V. has more than 80 subsidiaries and affiliated companies with operations in more than 50 countries and 1983 earnings of about $142 million on sales in excess of $5 billion. (Response to CoMplaint II 1.3, 1.6; Zempelin, RX-7 p. 3).

6. NOM, Enka's partner in Arami, was established in 1974 by the Dutch Government "to help improve the social-economic structure of and employment in the northern provinces of the Netherlands." It is organized as a limited liability company, but the Government of the Netherlands holds all of its stock through the Dutch Ministry of Economic Affairs. (Wisman, RX-9 p.

7. Since its establishment in 1974, NOM has never earned a profit (Wisman, CX-652 p. 24), with the possible exception that the figures for calendar year 1984 "may show a profit" when they are finalized (Wisman, Tr. p. 2585). In his yearly report for NOM on January 10, 1984, Mr. Wisman stated that half the Government funds invested by NOM up to that time (then approximately 400 million guilders) had been written off as losses. (RX-422 p. 8000124).

8. NOM, the Ministry of Economic Affairs and Akzo N.V. reached agkeement on all the principal terms of the Arami partnership arrangehWilts in

July 1932. (CX-572; Wiseman, Tr. p. 1574). These terms were incorporated, in somewhat more detail, in the partnership instruments formally signed by the parites on March 4, 1983. (RX 1309 and RX 1810). Both the July 1982 agreement in principle and Article 15.2 of the formai Agreement of March 1933 set forth in identical terms the parties' intent that the Arami partnership should permit Akzo, N.V. to operate the aramid business with substantial Government financial assistance:

> "Akzo/Enka have confirmed that the aramid project is of essential importance to Enka and that Enka, despite its dominant position in relation to NOM, nevertheless desires a joint venture with NOM as well as a large financial contribution by the Government." (RX-1809 pp. E 700794-95; CX-572 p. E 407195; Wiseman, Tr. pp. 275-78).

9. Dr. Zeppelin confirmed in his testimony that

However Arami receives no special grants or subsidies from the Dutch government (Wisinorl RX-11 p. 4).

10. Dutch Government financial assistance supports the Arami partnership in the following respects:

a. Through NON, the. Government contributed guilders in 1933 when the Arami partnership ws found)) in equity capital. Although Enka nominally made a similar guilder contribution to capital, only about sunders were in cash and the balance was the value assigned to contribution of "know-how." (t7isman, RX-9, p. 4, Tr. p. 2579).

b. Arami received an additional guilders In Investment Premiums Regulation (IPR) *amid* WIR investment credial[4]

(WIR). (Wiseman, RX-9 p. 5). The IPR premium is a cash payment to Arami, and the WIR credit takes the form of tax relief. (Wisman, Tr. pp. 2581-82). A number of cash installment payments have been made under the IPR premium, but neither Dr. Zempelin nor Mr. Viseman could recall the total amount. (Zempelin, Tr. p. 1517; Wisman, Tr. p. 2581). The IPR and the WIR are available to any company operating in the Netherlands, including Du Pont, which has a facility in Dordrecht. According to information which Mr. Wisman received, Du Pont has received a WIR investment credit over the past year (Wiseman, Tr., p. 2606; Wisman RX-11 p. 4).

c. The Government provided a development credit, in The form of an incentive loan to encourage new development, from which Arami benefits. (Wiseman, Tr. p. 2582).

d. The National Investment Bank (NIB), which is affiliated with the Dutch Government provided a guilder loan to Arami. (Id. pp. 2582-83).

e. The Dutch Government has provided loan guarantees to Arami in the amount of guilders . (CX-546, pp. 34-35; Wisman, Tr. pp. 1583-S4).

III. TEE PROCESS IN ISSUE

11. The '756 patent in issue contains only process claims.

(Zeppelin, DX-7, p. 5). Du Pont's competing aramid fiber is sold under the registered trademark "Kevlar". (Heckert, CX-1, pp. 8-10).

12. advanced by Akzo that its aramid fiber does not infringe the asserted claims of the '756 patent are that the '756 patent is invalid and unenforceable. (RPH).

13. "Aramid" is a generic definition for a manufactured fiber in which the fiber-forming substance is a long-chain synthetic polyamide in which at least 85% of the amide linkages are attached directly to two aromatic rings. (CX-837 p. 16).

14. Both "Kevlar" and "Twaron" aramid fiber are formed of poly (p-phenylene terephthalanide) commonly referred to as "PPD-T" where all the amide linkages are attached at the para position of the aromatic rings. Such fibers are sometimes known as para aramids. (Uhlmann, CX-835, pp. 7-8; Witherspoon, CX-53 p. 8; Weijland, CX-901, p. 84 1. 22-85 1. 6; CX-904).

15. Aramid fiber is the strongest commercial synthetic fiber known to man -- about five times as strong as steel on an equal weight basis. (Broekmeyer, RX-8 p. 2). It has opened vast new technical horizons. (Id.)

16. Du Pont's "Kevlar" aramid fiber has a unique combination of properties never before achieved in a synthetic fiber. (Henry, CX-36, P. 6). In addition to extraordinary as-spun strength "Kevlar" has a modulus (i.e., its resistance to stretch) equal to glass (Uhlmann, CX-835 p. 10), eight times as high as industrial grade polyester and 25 times as high as industrial grade nylon. (Henry, CX-36 p. 7).

17. "Kevlar' fiber also displays remarkable heat resistance. "Kevlar" will not melt. It retains one-half its room temperature tensile strength at 254 Celsius, which is the melting point of industrial grade nylon and polyester. "Kevlar" only chars at exposure to high temperatures. (Henry, CX-16 p. 7).

18. Because of its unusual properties, "Kevlar" fiber has many diverse applications -- in ropes, spacecraft, airplanes, bullet resistant and other protective clothing, tires, boat hulls, hard armor. gaskets, and other objects. It can be used where high strength and light weight are sought. In some uses, its rustproof character or stability in high or low temperatures contribute to its utility. Depending on the use, "Kevlar" aramid fiber can substitute for steel, aluminum, asbestos, nylon, rayon, polyester, cotton, or carbon fiber. (Henry, CX-36 p. 7).

19. Du Pont has developed a broad variety of "Kevlar" aramid fiber products to meet the needs of customers and potential customers who have differing uses for the product. "Kevlar" is available as continuous filament yarns and rovings, in a broad range of deniers, ranging from 195 to 15000 denier. (Henry, CX-36 pp. 9-10). Denier is the weight in grams of 9000 meters of yarn (Henry, CX 36 p. 9) and "dtex" is the weight in grams of 10,000 meters of yarn. (Uhlmann, CX-835 p. 4, Tr. 832. pp. 1-17; CX-902; CX-911 p. 3).

20. "Kevlar" fiber is also produced as staple and as pulp. Staple consists of short, crimped fibers designed primarily to be spun into yarn and for use as reinforcement in composite material. "Kevlar" pulp is a finely ground fiber used for applications such as the reinforcement of elastomers and for asbestoes replacement in friction products. (Henry, CX-36, p. 10).

21. "Kevlar" fiber is also available at two levels of modulus. The regular modulus Kevlar is sold under the names "Kevlar" and "Kevlar 29". "Kevlar 49" is a continuous filament yarn that has been subjected to heat and high tension to create a higher modulus form of the fiber. It is used

primarily as a reinforcement material in high technology composites for such applications as aircraft and space vehicle parts and boat hulls. (Henry, CX-6 p. 10).

22. Properties and uses of "Kevlar", "Kevlar 2'" and "Kevlar 49" are described in Du Pont's Technical Bullentins for those products. (CX ¯42).

23. Akzo's "Twaron" aramid fiber has substantially the same properties and uses as Du Pont's "Kevlar" fibers. (Zempelin, RX-7, p. 5). Properties and uses of Twaron are described in Akzo's Technical Bullentins for its products. (CX-911). "Twaron" is similarly available at two levels of modulus. (CX-911, p. 3; Weijland, CX-901, p. 115, Is. 13-23).

24. "Twaron" fiber is made and sold in various types. (Witherspoon, CX-853, p. 3; CX-856 pp. 7-8 (Request 13); CX-903 p. 5 (Int. /1)).

25. Du Pont's physical Exhibits CPX-804 to CPX-809 are illustrative of Akzo's "Twaron" aramld fiber. (Witherspoon, CX-853 p. 4, Tr. p. 1410, 1. 20 - 1412, 1.10; CX-902; CX-S56 pp. 7-3, Req. No. 13).

26. Akzo's "Twaron" fiber is currently being produced in The Netherlands in a pilot plant in Arnhem. By October 1985 this fiber will be produced in a commercial plant being constructed in Emmen, The Netherlands. (Zempelin, RX-7 pp. 4-6, paras. 8, 10, 11).

27. "Twaron" fiber is currently produced by a spinning process which comprises

(Witherspoon, CX-853 pp 5, 7, 8; Weijland, CX-901 pp. 27, 11. 3-11 and p. 121, 1. 22-126, 1. 8; CX-913). This same spinning process will he used to produce Twaron fibers in the Emmen plant. 118 (Weijland, CX-901 p. 71, 1. 17-72, 1. 11; CX-903 pp. 13-14, Respondents'

Response to Complainant's' Interrogatory No. 5).

28. "Kevlar" fiber is produced at Du Pont's Spruance, Virginia plant (Henry, CX-36 p. 72) by a spinning process comprising

(Uhlmann, CX-835 p. 20, 2nd paragraph; RX-448, Part 2 pp. TC 080947, TC 080895 and TC 080987).

2n. The "Kevlar" and "Twaron" commercial spinning processes are

	<u>"Twaron"</u>
Polyanide:	
<u>Solvent:</u>	
<u>PPD-T Concentration:</u>	
<u>PPD-T I.V.:</u>	
<u>Air Cap:</u>	
<u>Coagulating Bath:</u>	

(PFF 3.13)

30. Akzo's aramid fibers are prepared by

(Weijland, CX-°01 pp. 13-111, 20-34, 67).

31.

(Tr. p. 4072).

IV. THC '756 PATENT

32. U.S. Letters Patent No. 3,767,756 ('756 patent) entitled "Dry-Jet Wet Spinning Process" issued October 23, 1973 on application Ser. No. 268,052 filed June 30, 1972. Ser. No. 268,052 was a continuation-in-part application of abandoned Ser. No. 239,377 filed March 29, 1972 which in turn was a continuation-in-part application of abandoned Ser. No. 172,515 filed August 17, 1971 which in turn was a continuation-in-part application of abandoned Ser. No. 138,210 filed April 28, 1971. The '756 patent has the named inventor Herbert Blades and, on its face, is assigned to Du Pont by virtue of an assignment dated June 29, 1972 from Blades. (CX-6, RX-57; CX-7).

Claims of the '756 Patent

33. The thirteen method claims of the '756 patent read:

> 1. A method comprising extruding a spinning dope from an orifice through a layer of inert non-coagulating fluid into a coagulating bath, said dope comprising **a polyamide and a solvent consisting** essentially of sulfuric acid of at least 98% concentration, chlorosulfuric acid or **fluoroulfuric acid and mixtures thereof at a** concentration (C) of at least **30 grams of said polyamide per 100 ml. of solvent, said polyamide having an inherent viscosity of at least 2.0 but no less than 12.8-.05(C-30) and consisting essentially of recurring units selected from the** group:
>
> ɸ 0 (U) 2 2
> —N-r-m—
> ()E) 0 a
>
> **wherein units I and II, if present in the polyamide, are present in substantially equimolar amounts, R, R' and R" which may be the same or different, are divalent radicals, n may be zero or the integer one-, and at least about 95 mol percent of the total R, R' and R" radicals in the • polyamide consist of single rigid radicals with extended bonds or a series of such rigid radicals which are linked together** directly by **extended bonds with the proviso that rigid ring radicals may be linked by azo or azoxy groups.**

2. The method of claim 1 wherein the acid is sulfuric acid of at least 981 concentration.

3. The method of claim 2 wherein the polyamide has an inherent viscosity of at least 3.0 and is present at a concentration of at least 40 grams per 100 ml. of solvent.

4. The method of claim 2 wherein the polamide is poly (p-phenylene terephthalamide).

5. The method of claim 1 wherein the layer of fluid is between 0.1 and 10 cm. thick.

6. The method of claim 1 wherein the layer of fluid is a gas.

7. The method of claim 1 wherein the coagulating bath is at a temperature of under 50°C.

8. The method of claim 7 wherein the fluid layer is air and the coagulating bath is aqueous and at a temperature of 28°C, or lower.

9. The method of claim 1 wherein the rigid radicals are single ring or fused multi-ring aromatic carbocyclic or heterorydic radicals, trans-1, -cydohexylene 1, 4-12,2,21-bicyclo-octylene, vinylene or ethynylene.

10. A method comprising extrudincia spinning dope from an orifice through a layer of inert non-coagulating fluid into a coagulating bath, said dope comprising a polyamide and a solvent consisting essentially of sulfuric acid of at least 98% concentration, chlorosulfuric acid or fluorosulfuric acid and mixtures thereof at a concentration (C) of at least 30 grams of said polyamide per 100 ml. of solvent, said polyamide having an inherent viscosity of at least 2.0 but no less than (2.8 -.05 (C-30)1 and consisting essentially of recurring units selected from the group:

O 0 R a 0 R
-N-W-N-
a) (II)

wherein units I and 11, if present in the polyamide, are present in substantially equimolar amounts, R, R', R" may be the same or different divalent radicals, n may be zero or the integer one, and at least about 95 mol percent of the total R, R' and R" radicals in the polyamide are selected from the group of trans-1,4-cyclohexylene, 1,4-phenylene, 1,5-naphthylene, 2,5-pyridylene, 4,4'-biphenylene, trans(trans - 4,4' - bicyclohexylene radicals and 1,4-phenylene groups linked by trans-vinylene, ethynylene, azo or azoxy with the proviso that R may also be selected from trans-vinylene, ethynylene, trans, trans-1,4-butadienylene and 121
2,4'-trans-vinylenephenylene.

> 11. The process of claim 10 wherein at least 95 mole p-rcent of the total R, R' R" radicals are 1,4-phenylene radicals.
>
> 12. The method of claim 10 wherein the spinning dope passes from the orifice through a layer of gas and into an aqueous bath at a temperature of under 50°C. and wherein the polyamide has an inherent viscosity of at least 3.0 and is present at a concentration of at least 40 grams per 100 ml. of solvent.
>
> 13. The method of claim 12 wherein the polyamide is poly(p-phenylene terephthalamide) and the solvent is sulfuric acid of at least 98% concentration.

(CX-6, RX-57, col. 18 Is. 69-75, col. 19, Is. 1-44, col. 20, Is. 1-31).

The '756 Patent Specification

34. The '756 patent discloses that application Ser. No. 268,057 filed June 30, 1972 relates to a product which may be prepared by the "present process" (CX-6, RX-57, col. 1,. ls. **50-53). Ser. No. 268,057 issued, as U.S.** Letters Patent 3,869,429 on March **4**, **1975. It is entitled "High Strength** Polyamide Fibers and Films"and **the named inventor is Herbert Blades. The patent** on its face is assigned to **Du** Pont.

35. The '756 specification teaches that the **invention relates to an improved process for the preparation of fibers from certain polyamides and to novel spinning dopes.** The resulting fibers are said to be **useful in tire cords and for other applications.** (CX-6, RX-57, col. I, Is. 53-57).

36. Under the heading "Background of the Invention" it is stated:

> **The prior art U.S. Pat. 3,414,645 to Morgan teaches a dry-jet wet spinning process of extruding a solution of wholly aromatic polyamides through a gesous [sic] medium into a coagulating bath, followed by stretching in a wash liquid, washing, drying and hot drawing to produce filaments.**

> German Offen. 1,810,426 to xwolek teaches the use of certain optically anisotropic dopes of carbocyclic aromatic polyamides in wet spinning processes to afford fibers of good strength as-spun, i.e, without a drawing process. A heat treatment with tension raises the strength to higher values. It is a desirable objective to prepare aromatic polyamide fibers of higher as-spun strength.

(CX-6, RX-57, col. 1, is. 58-72).

37. The invention is summarized as follows:

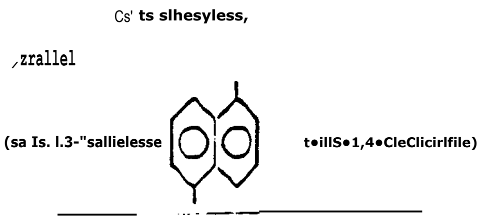
> The invention involves the process of extruding a dope of a hereinafter described nature from an orifice through a layer of an inert non-coagulating fluid into a coagulating bath to form fibers or films. The dope comprises a polyamide as specified below in a solvent consisting essentially of sulfuric acid of at least 98% concentration, chlorosulfuric acid or fluorosulfuric acid and mixtures of these acids at a concentration of at least 30 grams and preferably at least 40 grams of such polyamide per 100 ml. of solvent.
>
> The processes of this invention can provide as-spun fibers having a filament tenacity of at least 15 grams per denier and a modulus of at least 300 grams per denier. Preferred conditions afford as-spun filaments of at least 20 grams per denier.

(CX-6, RX-57, col. 2, Is. 3-17).

38. Under the heading "Detailed description of the drawing" it is explained that as shown in FIG. 1, "the spin dope is pumped through transfer lines 1 through a spinning block 2, through the orifices of a spinneret 3 through the layer of gas 5 and into a coagulating liquid 6 where the filaments 4 are conducted under guides 7 and 8 and strong as-spun yarn 15 is wound up on a rotating bobbin 9" (Cx-6 , RX-57 at col. 2, Is. 30-35). It is further explained that FIG. 2 "shows a modification whereby the extruded filaments 4 are forwarded through the coagulating liquid 6 that is flowing from container 11 through spin tube 10 to container 12 from whence the liquid is returned by pump 13 and tube 14 to container 11. The filaments are conducted under guide 7 and strong as-spun yarn 15 is wound on rotating bobbin 9." (CX-6, RX-57 col. 2, Is. 36-42).

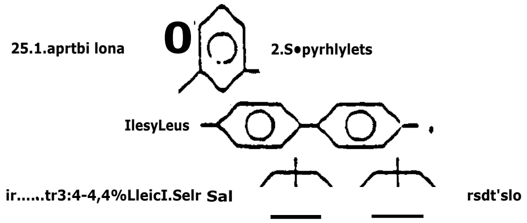
39. Under the heading "Description of the Preferred Embodiments" and the subheading "Suitable polyamides" it is stated:

> The Linear condensation polymers employed in the present invention consist essentially of recurring units selected from the group:
>
> 0 o 7 R o
>
> and —4:-11"-14.-.
>
> cu) Umr)
>
> wherein units I and II, if present in the polymer, are present in substantially equimolar amounts, R, R' and K" which may be the same or different are divalent radicals. n may be zero or the integer one, and at least about 95 mol percent of the total R, R' and R" radicals in the polymer consist of single rigid radicals which are linked together directly be extended bonds. In addition, azo--N=N-- and azoxy
>
> 0
>
> radicals can serve to link two rigid ring radicals. Thus, the essential portion of the polymer consists of polyamide units (including polyoxamide units when n is zero), which provide stiff chains. .
>
> fly the expression s'rigil radicals" is meant (a) the ring 'radicals: single ring or fused multi-ring aromatic carboyclic or heterocyclic radicals, trans-1,4-cyclohexylene
>
> <1>
>
> and 1,412,2,21-bicyclo-octylene and (b) the linear unsaturated radicals: vinylene
>
> and ethylene --C=C--. It will be understood that monomers containing amino groups directly attached to linear unsaturated radicals are not stable and hence vinylene or ethylnylene cannot serve as R' or that portion of a R" radicals attached to
>
> a
>
> By the expression "extended bonds" is meant chain - extending bonds of the radical (as determined by the true bond angles) which are essentially coaxial

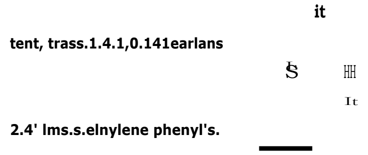


and oppositely directed. These polymer structures additionally have the charadteristic of forming anisotropic or liquid crystalline phases when mixed with certain strong protonic acid solvents, as will be discussed in greater dntail in a later section.

Preferred radicals with extended bonds suitable for R, R' and R" are trans-1,4-cyclohexylene, 1,4-phenylene, 1,5-naphthylene,



and 1,4-phenylene groups liMked by trans-vinylenn, ethynylene, azn or azoxy. In addition, R may hn trnhs-vinylene, ethynylmnn,



The latter may also serve as R.

R,R' and R" are intended to include substituted and/or unsubstituted radicals. The substitutes, if any, should preferably be nonreactive (e.g., thermally). Such reactivity may be unietsirable in that it may cause branching and cross-linking of the polymer and may adversely affect the dope and/or fiber properties. Among the preferred nonreactive substituents may be named halogens (e.g., chlnro, bromo and fluoro), lower alkyl (e.g., methyl, ethyl and isopropyl), methoxy, cyano, and nitro. Other suitable substituents will be evident to those skilled in the art and are contemplated herein. Generally, it is preferred that no more than two (•nr! more preferably no more than one) suitable substituents be present per single radical. Preferably no more than 20 mol percent of the total R, R' and R" radicals in the polymer should he substituted R".

A preferred class of the polyMers of the group described above are those polyamides (n being the integer one) wherein at least 50 mol percent of the total of R, R' and R" radicals are wholly aromatic. A more preferred class of these polymers are those polyamides wherein R and R' are selected from the group 1,4-phenylene, 4,4"-biphenylene, 2-5-naphthylene, 2,5-pyridylene, trans-vinylene and trans 1,^{3}-cycloexylene and R" is 1,4-phenylene "ith the proviso

> that at least 50 mol percent of either R or R' radicals are 1,4-phenylene.
>
> The chains of the linear condensation polymers of the group described above may include up to about 5% (mol basis) of radicals not conforming to the the above cited description, e.g, not having extended bonds or non-rigid. It is to be understood that these non-conforming radicals differ in their effect on the properties of the spun fibers. Thus, rigid radicals such as m-phenylene, whose chain extending bonds are neither coaxial nor parallel and oppositely directed, and highly flexible radicals such as hexamethylene and decamethylene will ordinarily be used in small proportions, whereas radicals such as 4,4'-bibenzylene may be used in Larger amounts, even exceeding 5% while still obtaining substantial benefit from practice of the invention. While it is not preferred, a small proportion of the amide units in the linear condensation polymer chain may be replaced, if desired, by other stable non-amide-forming units, e.g., ester-forming units or urea or sulfonamide-forming units. In general, such products are more difficult to prepare and are more restricted in their utility.
>
> The polymer to be spun may be a homopolymer, random copolymer, ordered copolymer or blend of homopolymers and/or copolymers of the above description, as may contain additives such as dyes, delusterant, antioxidants, etc.
> Among the suitable polyamides may be named:
> poly(p-phenylene terephthalamide) (hereafter PPD-T);
> poly(p-phenylene p,p'-biphenydicarboxamide);
> poly(p-phenylene 1,5-napththalenedicarboxamide);
> poly(trans, trans-4,4'-dodecahydrobiphenylene terephthalamide);
> poly(trans, 1,4-cinnanamide);
> poly(p-phenylene 4,8-guinolinedicarboxamide);
> poly (1,4 - 12.2.21 - bicyclo-octylene terephthalamide)
> copoly(p-phenylene 4,4'-azoxybenzenedicarboxamide/ terephthalamide);
> poly(p-phyenylene 4,4'-trans-stilbenedicarboxamide) and
> poly(p-phenylene acetylenedicarboxamide). (Emphasis added)

(CX-6, RX-57, col. 2, Is. 49-72, col. 3, col. 4, Is. 155).

40. In the 756 patent specification under the heading "Description of the Preferred Embodiment" and the subheading "Preparation of polyamides "it is stated:

> The polymers for use in this process are conveniently made by reacting suitable meonmers in the presence of an amide type solvent by low temperature techniques as taught in U.S. Pat. 3,063,966 to Kwolek et al. In order to obtain high molecular weight polymers the monomers and solvent should contain a minimum of impurities and the water content of the total reaction mixture should be less than 0.03% by weight.
>
> Poly(p-phenylene terephthalamide) is conveniently made by dissolving 1728 parts of p-phenylenediamine in a mixture of 15,200 parts of hexamethylphosphoramide and 30,400 parts of N-methylpyrolidone, cooling to 15°C, in a polymer kettle blanketed with nitrogen and then adding 3243 parts of powdered terephthaloyl chloride with rapid stirring. The solution gels and turns into a dry crumb-like material in 3 to 4 minutes. The stirring is continued for 1.5 hours when possible with cooling to keep the product temperature at about 25°C. The polymerization is essentially quantitative and the final reaction mixture contains 7.5% polymer of about 5.5 inherent viscosity (hereinafter I.V.). The I.V. of the polymer from this system can be controlled by the ratio of monomer to solvent. Reduction of the amount of monomer from 9.83% above to 8.64% gives a reaction mixture containing 6.5% polymer of 6.0 I.V. The use of about 11.7% of monomers gives a reaction mixture of 9.0% polymer of 2.5 I.V.
>
> The crumb-like acidic product is vigorously stirred or ground with water in a waring Blendor or a colloid mill and the resulting polymer slurry filtered. The wet polymer is further washed by reslurrying with soft water to remove solvent and HCI and collected on a filter. This slurrying and filtering is repeated about four times in sequence followed by a final wash with distilled water. To aid in neutralization, one of the soft water washes may also contain sodium carbonate or hydroxide. The polymer is then dried at 120-140° C.
>
> Polymerizations can also be carried out by the continuous mixing of the monomers.

(CX-6, RX-57, col. 4, Is. 57-75, col. 5, ls. 1-21).

41. The '756 patent specification discloses that the spinning solvents consist essentially of sulfuric acid of at least 98% concentration, chlorosulfuric acid, fliorosulfuric acid, and mixtures of these acids, and

that the sulfuric acid may be of greater than 100% concentration, i.e, fuming sulfuric acid. Sulfuric acid at a concentration 0:: about 99.8% is said to be preferred. Although higher concentrations may be used, the presence of excess sulfur trioxide is said to degrade the polymer causing a reduction in the inherent viscosity and this it is stated could cause loss of filament tenacity. The degradation is said to be time and temperature dependent so that if fuming sulfuric is used, the exposure time at elevated temperatures should he kept to a minimum. The definition of suitable solvents was not intended to preclude the presence of certain additives. Thus hydrofluoric acid, halogenated alkylsulfonic acids, halogenated aromatic sulfonic acids, halogenated acetic acids, halogenated lower alkyl alcohols, and halogenated ketones or aldehydes ordinarily can be said to be present in an amount up to about 30% of the total weight of the solvent and additive. It is said that the exact amount of additive that may be present will depend upon the particular solvent-polymer combination that is employed. The use of rliorosulfuric (rather than sulfuric) acid, or lower polymer concentrations is said to permit the use of a greater amount of an additive. In general, it is said that the greater the percent of halogen present in the additive, the grrl'ater the amount of additive that can be used up to the limit of phase separation. It is stated that trifluoromethanesulEonic acid can ordinarily be present ir ar amount equal to the weight of the above s▯lfuric acids. Additionally sL.7: ˙nes, t'orinated phenols and niLroberzc ,-, can be used as a solvent _ 'esser amounts than the halogenated additives described above. (CX-6, RX-=7, col. 5, Is. 24-56).

42. Under the heading "Description of the Preferred Embodiments" and the subheading "Preparation of dopes" it is stated:

> The water content of the dope should be carefully controlled to be less than 2%. Excessive water can interfere with the formation of dopes suitable for spinning and also lead to excessive degradation of the polymer. The relatively dry polymer (preferably less than 1% water) should be mixed with a "dry" solvent under conditions minimizing exposure to atmospheric moisture and the dope stored under a dry atmosphere.
>
> The dopes should be mixed and held during the spinning process at as low a temperature as is practical to keep them liquid in order to reduce degradation of the polymer resulting in the lower I.V. values. Exposures to temperatures over about 90° C. should be minimized.
>
> A particularly useful method is to continuously prepare the dope and feed directly to the spinnerets, thus minimizing the holding time. (CX-6, RX-57, col. 5, Is. 57-73).

43. Under the heading "Description of the Preferred Embodiments" and subheading "Preparation of dopes" it is said that the concentration (C) of the dope is defined herein as grams of polyamide per 100 ml. of solvent at 25 ° C. The term "solvent" is meant the actual sulfuric acid plus any solvent-additive present. It is said that at lest 30 grams of polymer per 100 ml. of solvent should be employed. Preferred dopes for the instant spinning process is said to employ between 40 and 56 grams of poly(p-phenylene terephthalamide) (PPD-T) having an **I.V. of at least 3.0 per 100** ml. of acid. This amounts to between about 18 and 23.4 weight percent of polymer in the acid dopes. **(CX-6, RX-57, col. 4, 1.** 43, col. 6, ls. 4-13).

44. The '756 patent specification states that:

> In the present invention it is useful to use as high dope concentration as possible. **It has been found in general that the tenacity of the fibers produced increases with the**

> concentration of the dope from which they were spun. Dopes of useful concentrations are solid at room temperature and melt to spinable liquids when the temperature is raised. Increasing temperature causes polymer degradation as shown by loss in I.V.
>
> It is desirable that the extrusion of a dope result in a fiber with an I.V. of at least 2.0 preferably at least 3.0.A given fiber I.V. can be obtained by starting with a polymer of a moderate I.V. and processing to keep degradation to a minimum or by starting with a higher I.V. and processing for more severe degradation. For purposes of the present invention, the I.V. of the polymer in the as-spun fiber (assuming appropriate washing and drying to prevent undue degradation) is taken as the I.V. of the polymer in the dope as it is extruded. Thus, the I.V. of the dope as it is extruded should be at least 2.0 and should be no less than [2.8-.05 (C-30)1 where (C) is as defined above.
>
> The spin dopes of the present invention posses unexpected stability. It appears that the "activity" of the sulfuric acid is reduced by the presence of high concentrations of the stiff chain polyamides. Dopes are made of PPD-T polymer of 4.88 I.V. in sulfuric acid (100%) at concentrations of 46, 21.3 and 3.7 g./100 ml. The dopes are heated for 3 hours at 100° C. Polymer isolated from the heated solutions has an L.V. of 4.2, 2.8 and 1.9 respectively. Further evidence for reduced "acidity" of the concentrated dopes is the fact that PPD-T dopes of 46 g./L00 ml. are substantially non-reactive with aluminum metal at 70-80° C whereas dopes of 25 g./100 ml. concentration react vigorously. (Cx-6, RX-57, col. 6, Is. 38-72).

45. The '756 patent specification disclosed that the dopes or polymer-solvent system used in the claimed process behave much like polymer melts; that a typical dope of 46 grams of PPD-T of about 4 I.V. in 100 ml. of 100% sulfuric acid may have a bulk viscosity of about 900 posies of 105° C which increases on cooling to about 1000 poises at 80° C and then rapidly increases upon further cooling until the dope solidifies to an opaque solid below about 70° C. It is said that the bulk viscosity increases with higher inherent viscosities at a given concentration and temperature. (CX-6, RY $^{-57}$, col. 7, Is. 1-10).

45(a). The '756 patent specification discloses that dopes containing about 49 grams of PPD-T per 100 ml. of sulfuric acid represent the highest concentration that can be handled in the conventional mixers, transfer lines and spinning equipment due to the extremely high bulk viscosity of mixes. It is said that when the usual technique of lowering the viscosity by 130 raising the temperature is used, excessive egradation of the polymer occurs and that the use of more effective mixes will permit the use of higher concentrations. The viscosities at high concentrations are said to be a function of the polymer - solvent system used. For example when poly-(chloro-p-phenylene terephthalamide) of 4.1 I.V. was used, a 23.11 weight percent dope can be employed. (CX-6, RX-57, col. 7, Is. 13-15).

46. The '756 patent specification discloses that in general dopes can be extruded at any temperatures from the lowest at which they aresufficiently fluid to be handled up to about 120° C; that since the amount of degradation is dependent upon the time and temperature, temperatures as low as practical should be used, preferably below 90° C; and that if higher temperatures are desired for any reason, the equipment should be designed so that the exposure time of the dope to the elevated temperature is kept at a minimum. (CX-6, RX-57, col. 7, -Is. 26-37).

47. The '756 patent specification discloses that the spinning dopes of the invention are unusual. Thus it is said at room temperature most are solid; as the temperature is raised they melt, becoming less viscous and translucent to transparent. It is said that they are optically anisotropic i.e, microscopic regions of a given dope being birefringent; a bulk dope sample is said to depolarize plane polarized light because the Light transmission properties of the microscopic areas of the dope vary with direction. This characteristic is said to be associated with the existence of at least part of the dope in the liquid crystalline or mesomorphic state. These dopes are said to exhibit anisotrophy while in the relaxed state. (CX-6, RX-57, col. 7, Is. 35-46).

48. The '756 patent specification discloses:

> For a well mixed dope of given composition and concentration, the temperature at which melting occurs is fairly reproducible and reversible. This melting behavior is accompanied by an absorption of heat as indicated by differential thermal analysis. **The melting temperature of**

> solidified dopes can also be determined by measuring the intensity of polarized light passing through a thin sample and a 90° crossed analyzer as the temperature is raised. The melting temperature is that temperature at which thetransmitted light intensity increases rapidly. In general, the melting temperature increases as the concentration increases. For example, PPD-T/sulfuric acid dopes of 32, 40 and 46 g./100 ml. acid show melting temperatures of 40-50° C, 63-65° C and 72-82° C, respectively. A dope that is incompletely mixed and has a distribution of phases of different concentration will have a broadened melting range.
>
> As the temperature of a molten, anisotropic dope is increased, a point is reached at which the amount of anisotropic phase begins to decrease. This temperature (T_a) can be determined by a measurement of the change in the scattering of polarized light at small angles (e.g. 1°) on passing through a thin layer of dope. Ta increase with the concentration of the polymer, e.g., for PPD-T/H2SO4 dopes of 32,40 and 46 g./100 ml. concentration T_a values are found to be about 80-100° C, 82-135° C and 110 to 122° C, respectively. Even above these temperatures the dopes are largely anisotropic and give good results in the present process, but highest tenacity fibers will be obtained by the spinning of dopes at temperatures above the melting point and below T_a. (CX-6, RX-57, col. 7 Is. 47-75, col. 8, ls. 1-2).

49. The '756 patent specification under the subheading "Extrusion conditions" (CX-6, col. 8, 1. 4-col. 9, 1. 57), disclose that the spin conditions for fibers are discussed in the subsections "Spinnerets" (col. 8, Is. 9-23), "Jet velocity " (col. 8 is. 24-33), "Spin stretch factor" (col. 8, Is. 34-49), "Fluid layer" (col. 8, ls. 50-56), "Spin tube and guides")col. 8, ls. 57-65), "Coagulating bath" (col. 8, 1. 66 - col. 9m 1. 9), "Washing" (col. 9, Is. 10-33), "Drying" (col. 9, ls. 34-41) and "Heat treatment" (col. 9, Is. 42-57).

50.. Ih the '756 patent specification in the subsection "Spinnerets", it is stated that the diameters of the holes (orifices) and the ratio of the length of the capillary/diameter of the hole (L/D) in the spinneret are not critical. Strong fibers have been obtained with round orifices ranging from 1.0 to 10 mils (0.025 to 0. 25 mm.) diameter and having a L/D ratio of from. 1.0 to 8.3. The process is also operable with non-round holes of various shapes. The spacing of the holes is not critical. (CX-6. RX-57, col. 8, ls. 9-23).

51. The '756 patent specification in the subsection "Jet velocity", states that the jet velocity (the average velocity of the dope in the spinneret capillary as calculated from to volume of dope passing through an orifice per unit time and from the cross-sectional area of the orifice) may range from 17 feet/minute (f.p.m.) (5.1 meters/ min.) or lower to 1150 f.p.m. (350 meters/min.) or higher. The minimum value for a given dope and orifice is determined by the ability of the dope to jet continuously and cleanly. The smaller diameter orifices will display a higher minimum jet velocity than larger orifices. (CX-6, RX-57 col. 8, ls. 24-33).

52. The '756 patent specification, in the subsection "Spin stretch factor", states that the spin stretch factor (SSF) is "the ratio of the velocity of the fiber as it Leaves the coagulating bath to the jet velocity. Spin stretch factors of as low as 1.0 or lower and as high as 14 or more can be used. The minimum spin stretch factor to be used with a particular spinning dope and orifice is determined by the ability to form a filament of relatively uniform denier and the desired physical properties. The maximum useful spin stretch factor is limited by filament breakage in the process. In general, increasing the spin stretch factor from a low value at a given jet velocity affords fibers with higher tenacities and moduli and lower elongations and denier. It is said that one skilled in spinning will readily adjust orifice diameter, thickness of the gas layer, jet velocity and spin stretch factor for a given spinning dope and apparatus to obtain a fiber of the desired denier and physical properties." (CX-6, RX-57 col. 8 Ls. 34-49).

53. The '756 patent specification in the subsection "Fluid layer", states that "it is essential that the spinneret face be 'separated from the coagulating batch by a fluid layer of gas or a non-coagulating liquid such as toluene, heptane, etc. The thickness of the fluid layer can vary from 0.1 to 10 cm. or more and preferably is from about 0.5 to 2 cm. thick. Use of larger thicknesses increases the opportunity for adjacent filaments to fuse together." (CX-6, RX-57 col. 8, Is. 50-56).

54. The '756 patent specification in the subsection "Spin tube and guides", states that the "configuration of the spin tube 10 and the character of the guide 7 in FIG. 2 can affect the elongation and modulus in the as-spun yarn. At the same jet velocity and windup speeds, a straight tube generally produces higher yarn elongation and lower modulus than a tube constricted at its lower end. Similarily, a roller guide generally produces higher yarn elongation than a snubbing pin. - Useful spin tube dimensions will vary with spinning speeds and yarn denier." (CX-6, RX-57 col. 3, Is. 57-65).

55. The '756 patent specification in the subsection "Coagulating bath", states that a "variety of baths may be used to coagulate the fiber. Satisfactory results have been obtained with both aqueous and non-aqueous systems. Useful aqueous systems have ranged from pure water to systems containing high concentrations of sulfuric acid (70%), ammonium hydroxide, or salts such as calcium chloride, potassium carbonate or sodium chloride. Aqueous baths containing water miscible organic solvents such as methanol, and ethylene glycol are also useful. Examples of non-aqueous coagulation baths include 100% methanol and methylene chloride solutions containing 5 to 50% of methanol, N,N'-dimethyloformamide or N,N'-dimethylacetamide. Bait,

temperatures ranging. from -25°C. to 28°C. have been satisfactory. It is considered that a wide variety of coagulants can be used at temperatures from subzero to 50°C. or more. Preferably the temperature of the bath is kept below 10°C. (more preferably below 5°C.) in order to obtain the highest tenacity in the filaments." (CX-6, Rx-57, col. 8, 1. 66- col. 9, 1. 9).

56. The '756 patent specification under the heading "Description of the Preferred Embodiments" and subheading "Extrusion conditions" states:

> Washing: Due to the degrading effects of even small amounts of acid in the yarn, complete removal of the acid is very important in obtaining high tenacity fibers. Water alone or combinations of alkaline solutions and water may be used for its removal.
>
> A convenient method is to spray the thread line as it leaves the coagulating bath with an aqueous alkaline solution (e.g. saturated $NaHCO3$ or 0.05 N NaOH), remove surface liquid from the thread line with a wiping device (e.g. a sponge) or a jet, wash with water (ca. 75° C.) to reduce the acid content to about 1% '(on a dry fiber basis) and wind up on bobbins. Such bobbins can be stored for short periods (up to about 24 hours) in water or dilute alkaline solution before the final wash. Preferably the final wash (e.g. with 75° C. water) should reduce the acid or base content below 0.01% (on a dry basis).
>
> While small amounts of yarn can be washed and neutralized on the bobbin, it is preferred that the yarn be washed as such in thin Layers in flumes, on rolls with overhead sprays, on screens, belts or the like. In a continuous process the thread line can be washed and neutralized continuously at the same speed as the thread line at any point between spinning and wind up.
>
> Drying: The thoroughly washed fibers can be dried on the bobbin with air at up to 150° C. The fibers can conveniently be dried on heated rolls (e.g. 160° C.) If the fibers are dried while under a tension of less than about 0.3 g.p.d. which is a preferred method, the properties are not significantly changed. The use of tensions above 0.3 g.p.d., reduces the elongation and increases the modulus from that obtained by tensionless drying.
>
> Heat treatment: The properties of the as-spun yarns can

> be altered by a heat treatment. Heating a yarn under tension, preferably in an inert atmosphere, at temperatures of 150° C to 550° C. increases the yarn modules from about IS to 100% and reduces the yarn elongation by about 50%. The modulus increase is greater with increasing tension and temperature. Typical tensions and times of exposure used at 150^{01} C. are 550°C are 0.5 to 2 g.p.d. for 1 to 6 seconds. At low and intermediate temperatures, the yarn tenacity is not significantly changed, but it may be reduced after treatment at 450°C or more. (CX-6, RX-57, col. 9, Is. 10-53).

57. The '756 patent specification describes test procedures for determining the properties of the fibers made by the '756 process including tenacity, modulus and elongation as well as the methods for calculating inherent viscosity in sulfuric acid and determining denier. (CX-6, P.X-57 col. 9, 1. 58 col. 10, 1. 50).

58. The examples of the '756 patent specification directed to PPD-T, spun from highly concentrated sulfuric acid are Examples I, II, III(d). VI, VII, and VIII). The '756 patent specification also contains examples of co-polymers (Examples IV, V) as well as the use of highly concentrated halogen-modified sulfuric acid as a solvent and various additives to I_2SO_4 solvent Examples III (a)-(c), (e)-(n)). (Uhlmann, CX-835 p. 10; CX-6, RX-57).

59. Example I(A) of the '756 patent specification sets forth the Blades' invention as he performed it for the first time on April 16, 1970 utilizing his twin cylinder device to mix and spin while applying heat to the high concentration PPD-T/sulfuric acid spinning dope (i.e., 20% PPD-T by weight). (Blades, Tr. p. 794, 1. 16 p. 798, 1. 17; CX-380 pp. 41-43).

that Example I(A), PPD-T of 4.4 I.V. is initially "mixed in a beaker with sulfuric acid (100.24 H_2SO_4) in the ratio of 46 grams of polymer per 100 ml. of acid (20% PPD-T *by* weight). The crude mixture of dough-like consistency is transferred to a mixing device consisting of two open top cylinders (each of about 250 ml. capacity) connected by a base block. Each cylinder has a hole in its base above a filter pack (3-50 mesh screens/1-325 mesh screen 3-50 mesh screens, mesh/inch (mesh/2.54 cm.)) in the base block which leads to a passage in the block to the other filter pack and cylinder. The mixing device is fitted to a pair of pistons which closely fit each cylinder. A small hole in each piston is opened for the initial filling by each piston to insure the removal of air and then closed. A water bath at about 95°C is placed around the mixing device. After about 1 to 2 hours the polymer-solvent mixture is pushed by th positions from one cylinder to the other for a total of about 15 cycles. With all of the mixture (now a dope) in one cylinder (and the connecting passage), the mixing device is connected through a hole (previously plugged) in the base block leading to the connecting passage by a length'of copper tubing in the shape of a goose neck to an electrically heated spinning block having a polypropylene felt filer and a 0.5 in. diameter spinneret with 20 holes of 2 mil (0.05 mm.) diameter. The 95°C. water bath is replaced around the mixing device and the copper tubing. The short length of this tubing between the water bath and the spinning block (101°C) is insulated with glass wool. The spinning block is positioned (FIG. 1) so that the face of the spinneret is inclined at about 45° to the surface of a coagulating bath of 15°C water with the lower edge of the spinneret being about 2 cm. above the surface of the water. The dope is extruded from the spinneret at a *jet* vel)city of 240 feet/minute (f.p.m.) (73 meters/minute; m.p.m.), through air into the coagulating bath, under a pin near the bottom of a bath and then under a second pin and out of the batch to a windup bobbin to give a SSF of 2.17. The fibers are washed free of acid with water, and air dried. The filaments of 3.8 d.p.f. have a tenacity of 18 gpd. an elongation of 3.9%, an initial modulus of 520 gpd and an I.V. of 4.1" (CX-6, RX-57 col. 1 . 10 1. 54- col. 11, 1. 21).

60. Example I(D) of the '756 patent specifications describes the Blades process using apparatus similar to FIG. 2 where a spinning dope of 20% PPD-T of 5.4 inherent viscosity in 99.7% sulfuric acid is spun into fibers having an as-spun tenacity of 26 grams per denier. (CX-6, RX-57 ol. 1, Is. 22-51).

61. Remaining Example II-/X of the '756 patent specification described the followup work done by Du Pont to spin fibers from PPD-T as well as from other polyamides and copolymers. Thus in Example Ii, various spinning dopes of 20% PPD-T in sulfuric acid varying in strength from 99 to 100% were spun into fibers. The inherent viscosity of the PPD-T varied from 4.8 to 6.0 and as-spun tennacities ranged from 15, 18, 21.2, 22.8, 24 and 24.3 gpd (CX-6. Rx-57 col. 11, 1. 55- col. 13, 1. 6). Example III describes the spinning of dopes of 16-22% PPD-T having an inherent viscosity of 4.6 and 5.4 in various solvents including 100% sulfuric acid, halogenated sulfuric acid, mixtures thereof and those solvents containing various additives. The as-spun filament tenacities ranged from 14 to 27 gpd. (CX-6, RX-57 col. 13 Is. 10-50 and Table I). Example IV describes the spinning of dopes of 20% polyamide in an acid solvent of sulfuric acid of 99.7 to 100.01 strength or mixtures thereof with fluorosulfuric acid. Also a dope containing 56 p of polymer per 100 ml. of sulfuric acid is used (23.4 weight percent). Various polyamides are used and the as-spun tenacities obtained range from 15 to 24 gpd. (CX-6, RX-57 col.

14, 1. 1-cal. 15, 1. 2 and Tables II and III). Example V(a) describes the preparation of the ordered co-polymer poly(4,4'-diaminobenzanilide terephthalamide) or "4,4' -DART" (CX-6, RX-57 col. 15, Is. 49-57) and the preparation and spinning of a 20% dope of that co-polymer in sulfuric acid of 99-100% strength to produce filaments with an as-spun tenacity of 17 gpd (CX-6, RX-57 col. 16, Is. 53-75). Examples V(b) and (c) describe the preparation of random co-polymers (p-benzamide/PPD-T 25/75) and (p-benzamile/chloro-PPD-T 75-25), respectively (CX-6, RX-57 col. 15, 1. 58-col. 16, 1. 2) and the preparation and spinning of a 20% dope of those co-polymers in sulfuric acid of 99-100% strength to produce filaments with as-spun tenacities of 32 and 23 gpd, respectively. In Example V(c), this is disclosed the preparation and extrusion of•a spinning dope at a temperature at 37°C. (CX-6, RX-57, col. 16, Is. 53-75). Example V(d) describes the preparation of a homoplymer polyp-benzamide) and the preparation and spinning of an 18% dope of that polymer in 99-100% sulfuric acid to produce filaments with an as-spun tenacity of 19 gpd. (CX-, RX-57, col. 16 Is. 45-75). Example VI describes the spinning of a 20 percent PPD-T solution in sulfuric acid of 99.7 - 100% strength. The inherent viscosity of the starting PPD-T was varied in addition to variations in the spinning temperature, coagulation bath temperature, polymer concentration, denier and spin stretch factor. The as-spun filament tenacities obtained ranged from 16 to 25 grams per denier (CX-6, RX-57, col.. 17, Is. 1-49, Table V). Example VII describes the spinning of a dope of 20% PPT-T in 99+% sulfuric acid having an inherent viscosity of 5.2 at different extrusion temperatures with resultant tenanities of fiber being from 11 at extrusion temperature of 115-120° to 19, 22 and 24 at lower extrusion temperatures. (CX-6, RX-57 col. 17, 1. 69 to col. 18, 1. 15). Example VIII describes the spinning of a dope of 14% PPD-T in 99-100%

sulfuric acid. The PPD-T I.V. was 5.2 and the as-spun filament tenacities with various dope extrusion temperatures ranged from 15 to 18 gpd. (CX-6. RX-57 col. 18, Is. 17-29). Example IX describes the spinning of a dope of a blend of 30 grams of 5.4 I.V. PPD-T and 5 grams of a 1.16 I.V. poly(m-phenylene isophthalamide) in an equal weight blend of flurosulfuric acid and sulfuric acid. The resulting as-spun filament tenacity was 23 gpd; when the PPD-T was eliminated from the polymer blend, the resulting as-spun filament tenacity was only 1.8 gpd. (CX-6, RX-57, col. 18, Is. 31-49).

(61(a). The prefered polymeric polyamide of the '756 patent specification, viz., polyp-phenylene terephtalamide has a para-positioned aromatic ring. Nearly all synthetic polymers (including nylon polyamide) have flexible claims. However, the introduction of aromatic rings in the polymer backbone serves to decrease the flexibility of the claims. When these rings are introduced in the meta or ortho position, the claims are still substantially flexible. However, when the aromatic rings are introduced in the polymer backbone in the para position, the result is a marked decrease in chain flexibility. When the polymer consists entirely of para-positioned aromatic rings, as in poly(p-phenyleneterephthalamide) the chains can be regarded as almost ideally rigid. If the backbone contains other moieties besides aromatic ring structures, such as the amide linkages in the preferred poly(p-phenyleneterephthalamide) (PPD-T) set for th i the '756 patent specification, the chains while much more rigid than their meta-positioned analogues, rtain some modest degree of flexibility. In appropriate solvents, they act as considerabLyrigid molecules. (Uhlmann, CX-835, pp. 6-7).

61(b). Besides affecting chain stiffness, the change from meta-positioned to para-positioned aromatic rings has a profound effect on solubility; that for example, while the meta-positioned poly(m-phenylene isophthalamide) is highly soluble in dimethylacetamide Cacl $_2$, and is spun commercially from such solutions containing about 161 polymer, the para-positioned PPD-T of comparable molecular weight is effectively insoluble inthis solvent; that the change from meta-positioned to para-positioned aromatic polyamides, and its accompanying effect on chain stiffness, has another dramatic effect on solution behavior; that the meta-positioned polymers from isotropic solutions at all concentrations of polymer; that in contrast, with the para-positioned PPD-T, anisotropic solutions can be formed above a critical concentration; that an isotropic solutions contain liquid crystalline domains, while isotropic solutions do not; that within each liquid crystalline domain, the molecules are aligned in a given direction, but the direction of alignment is different in different domains; and that such anisotropic solutions exhibit pronunces optical birefringence. (Uhlmann, CX-835, p. 8).

62. Dr. Robert B. Davis, a technical expert of respondents, took the mathematical formula set forth in claims 1 and 10 of the '756 patent which reads, with respect to the inherent viscosity of the polymer in the spinning dope, as follows: "at least 2.0 but no less than [2.8-0.5 (30)1" and suhstituted various values for ^{R}C" (concentration of polymer in grams/100 ml of solvent) to show the relatively slight difference a change in polymer concentration ("C") makes an inherent viscosity. He arrived at the following:

'756 Patent	g polymer/ 100 ml. 98% H2SO4	polymer wet. %	min. inherent viscosity
claims 1.10	30	14%	2.8%
claims 3, 12	40	18%	2.3%
Ex. IV (col. 7, 1. 25)	56	23%	2.0%

(Davis RX-2, p. 9 and Annex B; CX-6

V. PPOSECUTION OF THE '756 PATENT

Ser. No. 138,210

63. On April 28, 1971, inventor Blades filed application Ser. No. 138,210 containing ten method claims and one claim to a spinning dope (RX-161, pp. 37-39).

64. On March 29, 1972, the Patent Office required restriction between the ten method claims and one composition of matter claims. Election of the method claims was made by telephone. The Examiner rejected all the method claims under 35 U.S.0 103 over U.S. Patent No. 3,414, 645 Monsanto's (Morgan '645 patent) extensively relied on by Akzo in this proceeding taken with U.S. Patent Nos. 3,558, 763 (Quynm et al. '763 patent) or 3,574,811 (Jamison '811 patent). The Morgan '645 patent was brought to the attention of the Examiner by Du Pont on page 2 of Ser. No. 138,210 wherein Du Pont disclosed to the Examiner that Morgan teaches a dry ject-wet spinning process. It was said that the Morgan '645 patent (5 in FIG. 1, col. 3, 1. 13, col. 4, Is. 1-4) discloses dry-jet wet spinning of applicant's polymer solution in concentrated sulfuric acid or TPA or mixtures thereof; that each of the Quynn et al '763 patent (col. 5, ls. 24-29, col. 3, Is. 55-60) and the Jamison '811 patent (col. 6, Is. 6-12, col. 5, is. 63-74) discloses similar solutions and

wet spinning steps. Claims 1-10 were also rejected under 35 U.S. 103 over the Morgan '645 patent taken with commonly assigned application Ser. No. 827,345 or Ser. No. 60,550. It was said that each of the applications disclosed applicant's spinning compositions. Since the '645 patent and the commonly assigned application applicants are directed to the same polyamides, the Examiner considered it obvious to employ such compositions in a dry-jet wet spinning process as taught by the Morgan '645 patent. The Examiner also stated that the claims should be patentably distinct among Ser. Nos. 827,345; 60,550; 172,515; and 138,210. U.S. Patent No. 2,425,782, No. 2,463,676, No. 3,412,191 and No. 3,636,187 were cited to show similar air-gap spinning processes and U.S. Patent No. 3,600, 350 (col. 15, is. 34-42) to show similar polymer and similar jet spinning process. (RX-161 pp. 46-47).

65. On July 28, 1972, applicant filed an express abandonment of Ser. No. 38,210 in favor of a continuation-in-part application Ser. No. 172,515 filed August 17, 1971. (RX-161, p. 52).

<u>Ser. No. 172,515</u>

66. On August 18, 1971, inventor Blades filed application Ser. No. 172,515 containing thirteen method claims and one composition of matter claim. (RX-162, pp. 1-44).

67. In a Patent Office action dated April 12, '1972i restriction was required between the thirteen method claims and one composition of matter claim.- Applicant elected, by telephone, the method claims. The Exabiner in the same office action repeated the rejection made in his office actioi›Cka

March 29, 1972 in Ser. No. 138,210. (11X-162, pp. 50-52).

68. in a preliminary amendment, reference was made to a telephone conversation between the Examiner and the attorney in which the Examiner suggested that it would be helpful to obtain a listing of patents other than those cited in the specification, that could provide further background for the consideration of the present invention. Accordingly, there was submitted by Du Pont the following Listing with copies, of a series of patents in the general areas of concern:

Kwolek	U.S. 3,063,966
Ucci	U.S. 3,080,210
Huffman et al.	U.S. 3,203,933
Preston et al.	U.S. 3,225,011
Cipriani	U.S. 3,227,793
Preston	U.S. 3,232,910
Preston et al.	U.S. 3,240,760
Epstein et al.	U.S. 3,269,970
Smith et al.	U.S. 3,354,125
Morgan	U.S. 3,414,645
Daniels et al.	U.S. 3,600,269

(CX-162, p. 54).

69. In an amendment filed July 10, 1972, reconsideration of the rejection of claims 1-13 as unpatentable over Morgan in view of Jamison and Quynn et al. under 35 U.S.C. 103 was traversed. It was said that the techniques employed by Jamison and Quynn et al. are wet spinning techniques whereas the claimed invention requires extruding a spinning dope from an orifice through a layer of inert noncoagulating fluid into a coagulating bath; that this distinction in technique is quite significant; that in general the extrusion of the spinning dope described in applicant's claims by known wet spinning techniques does not yield fibers or films having the high level of

tensile properties achieved in accordance with the applicant's invention. The Examiner's attention was called to Example vie and the supplemental Example on page 36, line 27 of the application (col. 17, line 30 of the '756 patent specification). The said example was said to compare the result obtained through spinning a 17 weight % dope of poly(p-phenylene terephthalamide) (PPD-T) in sulfuric acid by way of the technique called for by the applicant's claims (Table V, Item e) and that obtained by placing the face of the spinneret under the surface of the water. It was pointed out that the tenacity of the fiber obtained by the latter procedure was only 3.7 grams per denier compared with 16 grams per denier resulting from the process of the applicant's invention; and that it was clear that the combination of Morgan with the wet spinning processes of Jamison and Quynn et al. is improper and that the rejection should be withdrawn. (RX-162, pp..62-63).

70. It was argued in'the amendment filed July 10, 1972 that, as the Examiner has "apparently recognized", the spinning dopes called for in the claims are not found in Morgan or in either of the secondary reference; that not a single spinning dope is shown in these references which would fall within the scope of the applicant's claims. While it was admitted that the Morgan '645 patent describes a process for spinning wholly aromatic polyamide fibers, it was argued that there was only one polyamide disclosed by Morgan that is encompassed by the formula of the applicant's claims, namely, poly-4,4'-diaminobenzanilide terephtalamide (B-PPD-T) (column 2, line 44) (4,4'-DABT) and that no example shows that polymer being spun or even in a spinning solution and that this lack of disclosure is significant. it was argued that all of the other polymers disclosed in Morgan contain radicals with nonextended bonds, e.g., meta-oriented segments; that while the latter

polymers are shown to dissolve in dimethylacetamide-lithium chloride, the polymer, U-PPD-T, is insoluble in such solvent even at concentration levels lower than those indicated in the examples of the patent. In this regard, the Examiner's attention was directed to a Rule 132 affidavit by Dr. Alex John DeDominicis which showed that B-PPD-T of inherent viscosity of 1.21 did not dissolve at about 9.31 polymer concentration in 24 hours in dimethylacetamide containing 6.5% lithium chloride. Accordingly it was submitted that Morgan's disclosure of B-PPD-T (4,4'-DABT) in a listing falls far short of suggesting the claimed invention to one skilled in the art. (RX-162, p. 63-64). Respondents have relied heavily on the disclosure of 4,4'-DABT in the Morgan '645 patent.

71. In the amendment filed July 10, 1972, it was further argued that the Morgan '645 patent discloses a number of solvents which may be used in combination with the polymers; that while concentrated sulfuric acid is mentioned at column 4, line 4,'there is no example of its combination with any polyamide; that so far as applicant was aware, the extrusion of a spinning dope of concentrated sulfuric acid and a polyamide containing radicals with nonextended bonds by the techniques of the claimed invention did not result in a marked improvement in tensile properties over that achieved by known wet spinning techniques; that in Example I of King U.S. 3,079,219 (CX 852-13), a fiber of poly(m-phenylene isophtalamide) (MPD-I) wet spun as an 18% solution in dimethylacetamide-calcium chloride (polymer inherent viscosity, I.V. 1.9) had a tenacity of 6.8 grams per denier after drawing; that attempts to spin (MPD-I) of similar I.V. 2.18 by techniques of applicant's claim resulted in fiberws having a tenacity of only 1.4 grams per denier after drawing as shown by an accompanying affidavit by Dr. William Reginald Hatchard. Other similar, but not identical, runs were said to give tenacities no higher than 2.0 gpd.

It as argued that the results obtained attest to the unexpected nature of the claimed invention. (RX-162, p. 64).

72. Applicant argued in the amendment filed July 10, 1972 that Morgan in column 4, lines 24-31 described a broad polymer concentration range that may be employed in the spinning process; that Morgan *did* not suggest to one skilled in the art how to arrive at the spinning dopes called for by applicant's claims; that the accompanying affidavits of De Dominicis and Hatchard made it clear that this is not a case of selecting polymer, solvent and proportions from among a group of equivalents; that in the absence of any suggestion and in view of the unexpected results, Examiner's the rejection was untenable and should be withdrawn. (RX-162, p. 65).

73. In the amendment filed July 10, 1972, reconsideration of the rejection of claims 1-13 as unpatentable over Morgan in view of Serial Nos. 827,345 and 60,550 of the common assignee was requested. It was pointed out that Serial No. 60,550 is now abandoned. It was said that the Examiner had taken the position that it would be obvious to employ the compositions of Serial No. 827,345 in the spinning process as taught by Morgan; that the spinning technique employed by Morgan is neither disclosed nor suggested in Serial No. 827,345; that the Examiner has presented no reason why it would be obvious to use any of the compositions of Serial No. 827,345 in the spinning process of Morgan. Accordingly it was argued that the combination proposed by the Examiner is unwarranted. (Rx-162, p. 65).

74. In the amendment filed July 10, 1972, it was argued that Ser. No. 827,345 resulted in the Kwolek '542 patent which respondents rely heavily on in this investigation. (RX-164) another reason why the combination of Morgan and the applications was believed improper was that there were a large number of spinning dopes disclosed in Serial No. 827,345; that insofar as applicant was aware, it was only the concentrated sulfuric acid type dopes

called for by the claims that gave the results obtained with the claimed invention; that amide dopes do not and neither do the less concentrated dopes **of concentrated sulfuric acid. An accompanying affidavit of Dr. John Joseph McBride was said to show that an amide dope of PPD-T spun through an air gap into a coagulating fluid can yield fibers having an as-spun tenacity of 7.4 grams per denier. It was said in contradistinction thereto, a concentrated sulfuric acid dope of PPD-T spun through an air layer into a coagulant (Example VIIa but at a different polymer concentration and /.V.) yielded fiber having a tenacity of 24 grams per denier; that in Example VIII a PPD-T sulfuric acid dope spun by the same general procedure but differing from the previous dope with respect to polymer concentration, gave a fiber having a tenacity of 17 gpd. It was said that these results pointed out the significance of dope solvent and high polymer concentration in achieving the high tenacities and that this was entirely unsuggested by either Morgan or Serial No..827,345 or any combination thereof.** (RX-162, p. 66).

75\. **With respect to the Examiner's recommendation that a clear line of distinction be maintained among Serial Nos. 827,345 60,550, 172,515 and 138,210 in the amendment filed July 10, 1972 it was pointed out that Serial No. 172,515 is the present application before the Examiner which is a continuation-in-part application of Serial No. 138,210; that Serial No. 60,550 has been abandoned; and that it was believed that the claimed invention is patentably distinct from Serial No. 827,345. (RX-162, p. 66).**

76\. **In the amendment filed July 10, 1972 the rejection of claims 1-13 under 35 U.S.C. 112 was traversed. It was said that applicant did not** consider the claimed process to be a wet spinning process as conventionally understood; that the language of the claims is definite in reciting that the spinning dope issued from the spinneret orifices initially contacts an inert noncoagulating fluid and subsequently enters a coagulating bath; that this sequence has significant impact on properties of the resulting product; that the claims also define the polymer, the solvent and proportions of the spinning dope. (RX-162, p. 67).

77. In the McBride Rule 132 affidivit accompanying the amendment filed July 10, 1972, it was stated in part:

> A spinning dope at room temperature containing 5.9% by weight of poly(p-phenylene terephthalamide) (inherent viscosity 3.8) in a mixture of 1 part by weight of hexamethyl phosphoramide, 2 parts by weight of dimethylacetamide and 1.2 Lid was extruded through a spinneret with one 8-mil diameter holes through a 0.5 to 1.0 inch air gap into 79°C. water and fibers wound up at 1665 feet/minute using a jet velocity of 580 feet/minute. After neutralizing, washing and drying the filaments had the following properties: tenacity 7.4 gpd, elongation 3.5%, modulus 376 gpd and 7.2 denier per filament. (RX-162, pp. 56-57).

78. In the Hatchard Rule 132 affidavit accompanying the amendment filed July 10, 1972, it was stated in part:

> A spinning dope was made of 15.8% by weight of poly(m-phenylene isophthalamide) of inherent viscosity 2.18 and 84.2% by weight of a 50/50 (by weight) mixture of 100.1% sulfuric acid and fluorosulfuric acid. The dope at 60°C. was extruded from a spinneret having five holes of 3 mil diameter through a 1 cm. air gap into a vertical spinning tube containing 1°C. water as a coagulant. The fibers were wound up at 30 feet/minute with a ject velocity of 40 feet/minute. After neutralization, washing and drying the as-spun fibers had the following properties: tenacity 0.46 gpd, elongation 70% modulus 25 gpd and denier per filament 22. Upon hand drawing the tenacity was increased to 1.4 gpd. (RX-162, pp. 58-59).

79. In the Deiominicis Rule 132 affidavit accompanying the amendment filed July 10, 1972, it was stated in part:

> 4,4'diaminobenzanilde (9.09 g., 0.04 mole) was dissolved in 160 ml. of hexamethylphoshoramide and the solution cooled for 15 minutes. An ice bath was placed around the solution and 8.12 g. (0.04 mole) of terephthaloyl chloride was added - to the stirred solution followed by 10 ml. of hexamethylphosphoramide as a rinse. The solution changed to an opaque gel in 2.5 to 3 minutes. Stirring was continued overnight. After standing 2 days the gel was ground in a blendor with two 400 ml. portions of water, one 400 ml. portion of alcohol and two 400 ml. portions of acetone. The sample was dried in an oven to yield 15.1 g. of poly(4,4'-diaminobenzanilide terephtalamide) having an inherent viscosity of 1.21. A 0.5 gram portion of the polymer did not dissolve in 5 ml. of dimethylacetamide containing 6.5% Lid in 24 hours (about 9.3% polymer). (NX-162, pp. 60-61).

80. In an Office action dated November 7, 1972, the Examiner stated that claims 1-13 are still rejected under 35 U.S.C. 103 over Kwolek U.S. Patent No. 3,671,542, which had issued from application Ser. No. 827,345 taken together with either Morgan U.S. Patent No. 3,642,06 or the Morgan '645 patent. It was said that the Kwolek patent (claims) teaches applicant's claimed spin dope composition (I.V of greater than 2 for PPD-T and similar polymer concentration in 98% plus concentrated fuming sulfuric acid (col. 7, lines 6-30; col. 9, lines 47-52; col. 6, lines 12-30 and examples; that Kwolek's "as-spun" fibers by "wet spinning" or dry spinning method can have as high modulus and tenacity as those of applicant's products as well as those disclosed in the submitted Rule 132 affidavit. Each of the Morgan references were said to show that the art recognizes the advantage of the air-gap wet

spinning technique to promote "spin stretch" effect for wholly aromatic polyamide fibers including applicant's polyamides. It was pointed out that Morgan ('645; col 3, lines 73-75 and col. 4, lines 1 4) and Morgan ('706; col. 2, lines 15-50 and 67-69 col. 4, lines 45-51; col. 5, lines 20 and 50-59; col. 8, lines 60 and 74) disclose concentrated sulfuric acids as a solvent as well as high tensile properties obtained thereof. In view of the Kwolek patent, the Examiner stated that neither the instant spin dope nor the high tensile property of applicant's as-spun product is patentably distinct; that in view of the secondary Morgan patents the air-gap wet spinning for such polyamide is not patentably distinct over the prior art. (RX-162, pp. 69-70).

81. The Examiner in the Office action dated November 7, 1972 further rejected claims 1-13 as unpatentable over the Kwolek '542 patent with the Morgan '706 patent or Morgan '706 patent in view of either Kwolek (U.S. Pat. No. 3,600,350; col. 8, lines 1 9 and 29 62) or Daniels et al (U.S. Pat. No. 3,600,209; col. 7, lines 28-40 and 60 72; col. 8, lines 35-65;) under 35 USC 103. It was said that the Kwolek '350 patent and Daniels '209 patent further teach the advantages of spin stretching, dry-jet wet spinning and inherent high tensile properties of para position aromatic polyamides. (RX-162, p. 70).

92. In the Office action dated November 7, 1972, applicant and his assignee were urged to maintain a clear line of patentable distinction amount their copending applications (especially those by inventor Blades and Kwolek and those directed to optically anisotropic aromatic polyamide dopes). (RX-162, pp. 70).

83. In February 1973, applicant abandoned application Ser. No. 172, 515 because the invention was now being claimed in continuation-in-part

applications Serial No. 239,377 riled March 29, 1972 and Serial No. 268,052 riled June 30, 1972. (RX-162, p. 72).

Ser. No. 239,377

84. On March 29, 1972, inventor Blades filed application Ser. No. 239,377 containing thirteen method claims and one claim to a spinning dope. (Rx-165, pp. 41-44).

85. In an Office action dated in November 1972, the method claims were rejected under 35 USC 103 over the Morgan '645 patent taken with the Morgan '706 patent or Kwolek '542 patent for reasons stated in the Office action of November 7, 1972 in Ser. No. 172,515. (RX-165, p. 62).

86. In the Office action dated in November 1972, method claims 1-13 were rejected on commonly assigned Ser. Nos. 172,515 and 268,052 on the ground that applicant's claims should'be patentably distinct. (RX-165, p. 62).

87. The Examiner in the Office action dated in November 1972, rejected the method claims under 35 USC 112 on the ground that the process steps should define spin draw factor; that the process should be distinct from dry spin plus wash, semi-melt spin, pleximentary spin, flash spin, interfacial spin, etc. (RX-165, P. 62).

98. Applicant in February 1973 abandoned Ser. No. 239, 377 because the invention was now being claimed in application Ser. No. 268, 052 filed June 30, 1972. (RX-65, p. 63).

Ser. No. 259,052

89. On June 30, 1972, inventor Blades filed application Ser. No. 268,052 containing thirteen method claims and one claim to a spinning dope. (RX-63, pp. 42-45).

90. In an amendment filed on October 19, 1972, applicant made of record the following reference and commonly assigned application. Ser. No. 827,345 nd 60,550

Moncrief et al.	U.S. 2,318,704	Preston et al.	U.S. 3,240,760
Bludworth et al.	U.S. 2,425,782	Epstein et al.	U.S. 3,269,970
Bludworth et al.	U.S. 2,463,676	Preston.	U.S. 3,484,407
Lieseberg	U.S. 2,957,748	Smith et al.	U.S. 3,354,125
Finlayson et al.	U.S. 2,988,418	Kitajima et al.	U.S. 3,412,191
Kwolek	U.S. 3,063,966	Morgan	U.S. 3,414,645
Ucci	U.S. 3,080,210	Carter et al.	U.S. 3,415,922
Ballard et el.	U.S. 3,121,766	Quynn et al.	U.S. 3,558,763
Denyes	U.S. 3,154,610	Jamison	U.S. 3,574,811
Parczewski	U.S. 3;154,612	Daniels et al.	U.S. 3,600,269
Huffman et al.	U.S. 3,203,933	Kowlek	U.S 3,600,350
Preston et al.	U.S. 3,225,011	Ohfuka et al.	U.S. 3,360,187
Rosenthal et al.	U.S. 3,227,793	Morgan	U.S. 3,642,706
Cipriani	U.S. 3,227,793	Kwolek	U.S. 3,671,542
Preston	U.S. 3,232,910	British	1,091,947
		French	902,826

Reference was made to an interview on September 20, 1972 when these references were discussed and the relationship between Ser. No. 268,052 and parent application Ser. No. 172,515 was noted. It was said that the Examiner suggested that the foregoing references and the substance of the response in Ser. No. 172,515 made on July 10, 1972 be made of record in Ser. No. 268,052. This was done (EX-163, pp. 59-63).

91. In the amendment filed October 19, 1972, it was said that among

the newly cited references is a patent to Morgan U.S. 3,642,706; that this patent relates to the incorporation of a wax into a spinning solution to increase productivity; that the disclosure therein is believed to be no more pertinent opposite the applicant's invention than the disclosure of Morgan U.S. 3,414,645; that thus, Morgan U.S. 3,642,706 shows no polymer encompassed by the applicant's claimed being spun or even in a spinning solution; that thus, the patent does not lead the art to such important facets of the applicant's invention as solvent and concentration requirements, or the need to use polymers having the rigid radicals with extended bonds in a spinning process involving extrusion through an inert noncoagulating fluid and into a coagulating bath in order to achieve the results of the applicant's invention. It **was** said that the effect of.wax on improving productivity of a different spinning system is not deemed to be a fair teaching of the applicant's invention. (RX-163, **pp**. 63-64).

92. The Examiner in an Office action dated January 2, 1973 rejected the method claims, under 35 USC 103 over Kwolek '542 patent taken with the Morgan '645 patent or the Morgan '706 patent. It was stated that the '542 patent (col. 1, lines 34-40; col. 7, lines 6-30; examples 1, 2, 23-47, 76 and 80) discloses applicant's spin dope for wet or dry spinning filaments. Many of as-spun filaments were said to have a tenacity of greater that 10 gpd without heat treatment; that the tencity doubles with heat treatment. The affidavits of DeDominicis McBride and matchard were said not to be persuasive in that Kowlek's example 76 and 80 disclose high tenacity fibers by conventionally wet spinning an organic solvent solutions of similar polyamides. It was said that Morgan '645 patent (col 2, lines 1-6; col-4, line 4) and the Morgan '706 patent (col. 2, lines 14-50 and 66-72; col. 8,

lines 60 and 73) discloses air-gap wet spinning of various aromatic polyamides (para. position and con. sulfuric acid); that Example 7 of the '706 patent to discloses tensile properties of 8.5 and 19.3 gpd with a para position aromatic polyamide derivatives. In view of Kwolek '542 patent, the Examiner said it would be obvious to one skilled in the art to employ a conc. sulfuric acid solution of PPD-T in an air-gap wet spinning process as taught by either of the two Morgan patents especially in view of the fact that the Kwolek '542 patent teaches such dope can be wet or dry spun. It was said the submitted affidavits lacked data on dry spinning. (RX-163, p. 66).

93. In the•Office action of January 2, 1973, applicant was cautioned to maintain a clear line of distinction from Ser. No. 72,515 and 239,377. (Rx-163, p. 66).

94. The Examiner in his office action of January 2, 1973 rejected the method claims over 35 USC 112 because the claimed process should define spin draw factor and because process steps should be distinct from dry spinning, interfacial spinning, pleximentary spinning semi-melt spinning etc. (Rx-163, p. 66).

95. Reference was made in the Office action of January 2, 1973 that applicant, because of a restriction requirement, had elected the process claims. (RX-163, p. 66).

96. In a response filed February 15, 1973, applicant argued that the patent to Kwolek discloses a variety of isotropic and anisotropic spin dopes of polyamides in any of a variety of liquid media; that among the media disclosed in Kwolek are amides and ureas containing specified inorganic salts, concentrated sulfuric acid, hydrofluoric acid and certain sulfonic acids; that the Examiner's statement that Examples 1, 2, 23-47, 76 and 80 of Kwolek

disclose the spin dopes that are used in the instant process is incorrect; that of the 29 examples to which the Examiner refers, only one spin dope meets the requirements of the present claims, namely, Example 23, Part B; that some of the examples of the group selected by the Examiner disclose spin dopes with polymer concentrations or inherent viscosities or a combination of such parameters which is Ear below that required in the applicant's claims. It was argued that Kwolek does not disclose extrusion of any spin dope through a layer of inert fluid and into a coagulating bath; that the patent to Kwolek does not suggest that certain of the spin dopes give fibers of markedly higher as-spun tenacity when prepared in the manner claimed compared to the same spin dopes when spun as described in Kwolek. It was said that to applicant's knowledge, amide dopes of his prescribed polymers would not yield the results obtained by the present invention; that the earlier submitted affidavit by Dr. McBride supported this contention because the affidavit showed the results of spinning an amide dope of polylp-phenylene terephthalamide) through an air layer into a coagulating fluid and fibers having an as-spun tenacity of 7.4 grams per denier. In contradistinction, it was argued that Example Vila of the '756 patent specification shows the production of a fiber having an as-spun tenacity of 24 grams per denier from a concentrated sulfuric acid dope of poly(p-phenylene terephthalamide) that was spun through an air layer into a coagulant; that Example VIII in combination with Example VIIa of the specification shows the importance of polymer concentration even in the situation where the proper polymer and solvent medium are employed; that the Kwolek patent contains no guide to the instant invention. (RX-63, pp. 71-72).

97. In the respone filed February 15, 1973, it was further argued that the Morgan '645 patent discloses air gap spinning techniques, but in all

eighteen working examples contained in the Morgan patent, there is not a single polymer described that would fall within the polyamide class required in the instant claims; that there is only a single polyamide mentioned in Morgan patent that does, namely, poly 4,4'-diaminobenzanilide terephthalamide (4,4' DABT). It was said that the combination of Kwolek with the Morgan '645 patent is believed to be improper and unwarranted; that the spinning techniques employed by Kwolek and the Morgan '645 patent are distinct; that one employs wet or dry spinning, the other air gap spinning. It was argued that neither patent suggests which from among the Kwolek spin dopes should be used in the Morgan '645 patent process; that from the disclosures of Kwolek and the Morgan '645 patent one could not predict that air gap spinning of specific spin dopes in Kwolek would result in high as-spun tenacities. It was argued that there is no disclosure in the Morgan '645 patent of poly-4,4'-diaminobenzanilide terephthalamide being spun or even in a spinning solution; that the affidavit by Dr. DeDominicis, previously submitted, showed that an attempt to dissolve this polymer in dimethylacetamide containing 6.5% lithium chloride, a typical solvent system of the Morgan '645 patent was unsuccessful; that **conversely the previously submitted affidavit by Dr. Hatchard showed that when poly(m-phenylene isophtalamide), a polymer outside the class required by the applicant's claims, was spun from sulfuric acid by air gap techniques, only very weak fiber was obtained. It was said that the Morgan '645 patent does not teach one how to select from the almost infinite possibilities within** his **disclosure, those dopes which are employed, in the air gap spinning process** of the **claimed invention; that the Morgan '645 patent**

contains not the faintest suggestion that unexpectedly high as-spun tenacities would be obtained as resulted from the Blades claimed process invention. (RX-163, pp. 72-73).

98. it was also argued in the response filed February 15, 1973 that the Morgan '706 patent is directed to an improved process for preparing filaments by incorporating in the spinning solution a small amount of a wax; that the Morgan '706 patent discloses both wet and air gap spinning. Example VII of the Morgan '706 patent to which the Examiner refers, was said to describe air gap spinning of a polyamide hydrazide, a polymer not included in the applicant's invention or claims. The Morgan '706 patent was said to fail to teach or to disclose the production of polyamide or polyamide hydrazide fibers having markedly improved <u>as-spun</u> tenacities. (RX-163, p. 73).

99. Applicant argued in the February 15 responie that with respect to the Examiner's reference to Examples 76 and 80 of the Kwolek patent, that while the former shows as-spun yarn tenacity values of 11.4 grams per denier and; the Latter shows as-spun filament tenacities of 10.6 and; that admittedly, these values are fairly high, the claimed invention represents an unexpected improvement over the Kwolek patent. It is said upon heat treatment of the products of Examples 76 and 80, some modest improvement in tenacity results, although far from double the tenacity alleged in the outstanding Office Action; that the claimed invention permits the realization of high as-spun tenacity without the need for subsequent hot dry treatments which tend to reduce elongation. Regarding the Examiner questioning the absence of dry spinning data in the affidavits, it was said, that none of Kwolek, Morgan '645 or Morgan '706 patents disclose dry spinning of a sulfuric acid dope. (RX-163, pp. 73-74).

100. In the response filed February 15, 1973, applicant argued reconsideration of the rejection of the methods claims under 35 U.S.C. 112. It was said that the applicant's process claims adequately define his invention and are distinct from dry spinning and the other spinning techniques enumerated in the outstanding Office Action. While it was said that applicant is prepared to insert a range of spin stretch factors, it was believed that this was unnecessary and would merely confuse the issue. (RX-163, p. 74).

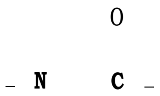
101. A notice mailed March 27, 1973 by the U.S. Patent and Trademark Office stated that the application was in condition for allowance and prosecution on the merits was closed. Certain changes in the application were indicated to have been made by the Examiner. (RX-63, pp. 81-82).

102. Following an amendment under Rule 312 and a request for a certificate of correction, a notice of allowance was mailed on May 2, 1973. (RX-163, pp. 81-86).

VI. TERMINOLOGY

Polyamides

103. Polyamides are polymers containing amide linkages:



$$-\mathrm{N}\quad\overset{\mathrm{O}}{\mathrm{C}}-$$

(RPFF 1)

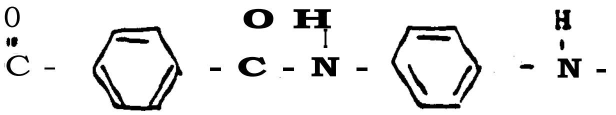
104. Aromatic polyamides are polyamides wherein the radicals linking the amide linkages constitute aromatic radicals, e.g., 1,4-phenylene.

It all of the radicals linking the amide linkages constitute aromatic radical:;, then the aromatic polyamide is termed a **wholly** aromatic polyamide. If those radicals are also para-oriented, then a wholly aromatic para-oriented, polymide is formed. (RPFF 2).

105. **A wholly** aromatic polyamide comprising equal parts of

$$\overset{O}{C}\quad R-\overset{O}{\overset{\|}{C}}-\quad \text{and}\quad \text{III)}\ -N-R'-N-$$

wherein R and R' are para-phenylene (1,4-phenylenc) radicals is poly(p-),henylene teruphthalamide) or PPD-T.

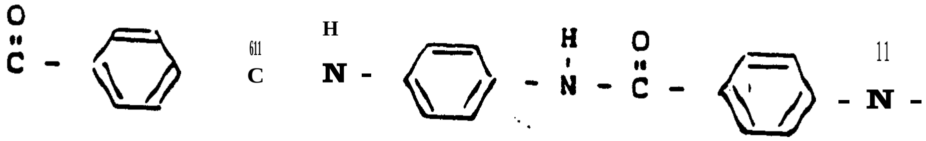


(Rx-124, col. 2 ls. 5-B).

106. A wholly aromatic polyamide comprising equal parts of

$$(I)\ -\overset{O}{\ddot{C}}\quad R-\overset{O}{C}-,\quad (I)\ -N-R'-N\quad \text{and}\quad (III)\ -\overset{O}{\overset{\|}{C}}-R''-$$

wherein R, R', and R' arc para-phenylene (1, 4-phenyl-one) radicals is poly-4,4'-diaminobenzanilHe terephthalamide or



(RX-58, col. 2, Is. 44-49).

107. There are three type of polyamides that can be formed using the substituents:

wherein if (I) and (II) are present, they are present in eguimolar amounts. If only substituent (III) is present, then an AB type polyamide is Formed, e.g., poly(p-benzamide). /E substituents (I) and (/I) are present, then an AABD type polyamide is formed, e.g., poly(p-phenylene terephthalamide (PPD-T). If all three substituents, (I), (II), and (III) are present, then a copolymer polyamide is formed, e.g., poly-4,4'- diaminobenzanilide terephthalamide (4.4'DABT). (Bailey, RX-3, pp. 5-6).

108. The preparation of an AB polyamide involves the polymerization of a single monomer, an amino acid, which contains an amino group, A, and a carboxyl group, B. For example, poly(p-benzamide) (PPS or PBA or 1,4-B1 is prepared through the polymerication of p-aminobenzoyl chloride hydrochloride (8). (RX-164, col. 38, ls. 21-46).

109. The preparation of an AABB type polymide involves the polymerization of two monomers, a diamine, AA, and a dibasic acid, BB. For example, poly(p-phenylene terephthalamide) (PPD-T1 is prepared through the polymerization of p-phenylenediamine (PPD) and terephtaloyl chloride (TC!). (RX-164, col. 24 Is. 45-62).

110. The co-polymer poly (4,4'diaminobenzanilide terephthalamide) is sometimes designated 4,4'-DABT polymer or internally at Du Pont as (PPD-B)-T. It is pictured in col. 2 of the Morgan '645 patent. The 4'4'-DABT polymer is a specific limited order copolymer. It is not a group of co-polymers, PPD-T and 4,4*-DABT are structured para-oriented wholly aromatic

polyamides. PPD-T is made up of repeating para-phenylenediamine (PPD) and terephthaloyl (T) radicals. 4,4'-DABT is made up of terephthaloyl (T) radicals joined to 4,4'-diaminobenzanilide (PPD-B) units. (Davis, Tr. pp. 2187-88; Uhlmann, CX-1147 p. 6; Magat, Tr. pp. 429,589; RX-58).

Polymerization

111. The preparation of polyamide copolymers involves the polymerization of various monomers -- amino acids, diamines and diacids. When the individual monomers p-aminobenzoyl chloride hydrochloridelB), p-phenylene diamine(PPD), and terephthaloyl dichloride1T1 are reacted simultaneously, **a** copolymer similar to 4,4'-DABT is formed. The copolymer is made up **of** randomly ordered PPD, 9 and T units and is called a random copolymer. Random copolymers may be comprised of the PPD and T, and B monomers in different mole ratios, i.e., they need not be made up of equi-molar concentrations of the individual monomer units (CX-6, RX-57, Example V(b) at col. 15, Is. 58-69). (Bailey, RX-3, p. 6).

Molecular Weight

112. The molecular **weight has a considerable effect** on the viscosity of the polyamide dissolved in various solvents. Various **viscosities** may be used to characterize such systems, e.g., relative viscosity, **which is** the vicosity of the polyamide solution divided by the viscosity of the solvent, and inherent viscosity ( ), which is the natural logarithm **of the**

relative viscosity divided by thg. concentration of 1.5 gram of polyamide per 100 ml. of solvent. For a given polyamide in a particular solvent, each of these viscosities increases with increasing molecular weight of the polyamide. (Uhlmann, CX-835 pp. 5-6).

Anistoropic spinning dopes

113. Anisotropic spinning dopes are formed by increasing polymer concentration, increasing polymer inherent viscosity, and/or, in the case of using sulfuric acid as a solvent, increasing the concentration of the sulfuric acid. (RX-1G4, FIGS. V and IV).

Aramid

114. riecaJse the physical property differences between fibers of oromatic and aliphatic polyamil'•s are greater than those between other ,existing generic classes of fibers, a new generic tern for fibers from aronatic polyanides was requested by Du nont in 1971. Subsequently, the generic term 'aramid" was adopted in 1974 by the United States Federal Trade Commission for designating fibers of the aromatic polyamide type: aramid - a nanufactured fiber in which the fiber-forming substance is a Long-chain synthetic polyamide in which at least of the amide linkages are attache' directly to two aromatic rings. At the same tine that the new generic term became effective, the generic term "nylon" was amended as follows: nylon - a

manufactured fiber in which the fiber-forming substance is a long-chain synthetic polyamide in which less than 851.of the amide linkages are attached directly to two aromatic rings. (Uhlmann, CX-835, p. 9; Man-Made Fibers Fact Book, CX-837 p. 16).

Extrusion

115. The extrusion of polymer into fibers is more often than not described by the word "spinning." There are melt, dry, and wet methods of carrying out this operations. In melt spinning, the molten polymer is extruded under high pressure through tiny orifices in a jet or spinneret, and the resulting very fine streams of molten polymer are cooled and converted into fibers or filaments. In dry spinning, the polymer is dissolved in a solvent to produce a spinning dope, and the resulting solution is extruded from the jet or spinneret into a hot atmosphere, which removes the solvent by evaporation, so as to leave the polymer in continuous fiber form. To wet spin, the polymer is dissolved in a solvent to form a spinning dope and the solution is extruded from a jet or spinneret, in a manner similar to that used in the melt and dry spinning. In that process the spinneret is typically immersed in a non-solvent liquid, termed a spinning or coagulation bath, in which the liquid filaments are solidified by coagulation. In a modified form of wet spinning, known as dry-jet wet or air gap spinning, a wet spinning process is utilized in which a small distance or gap separates the spinneret and the surface of the spinning or coagulation bath. This gap generally comprises air (hence the term "air gap" spinning) but may comprise other inert fluids. (Davis, RX-2, p. 7).

Fiber Tenacity

116. The method of defining the size of filaments and yarns is not by means of the the cross-sectional area but rather by their linear density. The expression of size of synthetic fibers has traditionally been in denier, that is to say, the weight in grams of 9000 meters of the fiber (the origin of this is historical and comes from the silk industry). Recently, the unit tex was proposed - the weight in grams of 1000 meters; tex is often used in scientific publications, but has found little acceptance in the industry as yet. Generally speaking, the strength of filaments or continuous filament yarns is expressed in tenacity in units of grams per denier or grams per tex. Both are based upon the force, expressed in grams required to cause failure in lengthwise extension, with the tenacity being calculated by dividing this stress by the total denier of the original material before being elongated. That is, the breaking tenacity does not take into account the decrease in the cross-sectional area resulting from the elongation of the sample being tested, even though this elongation may vary from material to denier itself is expressed in Linear density, material and may be as low as 5% or as high as 501. Thus, since two materials having different densities, such as polypropylene and cellulose, may be possessed of equal denier, equal elongations at failure, and equal tenacities, but yet still have quite different tensile strengths. Other physical properties used to characterize fibers include elongation at break, which is the increase in length of a filament of yarn sample at the moment of break, expressed as a percentage of the original sample length, and initial modulus (also called Young's modulus or tensile modulus) which is the load required to stretch a specimen of unit cross-sectional area by a unit amount, usually expressed as grams per denier. (Uhlmann, CX-B35, pp. 4-5).

VII. DU PONT'S RESEARCH EXCLUDING INVENTOR BLADES

117. In April 1957 Du Pont's scientist O. W.' Morgan, prepared high molecular weight PPD-T. On Apr'il 17, 1957, the solubility of PPD-T in concentrated sulfuric acid was noted. It was said that the polymer could be wet spun from sulfuric acid into aqueous salt baths. Vitcous 6-percent solutions of PPD-T in conc. sulfuric acid were made. Small films of the solution were cast and coagulated in water, sodium tydroZide and saturated sodium sulfate. The gel films were clear if cast thin and were strong in tensile but low in tear strength. On drying the films were brittle:' On May 20, 1957, Morgan prepared excellent solutions of high viscosity EIPD-T polymer dissolved in concentrated sulfuric acid. The color of the solutions was pale yellow and the concentration by weight was aboUt 12 percent. (RX-200).

118. Du Pont's P.W. Morgan in a notebook entry dated May 20,'1957 stated:

> Excellent solutions were made from the high viscosity PPD-T polymer (n [igi 1.9) dissolved in conc. H2SO$_4$. The color was pale yellow at a concen. of aboUt'12i.
>
> Strips were cast on microscopic slides and immersed in various aqueous batter and organic solvents, such as 10% Na)H, H2O, stated. Na2SO4, ethanol and butanol.
>
> Clear flexible film was obtained in aq. Na0H. This remained quite strong as washed gel but could not be dried down at 25° or 10° without great srinkage and becoming brittle. Part of the problem is probably the lack of orientation and the formation of a fiber which could be drawn might solve this difficulty. The wet gel was judged to be strong enough for easy wet spinning.
>
> Another problem is to wash the salt containing gel without it becoming opaque. Upon water washing opaque areas appeared where the film was thick, so this difficulty might not arise in fine fibers.

> Progress with this polymer is excellent and work should be continued. This polymer is a candidate for the class of high modulus, high tenacity of fibers being sought by Bohn and Parrish. (RX-200, p. D110668).

119. A Du Pont notebook entry dated November 3, 1958 shows the synthens by P.W. Morgan of high molecular weight PPD-T using HMPA. This became example XIX in U.S. 3,063,966 which issued to Kwolek, P.W. Morgan and Sorenson on Nov. 13, 1962 and is based on a patent application filed Feb. 5. 1958. (CX-803, 43; CX-852, 17; CX-803, p. 4).

120. A Du Pont notebook entry dated November 7, 1958 shows the synthesis by P.W. Morgan of Cl PPD-T. This synthesis provided examples for U.S. 3,349,062 which issued to Hill, Kwolek, and Sweeny on October 27, 1964. (CX-803, 04; CX-803, p. 4).

121. In November 1958, Du Pont's Morgan wrote in his notebook:

> PPD-T is of interest at the moment because W. Hare thinks he can wet-spin it from 'sulfuric acid. I wet cast films last year which were tough but brittle dry.

• •

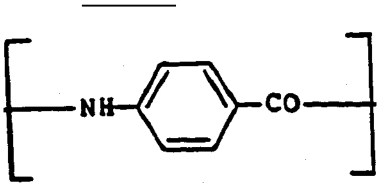
> This is remarkably high viscosity value for any aromatic polyamide. Preparation of formed products will be most interesting. (RX-202 p. D131060).

122. Pioneering Research is the research laboratory established at the Du Pont Textile Fibers Department for the purpose of discovering and developing new fibers and new fibrous products. Research on existing fibers is carried out by the other laboratories of the Textile Fibers Department associated with each commercial fiber. Pioneering Research was established in the late 1940's and, by 1964, it had a staff of approximately 100 Ph.D.s and 150 support personnel, aLl doing research aimed at new fibers and fibrous products. By 1964 the staff at Pioneering Research had discovered many

commercial fibers following nylon -- for example "Orlon" , "Lycra", "Teflon" and "Nomex". Dr. Eugene E. Magat took over in 1964 as one of Pioneering's four research managers with responsibility for new polymers and new fiber compositions and with approximately one-quarter to one-third of the staff reporting to him include most of Pioneering's organic chemists, but also physical chemists, material scientists and engineers. (Magat, CX-801, pp. 4-5)•

123. Dr. Magat who has a B.S. in Chemistry and a Ph.D in Organic Chemistry in 1945, joined Du Pont at the nylon research laboratory as a research chemist. For the next 18 years he was deeply involved in research on polyamides and progressed through the positions of Research Chemist, Research Associate, Research Supervisor and Research Fellow. As a Research Fellow, he was at Du Pont's highest Level of independent researches with authority to pick his own area of interest and supervise his own staff. He had developed experience. in both research and management of research and, in 1964, transferred to the Pioneering Research Laboratory as Manager of the Polymer Research Section. In this position he was responsible for the discovery and identification of new polymers and fibers for the Du Pont Textile Fibers Department until he retired in 1979. He received twenty-nine United States patents for inventions concerning for example, antistatic nylon, radiation grafting of polymers, interfacial polymerization of polyamides and interfacial spinning directly from intermediates to fibers. He has published several papers and have given talks at Gordon Research Conferences, the Royal Society of London, Bicentennial ACS Symposium on fibers and other international polymer science meetings. (Maga!, CX-801, pp. 3-4).

124. PHD-27 is said to be a high strength, high modulus fiber made from poly (p-benzamide) (1,48). It is represented graphically:

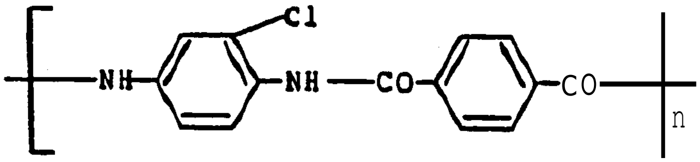


PRD-27 was Du Pont's first para-positioned polyamide that could be dissolved and spun into fibers with high modulus and tensile properties. PRD-27 has been referred to by the code name "Fiber BTM. As of 1969 PRD-27 (PPB) was considered by Du Pont the best candidate for commercialization. Fibers having an as-spun tenacity between 10-12 grams per denier (gpd), an elongation of approximately 6% and an initial modulus between 400-500 gpd were by then routinely obtained. Upon heat treatment, the tenacity of the fiber increased to 18-20 gpd and the modulus to 1,000-1,200 but its elongation was decreased to about 2%. (Magat CX-801, p. 8).

125. The polymer base for PRD-27 fiber was prepared by polymerizing the hydrochloric acid salt of para-aminobenzoylchloride in a mixing vessel using as a solvent dimethylacetamide (DMAC) and lithium chloride salt. This resulted in a liquid crystalline spinning solution containing 6% by weight poly(p-benzamide) having an inherent viscosity of 2.8-3.4 (as measured in sulfuric acid) and a viscosity of generally 100 poise or less. The polymerization of the polymer directly in the spinning solvent has been referred to as 'in situ" polymerization. This liquid crystalline spinning solution was then transferred(or pumped) from the mixing vessel to a wet spinning device where the solution was forced through a spinneret submerged

directly in a coagulating bath. When forced through the spinneret, a high degree of orientation is imparted to the extruded liquid crystalline solution, and before it relaxes or becomes disoriented, the coagulating bath quickly freezes that orientation as the resultant filament is formed. Then, as the extruded filament passed through the bath to a wind up roll, the lithium chloride salt was extracted. Typically the fiber was spun at speeds of 150 to 250 feet per minute. The chief drawback of this fiber was economic because (1) the intermediates used in the polymerization step were costly and difficult to purify and (2) the 12 gpd tenacity of as-spun fibers provided borderline value-in-use advantages over existing fibers for tire reinforcement. The low elongation of the 20 gpd fiber obtained by heat treatment was inadequate for tire use. (Magat CX-801, pp. 5, 9-10).

126. PRD-48 is Du Pont's code for fiber made from poly(chloro-p-phenylene terephthalamide. (ClPPD-T:



Research on this fiber was carried out from 1968 to 1970. The fiber was made by polymerizing chloro-p-phenylene and terephthaloyl chloride in situ in the spinning solvent and the solution then was wet spun into a coagulating bath to form fiber. Specifically, ClPPD-T was polmerized in a mixing vessel in dimethylacetamide (DM›C) solvent and lithium chloride salt to give a liquid crystalline spinning solution containing 6.61 ClPPD-T having an inherent viscosity of 3-4 (as measured in sulfuric acid) and a viscosity of generally

100 poise or less. Spinning speeds as high as 450 feet per minute were obtained.(•agot, CX-801, p. 10).

127. As-spun fiber properties of PRD-48 were slightly better than PRD-27 fibers but the heat treated version was 208 lower in tenacity and modulus than PRD-27. PRD-48 fiber being made and spun in the same solvents and salt as used in PRD-27, had an initial cost advantage over PRD-27 because of lower intermediate costs and ease of purifying its starting intermediates. However, later the economics of the PRD-48 intermediates were revised downwards because of the discovery of an alternative route using p-aminobenzoyl chloride dimer (called PRD-27D). Thus PRD-48 became substantially less attractive than PRD-27. (Magat, CX-801, pp. 10-11).

128. Research on PRD-48 was terminated early by Du Pont in 1970 with (1) the discovery of a new low cost route toPRD-27 intermediates and (2) the recognition that CIPPD-T could not be delivered at the rate it would be needed for rapid development and at the low intermediates prices that were originally projected. (CX-803. p. 9).

129. PRD-44/aramid is Du Pont's code name for fiber made from poly (p-phenylene terephthalamide) (PPD-T) spun in an amide solvent. This fiber was processed in a manner similar to PRO-27 in that p-phenylenediamine and terephthaloyl chloride were polymerized in situ in the spinning solvent and the resultant solution was wet spun. (Magat, CX-801, p. 11).

130. At Du Pont there were two campaigns to make PRD-44/amide. The first campaign commenced in 1966 and was discontinued to 1967 because poor properties were obtained as compared to PRD-27. . In this work preformed PPD-T. polymer was dissolved in a mixed amide solvent to form the spin solution. The second campaign commenced in mid-1968 and by late 1969, better fiber

properties were achieved. in this second effort PPD-T was polymerized in situ in a mixing vessel in hexamethylphosphoramide (HMPA)/ N-methlpyrrolidone-2 (NMI') solvents and lithium carbonate salt, forming a liquid crystalline spinning dope containing 61 by weight PPD-T having an inherent viscosity of 4-5 (as measured in sulfuric acid) and a viscosity of generally 100 poise or less. Spinning speeds were low, in the order of 120 feet per minute. (Magat, CX-801, pp. 11-12).

131. The economics of PRDD-44 amide were superior to PRD-27 because of the lower cost of the intermediates used to make PPD-T. However, in late 1969 after several years of work, fiber properties of PRD-44/amide were very sensitive to selection of spinning conditions and were not as good as PRD-27. The major problem was fiber inhomogeneity, i.e., the fiber skin (outer surface) was highly oriented and had good tenacity while its core was considerably less oriented and correspondingly much lower in tenacity. Overcoming this fiber inhomogeneity in PRD-44/amide continued as a major but unsolved objective. (Magat, CX-801, p. 12).

132. PRD-44/sulfuric acid (PPD-T-H_2SO_4) is Du Pont's code name for fiber made from poly (p-phenylene terephtahalamide (PPD-T) and where highly concentrated sulfuric acid is used. Thus PRD-44/sulfuric acid is not formed in situ. Instead, the PPD-T polymer was made using an amide solvent in

a mixing vessel under conditions which permitted the production of a polymer with high inherent viscosity. After polymerization, the PPD-T polymer was precipitated with water, separated from the amide solvent, washed and dried. Then the polymer was mixed and dissolved into highly concentrated sulfuric acid so as to form a liquid crystalline spinning solution which was then wet spun into fiber. (Magat, CX-801, pp. 12-13).

133. The examination of poly-1,4-benzamide at du Pont's Pioneering Research was stimulated by the issuance of Belgian patent 620,511 (OPI 3/9-15/64) and Luxemburg Patent 44,411 (3/10/64) to the Monsanto Co. The initial reaction was that this polymer could be a threat to the Nomex products venture. Further, there was the possibility that Pioneering Research records would show an early experimental record adequate for filing a U.S. Patent application. Such as action rested also on the provision that an immediate stude of the polymer proved it worthy of patent protection. (CX-803, #1, p. 3).

134. On April 29, 1964, P.N. Morgan, in a meeting with G.F. Lanzl and others, agreed to undertake the necessary study of poly-1,4-benzamide (a para-positioned polyamide) and S.L. Xwolek was assigned by Morgan to carry out experiments on the polymer when a search of the records showed only scanty data available in its files. This work was carried out under PX-35 and PX-266, "Polymer Scouting" and "Study of Intractable Polymers". (CX-803, 81, p. 3).

135. A patent proposal (Q-928), prepared by Morgan on May 6, 1964, was submitted in order to officially bring Pioneering Research interests to the Patent Division, to obtain prior art search, and to reach a decision on

filing before the anniversary of the Monsanto Belgian and Luxemburg patents. Eventually, a decision not to file was made because of lack'of experimental support in the early records. Statements in the patent proposal showed that the potential. of poly-1,4-benzamide was thought to be as a superior material in the form of strong, durable fibers, films, and fibrids having exceptional thermal resistance, electrical insulating properties, and resistance to hydrolysis. (CX-803, $1, p. 3).

136. Experimental work on poly-1,4-benzamide was started by S.L. Kwolek on June 3, 1964. On July 23, 1964, poly-1,4-benezamide (viscosity 0.78) was prepared from p-aminobenzoyl chloride hydrochloride by reaction in hexamethylphosphoramide. This polymer was soluble in DMAc-LiC1 and a somewhat fragile film was cast. Polymer with viscosity 1.77 was obtained on September 14, 1964. A broad search for useful spinning solvents was undertaken. Ethane-and methanesulfonic acids and antimony trichloride were solvents. Fair solutions were obtained with tetramethylurea Lid and further-experimentation later showed that repeated heating and cooling would yield a wet - or dry-spinning solutions. Self-supporting films were wet cast-crude spinning was done with a hypodermic syringe. There followed a period in which the preparation of monomer was perfected. On December 1, 1964, polymer with viscosity 1.14 was prepared in tetramethylurea without neutralization. wet-spinning from sulfuric acid was first done on January 15, 1965, with the production of fair fiber. These fibers were heat-treated at temperatures from 427° to 538°C. on a 3" hot shoe. The highest initial modulus was 132 gpd. Subsequent spinning from sulfuric acid yielded fibers with $T/E/M_i$ of 1.45/10.4/69 as spun and T/E/M of 2.6/1.54/244 after heat treatment at. 432°C.AmaximmniCof 343 gpd was attained. (CX-803, 41, p. 4).

137. On May 20, 1965, the preparation of tetramethylurea-LiC1 solutions of poly-1,4-benzamide for dry-spinning was undertaken. The observation was noted that these solutions showed pearlescence or birefringence when poured or distrubed. They were thought, therefore, to have the character of a dispersion of aggregates rather than true solutions. Dry-spinning on May 28, 1965 yielded excellent, bright filaments. The best as-spun sample had $T/E/M_i$ 6.0/2.2/430. Successive spins soon gave tenacities over 9 gpd and heat treatments gave initial moduli over 700 gpd, with sonic moduli as high as 1500. It was considered that an extraordinary organic fiber had beeh discovered, which property-wise was potentially superior to glass as a reinforcing material for plastics and rubber. The code, PRD-27, was assigned to the poly-1,4-benzamide program on June 15, 1965. (CX-803, 11, pp. 4-5).

138. Beginning in early October, 1965, M.W. Williams and W.P. Fitzgerald,were assigned to work under *Irwin* on polymer preparation and dry-spinning, respectively of PRD-27, P.S. Antal was assigned to work under L.F. Beste on solution preparation and new solvents. The process at this point was that developed by S. L. Kwolek, wherein the polymer was prepared in an amide solvent but isolated, dried and redissolved. Because of the critical nature of these procedoies, variability in intermediates, and the many idiosyncrasies of this polymer system, *a* long period of difficulties with reproducibility ensued. (CX-803, 41, *p.* 6).

139. Kwolek in the sixties observed that the spinning solution of PRD-27 in TMU-LiC1 was unusual in that it had a persistent pearly character (birefringence) under even mild shear. The solution, when dry or wet spun, gave oriented fibers directly, whereas such spinning normally yields completely unoriented fibers. The degree of orientation was increased considerably by increased spin stretch ratio and even to a greater degree by a

simple short-term, high temperature treatment. Casting of films on a glass plate led to orientation and low tear strength in the transverse direction. Sulfuric acid,.as.a solvent, gave clear solutions which produced none of these results. The, pearly (birefringent) quality was absent in TMU-LiC1 solutions at low concentrations or. with polymers having ninh below about 0.7. (CX-803 #1, p. 16).

140. R. Scott (Jan•ary, 1966) noted and measured the exceptionally high refractive index of PRD-27 and PPD-T. He noted the tendency of the PRD-27-TMU solutions to form a partially oriented net work of fibrils on drying and that the as. spun-fiber had a similar character. The small fibrils were found to have higher orientation than the total as-spun fiber and there was a perfection of alignment of fibrillar elements on heat treatment. He developed an orientation function to replace x-ray orientation angle in the description of fiber quality. Other simple microscopic tests were devised to distinguish spinnable solutions. (CX-803, tl, p. 17).

141. Ryas tts. Kwolek in 1965 who discovered that certain para-positioned polyamides could be dissolved and spun into fibers having high modulus and tensile properties. Prior to that time, para-positioned polyamides were regarded as essentially intractable and not capable of being formed into fibers. She also discovered that under .certain conditions, solutions or "dopes" of these para-positioned polyamides were in a liquid crystalline state (i.e., anisotropic state) and, when properly wet or dry spun, fibers -retained the high degree of orientation imparted by the spinneret prior to coagulation into fibers. The fibers "as-spun" were oriented and had high modulus (stiffness) and relatively high tenacity (tensile strength) without subsequent drawing. Wheh given a heat treatment the fibers underwent recrystallization which raised these properties still higher. In previous high strength synthetic fibers such as industrial nylon, any orientation

imparted to the spinning solution by the spinneret was lost by relaxation of the polymer melt or solution. As a result-fibers were unoriented upon solidification or coagulation and the as-spun fibers had to be subsequently drawn to achieve acceptable orientation and crystallinity. (Magat, Cx-801, pp. 5-6).

142. A notebook record dated June 17, 1965 stated that Ms. Kwolek was successful in obtaining fibers with very high modulus from poly-1,4-benzamide. (PRX-27) (CX-803, 12).

143. Pioneering Research at Du Pont discovered three basic concepts in 1965 which led to the choice of poly-p-benzamide as the preferred candidate Eor initial scale-up. The three new concepts discovered were (1) that p-aromatic polyamides are capable under certain conditions (It solids, solvent type, temperature) to give liquid crystalline anisotropic spin dopes, (2) these anisotropic dopes upon wet or dry spinning retain the high degree of orientation imparted to the fibers prior to coagulation to give high tenacity, high modulus fully drawn "as-spun" fibers (all other known polymers relax prior to coagulation), and (3) as-spun fibers upon brief heat treatment at around 500°C. undergo a recrystallization process which raises fiber modulus from a level of 500 to over 1000 and the tenacity from 12 to 18 gpd. (CX-803, p. 2).

144. Prior to 1966 PRD-44 (poly-p-phenyleneterephthalamide) along with PRD-27 (poly-p-benzamide) was considered an essentially intractable polymer, soluble only in very strong acids. Non Du Pont literature references as late as April 1969 continued to describe both these polymers as "only . difficulty soluble" or "virtually insoluble". (CX-803, 15, p. 1).

145. A Du Pont report (PR-166-1341'for the period 11/1/65 to 5/15/66 and dated 11/16/66 by T.I. Bair stated thatthe discovery that poly-1,4-benzamide, called an AB polyamide, based upon a p-phenylene backbone, exhibits a very high initial modulus has stimulated considerable interest in polymers which may have equivalent or superior properties and offer advantages in cost or processibility. AABB, p-phenylene poly-amides differ from their AB analogs only in amide sequence an were said to *be* logical candidates for initial investigations. Under the heading Summary and Conclusions was the following:

> Preliminary work has shown that poly(-phenylene terephthalamide), the AAB analog of poly-1,4-benzamide, can, be wet spun from sulfuric acid into a water bath. The fibers have the highest modulus of all the AABB polymers spun (272 gpd.). This modulus is considerably lower than that of poly-1,4-benzamide spun from tetramethylurea/lithium. chloride but is higher than the modulus of heat treated poly-1,4-benzamide spun from sulfuric acid. ,Further work .reqPired to establish the maximum properties of poly(E-phenylene terephtalamide) and to discover other solvents.
>
> The discovery of mixed solvent systems,. such as N,N-dimethylacetamide/tetramethylene sulfoxide/lithiuM chloro, has made it possible to spin and evaluate poly-(chloride-E-phenylene terephthalatide) and copoly(E-phenylene/2,6-dichloro-E-phenylene terephalamide). Poly (chloro-E-phenylene terephthalamide) and poly(2,6-dichloro-E-phenylene terephthalamide), polymers in which fifty percent of the aromatic units are chloro-substituted, yielded fibers with good properties but a modest initial modulus (150-170'gpd.) when compared to poly-1,4-benzamide. Fibers from copoly(E-phenylene/2,6-dichloro-E-phenylene terephthalamide)_ (0.6/0.4 used) in which only twenty percent of the aromatic units are chloro-substituted had a somewhat higher modulus (215 gpd.).
>
> The majority of the 1-aromatic polyamides were readily prepared in high molecular weight by known methods in amide solvents. Post-neutralization of reaction media with lithium

> oxide or calcium oxide was found to be advantageous with some chloro-substituted polymers which otherwise gave low molecular weight. Presumably both peutrazlization of protonated amine groups and solubilization of telomers by generated Lithium chloride or calcuim chloride are needed for continuation of the polymerization in these cases.
>
> The solubilities of several AABB, 2-aromatic polyamides in solvents such as N,N-dimethylacetamide/lithium chloride and N,N-diacetamide/tetramethylene sulfoxide/lithium chloride were found to be correlated to the degree and symmetry of chloro-substitution. Those polymers possessing the highest degree and least symmetry of chloro-substitution are the most soluble, and those possessing no chloro-substitution the least soluble.

It was said that the preparation of PPD-T had been disclosed in the literature but that no claim or disclosure of a fiber from the PPD-T polymer was known to the author. Under a section entitled "III. Polymer Spinning" it was stated:

> PPD-T. The low solubility of PPD-T in existing solvent systems has precluded dry-spinning this polymer. An attempt to wet-spin a 2% solution in HMPA-TMSO-LiC1 into a water bath gave filaments which could be wound-up, but which fused on the bobbin and could not be backwound. This as probably due to a large quantity of residual solvent.
>
> on the other hand sulfuric acid solutions were wet-spun with a mechanically driven syringe-type apparatus into a water or dilute acid bath (see Table XV). Further spinning designed to find the optium conditions is part of the current program on PPD-T.

Table XV shows that the sulfuric acid used was concentrated sulfuric acid. wet spinning of PPD-T in HMPA TMSO/LiC1 gave poor results. Bair did show that PPD-T could be wet spun from sulfuric acid into a water bath to give fibers with a modulus of 212. (CX-803, *7; CX-803, p. 4,; CX-803, 85).

146. A Du Pont report (PR-66-196) for the period 5/15/66 to 11/15/66 and dated March 3, 1967 by T.I. Bair summarized his work conducted in

this period as follows:

High tenacity, high-modulUs fibers have been obtained from high molecular weight *:'1y(E-phenylene terephthalamide) wet-spun from hexamethylphosphoramide/n-methyl-2-pyrrolidone/ lithium chloride. Single breaks on drawn and annealed fiber has given values for T/E/Mi as 'high as 10/2.1/492. Even higher properties should be obtained with further experimentation designed to'find the optimum draw temperature and ,,ratio, as well as annealing temperature.

Preliminary work on spinning sulfuric acid solutions has yielded, after drawing and the annealing, poly(E-phenylene terephthalamide) fibers with T/E/Mi = 4/1.6/350.

The tensile properties of as-spun fibers of poly-(E-phenylene terephtahalamide)/poly-1,4-benzamide (0.5/0.5 used) and poly(E-phenylene terphtalamide)4,4 ^{1}-bibenzamide (0.5/0.5 used) copolymers were found to be similar to those of poly(E-phenylene terephthalamide) of comparable inherent viscosity. These fibers•could be draWn at relatively low temperature (300°) but higher temperaturei gave brittle fibers. Similar drawing behavior is observed for fibers of poly(E-phenylene terephthalamide) when the inherent viscosity is below 1.9.

New mixed amide/lithium chloride solvents have been disCovered for AAB0,.2-aromatic polamides, which are comprised of hexamethylphoshoramide and tetramethylurea, dimetylacetamide, or 14-methyl-2-pyrrolidone. The first wo mixtures give good. solutions with copolymers, but the third is more satisfactory for poly (E-phenylene terphthalamide). A mixture consisting of two parts heramethylphosphosamide and one part N-methyl- 2-pyrolidone (by vol.) and containing lithium chloride in an amount such that the molar ratio of salt to polymer-amide-links is 1.75 was found to be the best solvent for.poly1E-phenylene terephthalamide) at low temperatures.

Control of the inherent viscosity of poly(E-phenylene tecephtalamide) by a number of chain terminators was evaluated and found to be feasible up to an inherent viscosity of 1.4. BecauSe the reaction of E-phenylene-diamine with terephthaloyl chloride is quite rapid, up to 95% of the final inherent viscosity being reached within a few minutes, the degree of polymerization in the higher range is affected as much or more by small and difficulty controllable changes in reaction conditions as by changes in the amount of chain terminator.

> Several E-phenylene/2-biphenylene polymers have been prepared, but only poly(benzidine terephthalamide) has been prepared with an inherent viscosity of 1.0. in order to achieve high molecular weight with benzidine, a new polymerization medium was developed consisting of 2,6-lutidine as acid acceptor as an amide solvent. (RX-803, HI, pp. 1-2).

147. Bair in his March 3, 1967 report under the heading "Polymer Spinning" and subheading "Sulfuric Acid Solutions" stated that PPD-T and its copolymers give spinnable solutions in concentrated sulfuric acid; that extruded filaments from concentrated sulfuric acid are somewhat weaker than those spun from BMPA-N,P-LiC1 and only high inherent (viscosity = 2.0) polymer has given good spins; that spins employing medium inherent polymer gave weak filaments which are difficult to wind up without breaking; that all spins from sulfuric acid have been carried out on the motor driven syringe-type apparatus and somewhat better results may be expected with better equipment. (RX-803, #8, p. 18).

148. Bair in his March 3, 1967 report under the heading "Polymer Solubility" stated that p-aromatic polyamidies have long been regarded as among the least tractable polymers dissolving only in such strong solvents as sulfuric acid and chlorosulfonic acids; that certain amid-inorganic salts have been shown to be excellent solvents for many p-aromatic polyanides but that PPD-T has at best marginal solubility in these systems. (RX-803, 118, p. 14).

149. All of the work reported in the Bair March 3, 1967 report was with PPD-T viscosities which were in the range of 2.5. (RX-803,._88, pp. 18-21; RX-803, p. 4).

150. Du Pont's P.W. Morgan in a notebook entry dated March 28, 1966 stated:

> Wet-Spinning Combined with Dry or Space Spimning.
>
> As a route to increased flow orientation and capture of this state in the fiber, we could extrude viscous solutions of PRD-27 and kindred polymers from fine-hole spinnerets with the maximum or at least high spin stretch factor into air and then before the stream of solution has time to relax and disorient, pass it into a coagulating bath of suitable composition. Thus sulfuric acid solutions could 'be extruded into air in a downward manner and passed into water or other coagulant and wound up.
>
> The air space should probably be quite'small, prdbablY' one-half inch or less. Such a system also possesses the advantage. of permitting the spinneret temperature to differ quite markedly from that of the bath and could have specific use in this way. That is, the solution might reqUire high (50°C) temperature or low f 25°C) whereas the bath could be at 25°C.
>
> The above process could be used to:achieve'the high oider desired in PRD-27 fibers but using solvents not at present considered useful for dry spinning such as DAMc, and those such as H2SO4 which have not yet yielded a high-modulus product by wet spinning. (Morgan Notebook p-2994,4X-281 p. '0008555).

151. As reported in a memo dated_March 10, 1967 byR.S. Irwin to Dr. Magat, an evaluation from Oct. 1965 to Feb. 1967 by P.S. Antal of alternative solvents for 1, AB, led to Antal's discovery that NMP-LiC1 was superior in solvent power to TMU-LiCl. Antal noted thehigh birefringence and anisotrophy of such solutions at rest., Under shear, e.g. between microscope slides, in capillary flow, or between contra-rotating copcertric cylinders; these dopes exhibited unexpectedly high flow birefringence. High orientation in the direction of shear was confirmed by x-ray diffraction. On removal of the shear stress, the dope Lost orientation at a very slow rate. Relaxation time varied from several seconds to many minutes, depending on temperature.

concentration, and degree of pre-shear. It was said that 1,4B dopes consist of a multiplicity of birefringent domains, oriented at random with respect to one another; that this led Antal to the concept that PRD-27 spin dopes were crystalline liquids comprised of small regions or domains; that within each domain the molecules have an overall preferred orientation; that the domains have no distinct boundaries and are fluid and deformable; that their scattering of light through narrow angles indicated an average domain size of the order of 3-59; that this corresponded with the dimensions seen under the polarizing microscope; that the sub-domain level 1,48 tends to exist as molecular aggregates rather than single molecules; that the domain structure disappears at low concentrations (ca. 4%) of polymer, and with increased LiC1 content the molecules deaggregate as well; that dilute solutions containing much LiC1 are essentially true molecular solutions. It was said in contrast to the structured spin dopes, 1,4B solutions in sulfuric acid are isotropic and behave as true molecular solutions; that orientation under shear is of a very low order, and this relaxes very fast when shear is removed; that Antal has demonstrated, that special low temperature dissolutions techniques can yield structural solutions of 1,4B in sulfuric acid; and that this structure is easily destroyed on warming, even to room temperature. Accordingly it was said that Antal has provided a useful working hypothesis as to the importance of liquid crystallinity in PRD-27 spin dopes for providing uniquely high orientation in as-spun PRD-27 fibers, in contrast to all other solution-spun fibers; that_1,413 dopes at rest, already possess a high degree of molecular alignment within domains; that by extrusion through a spinneret those domains become highly aligned and elongated; that alignment eventually becomes such that domain boundaries disappear and highly oriented solution jet emerges from the spinneret; that spin stretch is highly important in maintaining shear on the dope from this point on, so that molecular orientation is maintained or even enhanced; that in addition, the relaxation times are so long that the fiber is set up into highly oriented arrangement before any orientation can be lost; that by contrast sulfuric acid dopes of 1,4B are poorly oriented on extrusion through a spinneret and they relax so East that the resulting fiber is appreciably oriented only in the skin while the interior is a poorly oriented spherulitic arrangement. (CX-803, #9, pp. 1-2).

152. As further reported in the memo dated March 10, 1967 by Irwin to Magat, it was said that Antal having identified a connection between liquid crystallinity in.PRD-27 spin dopes and good fiber properties, devised a method to measure quantitatively this property; that in contrast with isotropic spin dopes, e.g. 1,48 in sulfuric acid, 1,4B solutions in amide-salt systems strongly depolarize plane polarized light that a beam of polarized light is completely extinguished by a polarizer normal to the direction of polarization; that an interposed thin layer of 1,4B dope depolarizes the light with the result that a large part of the light beam is now transmitted; that the ratio of transmitted to incident light is a measure of depolarization; that this characteristic is general for 1,4B in other solvent systems and provides the general definition of a useful spin dope - those which, in a layer 70 thick, cause at least 10% depolarization of light; that arising from this work of liquid crystal solutions is the general concept that linear stiff aromatic p-benzamides in solution should provide liquid crystalline solutions and highly oriented as-spun fibers. (CX-803, 49, p. 3).

153. A Du Pont report (PR-67-86) for the period Nov. 15, 1966 to June 15, 1967 and dated October 23, 1967 by T.I. Bair under "Summary and conclusions* stated in part:

> Two AABB, i-aromatic polyamides, poly(1,4-phenylene terephthalamide), PPD-T, and poly 2-cholo-1,4-phenylene terephthalamide), UPPD-T, and the AB-AABB ordered copolymer, B-PPD-T, have been found to give anisotropic (liquid crystalline) dopes in amide-salt solvents. During the investigation of these and other rigid polymers, it was found that 100% sulfuric acid was an excellent solvent for obtaining anisotropic dopes of numerous AABB, R.-aromatic polyamides as well as PRD-27.

(CX-803, #10, p. 1)..

154. A Du Pont memorandum dated September 28, 1967 from T.I. Bair to R.P. Barkley of Du Pont's Patent Division stated in part:

> - A Celanese patent (U.S. 3,154,613) discloses the use of sulfuric acid and fuming sulfuric acid with at least 1% of a salt such as (NH4)2804 as spinning solvents for PPD-T and similar p-aromatic polyamides (PRD-27 is not included). An investigation of added salts to anisotropic PPD-T sulfuric acid dopes has just begun. Preliminary data has shown essentially no difference in dope character upon the addition ofIga2SO4 or (N114)2SO4to an anistoropic dope of PPD-T•in 0-.81 SO3(H2SO4). These dopes have been used to prepare fibers, however, data is not yet available for comparison with dopes containing no salt.
>
> High as-spun properties and very high modulus Fibers appear to be related to the ability of the polymer to give an anisotropie dope. Numerous p-aromatic polyamides have been found to give this character in ca. 100% sulfuric acid. Table VI is a list of these polymers. Three of these polymers, PPD-T/BB (50/50), C1PPD-L, 4B-T(1:1:1), and B-PPD-T have been spun from anisotropic, sulfuric acid dopes. Data on

as-spun fibers is tabulated in Table VII. (Rx-2226, p. TC112310).

155. A Du Pont report (PR-68-48) for the period June, 1967 to January 1968;(part-time) and dated August 30, 1968 by T.I. Bair involved the discovery that anisotropic dopes could be obtained with many p-aromatic polyamides in around 100% sulfurit acid. This discovery was said to provide a lead to a new, inexpensive process for spinning, which could be applied to a wide range of polymer compositions as well as a greatly extended range of molecular weights. (CX-803, *12, p. 1).

156. The Du Pont report (PR-68-48) dated August 30, 1968 by T.I. Bair under the heading "Summary and Conclusions" stated impart:

> High tenacity, super-high modulus fibers of both PRD-27 and PRD-44 have been obtained from liquid anisotropic, sulfuric acid dopes. PRO-27 filament moduli up to 946 gpd and tenacities greater than 15.0 gpd have been attained upon heat treatment. Similarly, PRD-44 has given. moduli of ca. 900 gpd and tenacities up to ca.,,15,0,gpd. •
>
> The modulus of heat-treated PRO-27 and PRD-44 has been correlated with the crystalline orientation,ang11! (O.A.). All fibers having an O.A. of about12° or lesshave had an initial modulus of 500 gpd. The tenacity of drawn fibers increases with increasing tenacity of the as-spun fibers. In general, the tenacity of drawn PRD-27 is greater than that of comparably treated PRD-44. .) ,
>
> A new lead in processing as-spun fibers was found during the latter part of this investigation, which consists of a "wet drawing" step with or without an annealing step7. The new treatment yields fibers which, in practically every case have a higher orientation and modulus (and. generally a higher tenacity) than fibers which are' dried prior. to drawing.
>
> The maximum tenacity for as-spun PRD-27, and PRD-44 has been about 7.0 gpd with moduli over 200 gpd.. The properties of as-spun fiber improve with increasing polymer inherent viscosity and decreasing crystalline orientation angle.

Other process and polymer variables affecting the properties of as-spun fiber includes the following:

1. Better as-spun fiber properties were obtained from dopes containing lesser amounts (preferably 5%) of free sulfur trioxide.

2. In general, the lower the polymer inherent viscosity the lower should be the acid strength in order to obtain satisfactory fiber.

3. Several spinning experiments with varying spinneret hole size indicated the properties of as-spun fiber spun from a relatively large hole (5 mil) were inferior to those spun from smaller holes (2 or 3 mil diameter).

4. Baths with up to 501 H2504 were found suitable for PRD-27 (ninh 2.5) at 10% solids, but baths containing much larger quantities were unsatisfactory.

***

Very little, if any, degradation or sulfonation of PRD-27 or PRD-44 was found to occur during the spinning-coagulation of the sulfuric acid dopes. Analyses of fibers for sulfur showed that a maximum of one out of one-hundred aromatic rings could have been sulfonated during the complete dissolution-spinning process.

PRD-27 and PRD-44 gave anisotcopic dopes in highly concentrated sulfuric acid. Three parameters associated with this phenomenon were investigated: 1) polymer concentration, (2) acid strength, and (3) polymer inherent viscosity. It was found that a minimum acid strength was required in order to obtain a liquid anisotropic dope. The minimum acid strength for PRD-27 (Binh = 2.7) is ca. 98.51 H2SO4 (by wt.). A slightly higher strength was necessary for PRD-44. Anisotropic dopes did not form until a critical amount of polymer was dissolved. This critical amount was higher for sulfuric acid than for amide-salt. The critical amount decreased slightly with increasing polymer inherent viscosity. (0(-803, pp. 2-3).

157. In Report PR-68-48, issued in 1968, Bair discussed results. from the previous year. to the introduction, he wrote:

High modulus fibers are being developed under the PRD-27 program for use in rigid compotites and as tire cords which

> will be superior to available materials on a cost-performance basis. The PRD-27 program has developed yarn of extraordinarily high tenacity and initial modulus (T/M_i = 20 gpd/I000 gpd) from liquid anisotropic amide-salt dopes. The discovery that PRD-27 polymer as well as other pare aromatic polyamides such as PRD-44, poly(1,4-phenylene terephthalamide), gave liquid anisotropic systems in ca. 100% H2SO4 ptovided a lead to a new, inexpensive process for spinning, which could be applied to a wide range of polymer compositions as well as a greatly extended range of molecular weights. Both expansions of applicability could yield products with improved property levels. (CX-803, p. 2).

158. The Du Pont report (PR-68-48) dated August 30, 1968 by T.I Bair under the subheading "B. Dopes" stated that:

> Early work . . . with sulfuric acid dopes of all-pars, aromatic polyamides dealt with concentrated (95-981)H2SO4. Solutions of PRD-44 and PRD-27 in 95-98% H2SO4 are isotropic and have short relaxation times when sheared. A consequence, of this behavior is that orientation is imparted only to the outer portion of the fiber during extrusion and coagulation giving a fiber with a thin, tough, highly-oriented skin and-an unoriented core. Anisotropic dopes of PRD-27, PRD-44 and poly(2-chloro-1,4-phenylene tenephthalamide), C1PPD-T, in amide-salt solvents develop high orientation under shear, and this orientation is maintained in the fiber during the spinning process presumably because of the large relaxation time relative to the coagulation time.
>
> The discovery that ca. 100% H2504 and fuming sulfuric acid gave anisotropic dopes with numerous all-pare, aromatic polyamides ... led to the present investigation of these systems. An immediately obvious advantage of sulfuric acid as a solvent is the ability to dissolve high molecular weight polymer at relatively high solids content (10%); and a primary objective of this research was to exploit that behavior by using dopes of very high inherent viscosity (nnih 3.0) polymers.
>
> Anisotropy Variables - Four parameters were investigated to varying degrees: (a) polymer concentration, (b) acid strength, (c), polymer inherent viscosity, and (d) added salts such as sodium sulfate.

(CX-803, p. 14).

159. The Du Pont report (PR-68-48) dated August 30, 1968 by T.I. Bair under the subheading "As-Spun Fiber" stated in part:

> <u>Anisotropic</u> <u>v.</u> <u>Isotropic</u> Dopes - Previous investigations ... with isotropic and liquid anisotropic, amide-salt dopes of pRD-44 and C1PPD-T showed as-spun fiber from anisotropic dopes exhibited superior properties to those from compariable isotropic dopes. An evaluation of C1PPD-T dopes in DMAc-LiC1 containing various volume percentages of liquid anisotropic phase showed that ca. 5.0% (or less) of anisotropic phase was satisfactory for obtaining superior as-spun properties. Unfortunately, all attempts to separate the sulfuric acid dopes into two separate phases have failed because of the high solution viscosity of these dopes. However, if the dopes are allowed to stand for several weeks at room temperature, a partial separation occurs giving a clear, isotropic phase and a still very cloudy and imperfectly separated anisotropic phase which by visual estimation comprises 20-50% by volume of the total dope. The anisotropic phase in many instances solidifies on separating, indicating its meta-stable nature.
>
> The difference in solution viscosity of sulfuric acid isotropic and anisotropic dopes has been noted above. The extremely high viscosity of the isotropic dopes at high solids limited to some extent the range of solids which could be spun conveniently; consequently, most spins of isotropic dopes were conducted with ca. 5-7% solids. Previous studies of fibers from isotropic dopes of PRD-27 in 95-98% H2SO4 are given in Tables VIII and IX. This early work used only medium molecular weight (ninh 2.0) polymer and gave low as-spun fiber properties. Fiber with initial modulus of ca. 400 gpd and tenacity of ca. 5.0 gpd could be obtained with multiple annealing (see Table IX). Early work with PRD-44 in 95-98% H2804 has been previously reported .... Somewhat better as-spun fiber was obtained than with PRD-27 (as would be expected from the coagulation studies previously mentioned); however, high temperature drawing, at that time, gave Eiber similar to that obtained for PRD-27 from 95-98% H2SO4.

(CX-803, 12, p. 22).

160. in the Du Pont report (PR-68-48) dated August 30, 1968, by T.I. Bair the properties of as-spun PRD-27 fiber were shown to be dependent on the strength of the sulfuric acid Data showed a decrease of filament tenacity,

initial modulus and orientation with increasing acid'strength from 99.7 to 104.5%. It was said a similar study was not inaugurated for PRD-44; that the PRD-44 dopes must be made from higher strength sulfuric acid than for PRO-27 in order to obtain Liquid anisotropic dopes; that PRD-44 is less soluble in a given sulfuric acid and, although higher strength is required, precipitation also occurs at a higher strength; that the probable net result would be that PRD-44 dopes can tolerate higher absolute SO_3 content but that relatively higher SO_3 content could be expected to give data similar to PRD-27; that since the properties of as-spun PRD-44 fiber from an isotropic dope are higher than comparable PRD-27, one would expect higher properties even with a large quantity of SO_3 in the dope; that an examination of the data in Tables XI and XIII tends to bear out this hypothesis; however, only. up to 101.1% H_2SO_4 was used in PRD-44 spin dopes. (CX-803, #12, pp. 25-26).

161. In the Du Pont report (PR-68-48) dated August 30, 1968 by T.I. Bair under. the sub-heading "Bath Temperature" it was stated in part:

> In several spins of PRD-44 from sulfuric acid the temperature was varied over a range of 30-40°. Data from these spins (e.g., P3280-47, P3280-124, P3326-96, Tables XI and XIII) indicated no great change with temperature in the 20-60°C range. More or less typical results are shown below for spin P3280-124.
>
> PRD-44 AS-SPUN FIBER OATH TEMP.
>
> | Temperature | S.S.F. | Tenacity | O.A. |
> |---|---|---|---|
> | 30° | 1.8 | 3.8 | n45° |
> | 40° | 4.05 | 3.9 | n45° |
> | 65° | 4.0 | 4.4 | n40° |

> Generally, higher spin-stretch factors were obtained at the higher temperatures and slightly higher tanacities and lower orientation angles for polymer with inherent viscosities 3.5. The small amount of date on polymer of very high inherent viscosity (3.5) indicated the lower temperature region may give better properties. It was convenient to operate in the middle range (30-40°C) bath as a compromise and because at lower temperatures the spin dope cooled as it reached the spinneret and became very viscous, thereby requiring very slow spinning in order to keep the pressure under ca. 400 psi. However, spinning at lower temperatures could be carried out with the small gear-driven apparatus where the dope remains at room temperatures.

Table XI showed the P3280-47 series to be at 12% concentration; the P3280-124 serves at 11% concentration; and the P3326-96 serves to 10% concentration. A P3280-54 was at 15% concentration. The concentration of sulfuric and was at least 99%. (CX-803, 412 p. 30 and Table XI).

162. Bair in the August 30,1968 report (PR-68-48) found that high tenacity, super high modulus fibers of PRD-44 could be obtained from anisotropic sulfuric acid dopes. The best heat-treated filaments of PRD-44 had tenacities up to 15 gpd and moduli of about 900. PPD-T polymers used in this work had viscosities in the range of 3.3. The maximum tenacity for as-spun PRO-44 was about 7.0 gpd with a modulus of over 200. Bair noted that the properties of as-spun fibers increased with polymer viscosity. Much of the PPD-T polymer used in the investigation was prepared by Veronika Foldi who worked out a simple laboratory procedure which allowed reproducible preparation of PPD-T at an level of 3.5-4.1. (CX-803, p. 5).

163. Bair in his report PR-68-48 dated August 30, 1968 obtained his best fiber properties at 10% PPD-T concentration, as-spun tenacity up to 7 gpd and initial modulus of 200 gpd. These properties were however, inferior to

those of PRD-27. (CX-306, pp. 1-2; Magat, CX-801, p. 13).

164. Bair in his report dated August 30, 1968 (PR-68-48) for code p 3280-54 sample at 101.26% concentrated sulfuric acid and 15% concentration of PRD-44 (Table XI) showed a resultant tenacity of 3.83 gram per denier, 5.5% elongation and initial modules of 174. For 13% concentrations of PRD-44 (Code P 3280-75) (Code P 3326-100) (Table XI) the tenacities were at least below six (Table xIII). (RX-134; Blades Tr., pp. 800-804).

165. A Du Pont report (PR-68-110) for the period August 1, 1967 to April 1, 1968 (part two) and dated December 18, 1968 by T.I. Bair stated that in contrast to the somewhat limited solubility of 2-aromatic polyamides in amide-salt solvents, high molecular weight random copolymers of PRD-27/PRD-44, PRO-27/ PPD-188 and PRD-44/PPD-BB are very soluble at very high molecular weight in ca. 100% sulfuric acid. Other acids such as chlorosulfuric acid and hydrofluoric acid were said to have been found by others to be powerful solvents as well. It is said that it is desirable to use anisotropic dopes when spinning 2-aromatic polyamides In order to obtain superior properties; that previous work on PPD-T and 1,413 had shown that an acid strength of at least ca. 98.5% H_2SO_4 was required to give anisotropic dopes of 1,4B of inherent viscosity 2.72; furthermore, the acid strength required increased with increasing polymer molecular weight; that an acid strength of ca. 99% H_2SO_4 was found to be required for PPD-T of inherent viscosity 3.32; that the maximum solubility in 100% H_2SO_4 of these PPD-T and 1,48 polymers was found to be 10.5% and 11.8% respectively; that the solubility is greatly increased by copolymerization of all pare monomers. Under the subheading "inherent viscosity" it was stated that the efficacy of high molecular weight

for sulfuric acid spinning, as against tow molecular weight had been noted in previous investigations. An isotropic dope of PPD-1,48-T (1:3:1) in 95.9% H_2SO_4 was said to give fibers inferior to shore spun from anisotroic dopes. (CX-803, 1 14, pp. 12, 14, 15).

166. In the report (PR-68-110) dated December 18, 1968 by T.S. Bair, it was said that previous data on PRD-27 and PRD-44 showed these polymers (with viscosity ca. 2.0) no longer gave anisotropic dopes in acid strengths much under 99-100% H_2SO_4;• that as one lowered the molecular weight the minimum acid strength required was reduced somewhat but still remained ca. 98% H_2SO_4;• that this coupled with the observed increase in inherent viscosity at ca. 100% H_2SO_4 indicated the possibility of a small conformational change leading to a less rod-like molecule; that the fact that copolymers form anisotropic dopes in 95.5% H_2SO_4 (and quite possibly even lower acid strengths) lends credence to the hypothesis that PPD-T or ,4B does not form an anisotropic dope in "ordinary" concentrated H_2SO_4 because of a positive interaction parameter. (CX -803, 1 14, p. 26).

167. Bair in his report PR-68-110 also wrote:

> Although low molecular weight (...(viscosity) 2.0) random copolymers are soluble in "single" amide solvents such as DAMc/LiC1, the isolated, high-molecular-weight copolymers inh 3.0) were found to be only slightly soluble even in the more powerful mixed amide solvents, such as EMPA/NMP/LiC1 from which clear, flexible films could be wet-cast. A11 of the copolymers were found to be soluble and gave liquid anisotropic dopes in 100% H2SO4. Many gave liquid anisotropic dopes even in ordinary concentrated (95-98% by wt.) sulfuric acid. (RX-135, p. 0014958).

168. Under Summary and Conclusions in the Bair report (PD-68-110) dated December 18, 1968, it is stated in part.

> In general, sulfuric acid spinning of all-para aromatic

> polyamides has not given fibers with as high a level, of tensile properties as does PRD-27 spun from amide-salt solvents. However, as-spun fiber properties of random copolymers were distinctly superior to those of PRD-27 and PRD-44 spun from sulfuric acid. The reasons for this superiority are not fully understood, but felt to be related to a favorable mode of coagulation of the copolymer dopes and in part to the ease of processing dopes of very high molecular ($_{inh}$ 4.0) copolymers. (CX-803, 1 14, p. 1).

169. Thomas I. Bair testified in deposition testified that in his work in 1967 and 1968 he did not heat the dope, the spinneret or the coagulation bath. (Bair, Dep. RX-24, pp. 65-66).

170. A Du Pont report (PR68-65) for the period January - June 1968. dated August 26,1968 and by V.S. Foldi stated in part.

> 4,4'-Diaminobenzanilide was copolymerized with terephthaloyl chloride (T) and/or 4,4^{1}-bibenzoyl dichloride (BB) over the range 1/0 to 0/1 T/BB. All polymers had high to very high inherent viscosity. Ahisotroic spin dopes in 99.21 to 100.7% sulfuric acid were wet spun into water. After annealing at 580-600°C$_4$ all fibers were well oriented (0.A 10-14°), had tenacities 10 gpd. and initial moduli ("1) 500 ..,
>
> 2. Spinning
>
> Anisotropic spin dopes containing 10-11% solids were easily prepared in 99.2-100.71 sulfuric acid by stirring appropriate amounts of polymer and solvent at room temperature in a closed system. The dopes were centrifuged before spinning.

(RX-258, pp. 1, 7).

171. A Du Pont report (PR-68-60) for the period January 1968 to June 1968 and dated August 15,1968 by H. Mukamal under the heading "Summary and conclusions" stated in part.

> The high level of as-spun yarn properties of PRD-27 spun from DAMc/LiC1 (T/Mi = 10/450) has not been obtained with PRD-44 spun from sulfuric acid (T/Mi = 6/300). However, these properties are comparable to PRD-27 spun from sulfuric acid indicating deficiencies in the spinning system and not in the polymer itself. Photomicrographs of PRD-44 as-spun fibers show highly oriented skin and a disoriented core accounting for the low as-spun properties of PRD-44. The low level of tensile properties is due to poor coagulation which should yield to further research. An additional difficultly

> is that
> H 4 SO PRD-44 solution anisotropy, which is considered a prerequisite to high as-spun tensile properties, is sensitive to water content ... and temperature. Anisotropy may be wholly or partially lost (disorientation) as water in the coagulating bath dilutes the spinning solution, or it may be lost be heat development in the cell or in the coagulation bath.

(CX-803, 1 15, p. 1).

172. The August 15, 1968 report (PR 68-60) by H. Mukamal under the heading "Effect of Acid Strength on Anisotropy" stated in part:

> B. <u>Results</u>
>
> 1. <u>Anisotropy-Isotropy Considerations</u>
>
> The importance of anisotropy to the formation of high strength fibers has been demonstrated for PRD-27 in amide/salt solvent systems .... It has also been demonstrated that sulfuric acid is a solvent capable of forming anisotropic solutions for PRD-27 and PRD-44
>
> * * *
>
> Although dopes of PRD-44 can be made in any acid strength for 96% to over 102% sulfuric acid the range of anisotropy is very limited... The following conclusions ..., can be made:
>
> 41.) Below 99.5% sulfuric acid an anisotropic dope cannot be made.
>
> (2.) The solubility region of PRD-44 (...[viscosity) = 3.3) in weak sulfuric acid (99.51-100.0% sulfuric acid is limited to 9.51-101. Therefore, any dope made up of higher concentration (111 or 12%) has solid particles.
>
> (3.) Dopes made up of strong sulfuric acid (102% sulfuric) are not spinnable and contain considerable "gel".
>
> (4.) Therefore, the useful range for spinning anisotropic dopes is limited to 99.5-101% sulfuric acid and to solute concentrations of 9.5-12%.

(CX-803, 1 15, pp. 11-12).

173. The August 15, 1968 Mukamal report (PR-68-60) stated:

> This investigation has demonstrated that ... (2) ... lower coagulating bath temperatures and lower acid strength ... all favor higher tensile properties;

> 6. The Effect of Bath Temperature and Solvent Acid Strength on Yarn Properties
>
> The two most ,important variables in the PRD-44/sulfuric acid spinning have been pinpointed to bath temperature and solvent strength. The effect of these two variables is shown in Figure 5. Two trends are observed. Stronger yarns are obtained at lower acid strength of solvent at any given temperature. Secondly, colder bath temperatures are preferred. The implications of these observations, primarily the former, are that best properties can be expected for isotropic dopes if these lines extrapolate linearly (see Figures 4 and 5). This point is certainly to be investigated. Secondly, the effect of temperature is less certain but for the runs which are reported, a decrease in the temperature of the bath is helpful, especially at higher acid strength solvent. The different in tenacity. between 18°C and 4°C increases with increasing acid strength. The two lines appear to converge at the point where anisotropy first begins to form at 99.5% sulfuric acid. These results suggest that the polymer chains in the fibers are not well aligned and that anisotropic-isotropic disorientatins take place before the fiber is completely set. These suggestions are reinforced by the skin-core nature of these fibers '...

Figure 5 show temperature of 4°C and 18°C and solvent strength from 99.7 to 100.7% H_2SO_4. MX-803, pp. 2, 14).

174. Mukamal by the work reported in his report PR-68-60 dated August 15, 1968 concluded that the as-spun tensile properties of PPD-T were increased to 10 gpd by proper election of coagulation bath conditions. However, Dr. Mukamal was not able to obtain as-spun properties as good as PRD-27 (1, 48) fiber. Mukamal°8 fibers had very strong and oriented skin surfaces while the core portions were poorly oriented accounting for the lower as-spun fiber properties. (CX-807, p. 1). Dr. Mukamal concluded that the "useful range" of PPD-T concentration for these spinning dopes was "9.5-121". (CX-807, p. 12(b)(4)), because he had found that the solubility range of PPD-T in 99.5-1001 sulfuric acid was "limited to 9.51-101" and "any dope made up of higher concentration (118 or 121)

has solid particles." (CX-807, p. 11(b)(2)). (Blades, CX-801, pp. 13-14).

175. A Du Pont report (PR 69-6) for the period July 1, 1968 to January 30, 1969 and dated July 1, 1968 to January 30, 1969 and dated June 30, 1969 by M.T. Waroblak under the heading "Introduction" stated in part:

> A high tenacity, high modulus fiber has been a goal of Pioneering research efforts for the past several years. . PRO-27 (poly-1,4-benzamide) has been the leading candidate in this area with as-spun yarn properties of T/E/M1 10/6/450 and 18/2/1000 when heat-treated at 600°. However, the estimated selling price at 20% return on investment was almost $1.00/lb more than the minimum price necessary to capture the 100 MM lb/year market opportunity indicated by IPRL for a high performance tire yarn. In contrast, cost estimates showed that PRD-44 (poly-p-phenylene terephthalamide) could capture this market because polymerization intermediates (PPD and TC1) were almost $1.00/lb cheaper than P-3 (p-aminobenzoyl chloride hydrochloride) used in the polymerization of PRD-27.
>
> In the past, work on PRD-44 has been mainly concerned with spinning redissolved polymer from H2SO4 and HF. Although properties were much lower than PRD-27 spun from DAMc, these studies clearly showed that PRD-44 and PRD-27 gave similar properties at a given inherent viscosity. Furthermore, similarity in structure strongly suggested that PRD-44 had the potential of obtaining the same high tenacity and modulus levels as PRD-27. These facts led us to scout for a suitable amide solvent/salt system in which PRD-44 could be prepared and spun. T. I. Bair, who carried out most of the early work on PPD-T, had found several solvent mixtures for isolated polymer.... Our approach was simply to apply recent PRD-27 technology particularly neutralization with Li2CO3 to the preparation of PRD-44 in these and other amide solvent systems.

(CX-803, 1 16, P. 9).

176. A Du Pont report (PR-68-140) for the period June 1968 to November 1968 and dated February 27,1969 by H. Mukamal under the heading "Introduction" stated:

> PRO-27 (poly-1,4-benzamide) is currently being developed at Pioneering as a low density, high strength, high modulus

> fiber for plastics reinforcement applications. While as-spun PRD-27 yarn (Ten = 11-12 gpd, M1 - 450 gpd) performs exceptionally well as a tire yarn, its high cost, primarily a result of high intermediates cost, may limit its acceptance in the tire cord market. PRO-44 (poly-phenleneterephthalamide) is a potentially cheaper candidate due to lower monomer cost (savings of 1.00 lb of polymer.
>
> Attempts have been made to determine if PRD-44 is capable of reaching the high tenacity, high modulus levels of PRD-27. Since PRD-44 had not yielded to dissolution in amide/salt systems (from which PRD-27 is spun) spinning has been restricted to strong acid solutions. (e.g. H2SO4, HF). High tenacity yarns were not obtained but this was- attributed to the acid solvent systems since high PRD-27 property levels could not be achieved either. The recent discovery that high molecular weight PRD-44 could be prepared in and spun from HMPA/NMP gave us the first opportunity to determine the potential of PRD-44 from a solvent system which was similar, though not identical, to the PRD-27 system.

Under "Summary and Conclusions" it stated in part:

> A recent spin of PRD-44 spun into a coagulating bath containing HMPA, NMP and Lid gave high tenacity, high modulus yarn (T/E/M1 = 11.4/6/300), thus proving PRD-44 is capable of achieving PRD-27-like properties. The addition of salt to the coagulating bath appears to be a prerequisite to reaching this tenacity level since without it the highest property level achieved under a variety of spinning conditions was T/M1 = 9/300. This lead is being actively pursued.

(CX-803, 1 17, p. 1).

177. A Du Pont report (PR-69-43) for the period August 1968 to January 1969 dated August 25,1969 by J.A. Fitzgerald stated that:

> PRD-27, poly-1,4-benzamide, has generated considerable attention PRL due to its high as-spun yarn tensile properties (T/R/M1 = 12/7/450), and the fact that it can be heat treated to a very high tenacity, superhigh moduluS. fiber (T/E/M1 = 16/2/1200). PRO-44, PPD-T (poly-para-phenylene terephalamide), had previously been shown to yield spinnable solutions from in situ polymerization of PPD and TC1 in mixed amide solvents.... Since the *AAB* polymer has potentially the same type of fiber properties as PRD-27, and represents a savings of approximately $1.00/1b in monomer costs, it became a logical alternate to PRO-27. Previous attempts to wet spin the in situ polymerized solutions (hexamethylphosphoramide/N-methylphrrolidone-2 solvent) into water as coagulant had resulted only in weak, chalky, defect-ridden fibers having

> T/E/M1/0.A. (filament) of 6.2/6.0/230/35° .... Clearly, a different mode of coagulation was needed to demonstrate the. potential of PRD-44 in rubber and plastics reinforcement applications.
>
> The objections of the report were:
>
> 1. Investigate non-aqueous coagulants as a route to strong, tough yarn from PFD-44/BMPA/NMP spin dopes.
>
> 2. Gain insight into the coagulation mechanism of PRD-44 dopes spun into aqueous and non-aqueous spin baths.
>
> A severe limitation of this process was the slow speed at which fibers with these properties could be produced (20 spin jet velocity with a spin-stretch factor of 1.5).

(CX-803, 1 18, p. 1; CX-803, p. 6).

178. A Du Pont report (PR-69-15) for the period August 1968 to March 1969, dated July 10, 1969, and by F.L. Killian stated in part:

> 7. Anisotropic Dopes
>
> When PRD-44 polymer is dissolved in highly concentrated sulfuric acid, it forms anisotroic dopes at solids concentrations above a Certain level. T. Bair has previously investigated the effect of polymer concentration, acid concentration, and polymer inherent viscosity on the formation of these dopes .... If the critical concentration is defined as the minimum polymer concentration necessary to form an anisotropic solution, then this has been found to be almost independent of the acid concentration once the minimum H2SO4 concentration is exceeded. However, the critical concentration was found to be dependent on molecular weight (inherent viscosity) of the polymer. Since we have prepared PRD-44 of higher molecular weight than had been previously evaluated in this respect, we determined the critical concentration of PRD-44 with inherent viscosities of from 4.35 to 6.3 in 100.3% H2SO4. The results are in Table X and plotted in Figure 4, including the points obtained by T. Bair. Previous results had indicated that the concentration of polymer necessary to form an anisotroic solution would decrease as the molecular weight of the polymer increased. The present results show that the critical concentration levels off at about 8% solids for polymer with inherent

viscosities from 4-6. In addition to the titration technique of T. Bair used to determine the above values, a solution of PRD-44 with (viscosity)... = 6.31 was prepared directly at 8% solids. This solution was isotropic, confirming that for PRD-44 with (viscosity about)... 6 the critical concentration remains above the 8% solids levels.

In contrast to these results, polymer with (viscosity)... = 12.4 formed an anisotropic solution in 100.25% H2SO4 at both the 8% and 7% solids level on a small scale in a test tube.• This may indicate that the critical concentration does decrease gradually at higher molecular weights.

C. Discussion

The use of concentrated sulfuric acid ([about)... 100%) as a solvent for wet spinning of high modulus aromatic polyamide structures would appear to have two distinct advantages over spinning from amide/salt solvents: 1) capability to spin much higher molecular weight polymer, and 2) preparation of spinning solutions containing higher percent solids. Present amide solvents for the spinning of PRO-44, for example, have been restricted to polymer with (viscosity less than a equal to)... 5, whereas PRD-44 with inherents as high as 6.5 have given spinnable dopes in H2SO4. Before this advantage of sulfuric acid as a solvent can be utilized;.a definite property advantage of high molecular weight will have to be demonstrated. Although tenacity increased with the inherent viscosity, it is still at a level below what may be obtained from spinning comparable molecular weight polymer from amide/salt solvent. In other words, a <u>higher</u> inherent viscosity polymer must be used in sulfuric acid spinning to obtain the same tenacity available from lower inherent viscosity polymer in amide/salt spinning. Although fibers obtained from sulfuric acid are lustrous and tough, they are not completely homogeneous. Imperfections in the form of incursions are still present in most fibers, and may be limiting properties. At the present time there seems to be insufficient data available to decide whether there are any other advantages to high molecular weight. Additional work will have to be done in this area.

Although PRD-44 solutions in sulfuric acid can be prepared at higher percent solids than are possible in amide/salt systems, these solutions are much more viscous than those normally encountered in wet spinning. Anisotropic dopes can be prepared in the region from about 8-10% solids, and the viscosity of these solutions is highly dependent on polymer inherent viscosity. Dopes prepared from polymer with (viscosity about)... 4 are fluid, but the description of a dope prepared from polymer with nn 6 would be more like a "dough". These dopes can only be spun by using pressures

> above 1000 psi and at slow delivery rates. Under our spinning conditions, a dope consisting of polymer with (viscosity)... = 6.4 at 10% solids was spun at the rate of less than 3 ml/min through a 500-hole 1.5-mil spinneret, giving a jet velocity of 18,5 ft/min. The pressure required to extrude this dope was 1350 psi. A filter pack consisting of a 125-mesh stainless steel screen and a 3-micron porosity polypropylene felt was used in the spinning of the dope. It seems likely that in order to continue spinning high molecular polymers from sulfuric acid, spinning equipment capable of withstanding higher pressures should be designed. It would also be useful to have the necessary equipment designed for preparing and handling viscous sulfuric acid solutions.

(CX-803, 1 30, pp. 22-23).

179. Killian in his report PR-69-15, dated July 10, 1969 stated in part:

> Wet Spinning of H2504 Solutions
>
> High molecular weight PRD-44 dissolved in concentrated sulfuric acid In 100%) to form anisotropic solutions at from 8-111 solids which were wet spinnable. Delivery rates were low In 20 fpm) due to the high bulk viscosity 3000-10,000 poise) of these solutions. Lustrous, high strength fibers could be prepared by spinning through very small hole size spinnerets (i.e., 500-hole 1.5-mil) into iced water baths (temp. 5°C). Yarn properties as high as T/E/M/i/Den = 12.0/5.9/361/942 were obtained from polymer with n = 6.4. (RX 2019 at 0023690).
>
> *
>
> 2. Dope and Spinning Varibles
>
> Since previous investigations had determined the effect of certain dope and spinning varibles on fiber properties, no attempt was made to further investigate all these parameters. For these variables we chose to select the best conditions, and used those throughout most of the program. From previous results it appeared that changing sulfuric acid concentration does not greatly affect fiber properties as long as anisotropic dopes are formed. Thus in this investigation sulfuric acid ranging in concentration from 99.7-100.6% was used. Most of the dopes were prepared at the 10% solids level, although a few were prepared at 91 solids level.

(CX-803, 1 30, pp. 2, 11).

180. Killian also in his report PR-69-15 dated July 10, 1969 stated:

> a. Spinneret and Bath Temperature.
>
> It has now been shown that hole size is important in determining fiber structure, but that bath temperature must be as low as practical in order to observe this effect. When PRD-44 was spun into aqueous baths 5°C, lustrous fibers were obtained. As the temperature of the bath was raised, fiber luster decreased until dull, delustered fibers resulted at room temperature.

(CX-803, 1 3, p. D023700)•

181. Dr. Killian in the work reported in his report PR 69-15 used very high molecular weight PPD-T (inherent viscosity above 4 and as high as 13) and his spinning solutions contained 101 PPD-T in approximately 1001 sulfuric acid. Killian however encountered very significant processing problems -- very high viscosity of the spinning solution (10,000 poise or about 100 times more viscous than PRD-27), very low spinning speeds (20 feet/minute) and the need to use very small spinneret holes (1.5 mil diameter) to minimize fiber inhomogeneity. The dopes were so very viscous, that, some were like "dough". Dr. Killian noted that these dopes "can only be spun by using pressures above 1000 psi and at slow delivery rates". (CX-808, p. 23). In March 1969 this campaign was discontinued. (Blades, CX-801, pp. 14-15).

182. A memorandum dated Dec. 9, 1969 from A.J. De Dominicis to R.E. Wilfong on PRD-44 Sulfuric Acid Spinning referred to the mention by Wilfong that the solvent power of sulfuric acid may be so high as to prevent the formation of PRD-44 liquid crystals and thus the potential of this system for preparing high tenacity, high modulus as-spun fibers may not have been assesed. It was said that Du Pont's best fiber properties (T/E/M/Den = 12/5.9/360/942) were achieved with <u>anisotropic</u> sulfuric acid dopes; that in order to make these solutions it was necessary to use H_2SO_4 which

contained less water than the usual commercial sulfuric acid solutions (984): that Wilfong's comment regarding the addition of water to achieve anisotropy and consequently reduce bulk viscosity, which is a serious draw-back of this system (30,000 poise), is contrary to what was actually found, that his suggestion that salts he added to decrease bulk viscosity had already been tried with a variety of salts being added to both the spin dope and coagulating bath and that any improvements, if any, on performance were small. Additional information was said to be obtainable from T.I. Bair, PR-68-48, 68-110, H. Mukamal, PR-68-60, and F.L. Killian, PR-69-15. (RX-62).

183. On page 3 of a copy of the December 9, 1969 memo from DeDominicis to Wilfong, Magat wrote "air gap may do better" (Magat, Tr. p. 43).

184. In the Dec. 9, 1969 memo df DeDominicis to Wilfong the following advantages of a PRD-44/H_2SO_4 vs. PRD-44/Amide System were set forth:

1. High Tenacity with High Elongation
2. Higher MW Polymer
    - Improved Creep, Pioneering Flex Life,
3. Higher Solids
4. Compact, "homogeneous" Fibers
5. High T/High M HT Fibers
6. No salt extraction; inexpensive solvent
7. Solvent Recovery

The following disadvantages were noted:

1. Higher NW Required to Achieve equivalent Ten
2. High Bulk Viscosity
3. Low Delivery RAteS
4. High ninh "Thermal" Polymerization polymer prepared in (HMPA/NMP)

5. Low Denier versatility

Small Holes, Low SSF

(RX -62).

185. As reported in a November 23, 1970 P.S. Antal memo to J.R. Weinlich in late 1969 and early 1970 the assignment of Antal to the PRD-58 (PRD-44 (PPD-T)) project was to find leads to improved spinning of PRD-44 amide solvent dopes, aiming at high, reproducicle yarn tenacity. Antal reported his supervisor, H. Blades, scouted spinning of these and low-concentration H_2SO_4 /polymer systems. He found a 10% PPD-T/H_2SO_4 dope of Blades to contain about half isotropic phase; the obvious conclusion, that much higher concentrations could be dissolved for better spinning was discussed with H. Blades (3/19, 3/23, 4/8/70, NB (notebook) P-4037-33), also the design of a polymer dissolver, using reciprocating flow to mix such high % dopes adequately (= H. Blades twin cylinder extruder). Antal had previously made and extruded anisotropic "28% 2-T/H_2SO_4 ' dope (10/16/69, NB P-3271-142), studies phase changes in 15% PPD-T/H_2SO_4 (1/15/70, NB P-4077-9) and recommended spinning of higher concentration amide dopes (2/6/70, P-4078-85). 4•R study of PPD-T/H_2SO_4 phase changes was recommended (3/23/70, P-4078-101). (RX-181).

186. Blades testified that it was his feeling that Antal had not made the suggestion to Blades to use higher concentrations of PPD-T In sulfuric acid. On a copy of the Antal Nov. 23, 1970 memo to Weinlich, there is a note by-Magat dated Sept. 1, 1971 to the effect that Antal was reporting to Blades; that Blades discussed some of his activities with Antal and gave Antal some of his spin dopes for examination; that Blades does not remember a direct suggestion of Antal. The note is unclear as to what the suggestion is (RX-82; Blades Tr. pp. 814-818).

187. In deposition Antal testified that on 3/19/70, 3/23/70 and 4/18/70 he discussed with Blades concentration of PPD-T in sulfuric acid at concentrations higher than 10 percent. Antal was then working for Blades. He testified he probably discussed with Blades heating the PPD-T sulfuric acid system to increase the amount of soluble polymer but that Antal's main point was the difficulty of mixing the system with respect to the 15% PPD-T sulfuric acid system referred to in Antal's Nov. 23, 1970 memo. He was not sure if he made the solution up or received it from somebody else. Antal testified that 96 percent represents ordinary commercial grade sulfuric and that he did heat the 15% PPD-T sulfuric acid system up to 70 degrees. In heating, Antal converted the system from an anistoropic system to a totally isotropic system. A notebook entry dated 5/4/71 of Antal stated that when he first suggested the spinning of 20 percent PPD-T/H_2SO_4 to Blades, Antal assumed that wet-spinning could be used as well as air-gap spinning. The air-gap feature, although convenient, was said to be incidental. (Antal Dep., RX-23, pp. 78-82, 88-96, 100-101).

188. A Celluca report (Cellura Report PR-71-40, RX-79) relates to preparation of certain polyamide copolymers. Page D019062 indicates that a copy was distributed to "T.F. Patent Division Files." Under the heading "Patent Situation" (p. D019066) it is stated:

> Both (PPD-B)-T and PPD:T:B fibers having high modulus are included in 10-1031R-1 (Kwolek '542). Air-gap spun fibers will be encompassed by applications Q-1123A (Blades '7561/1127. Monsanto holds a patent on (PPD-B)-T polymer (U.S. 3,354,123/1967) and has disclosed fibers in patents and publications.

The Cellura report, which covers the period August 1970 through February 1971, deals with the preparation of and the wet and air gap spinning of 4,4'-DART termed also (PPD-B)-T and random copolymers of like 4,4'-DABT, termed PPD:T:B. The report indicated that excellent fibers were produced by air gap spinning those polymers in 99+% sulfuric acid:

> These polymers were air-gap spun from 99+% sulfuric acid and coagulated in water. Under these conditions, high to superior tensile properties were obtained (filament T 18g/d). ... Preliminary evaluation of dipped cords has shown PPD:T:B (43:43:14) to be superior to NP-9 (PPD-T) in performance. (RX 79 p. 0019063).

> (PPD-B)-T was prepared over an inherent viscosity range of 2.0 to 7.5, air-gap spun from 99+% sulfuric acid and coagulated in water. Properties were high with filaments reaching a tenacity level of 17.0 g/d. (RX 79 p. D019063)

> It has been demonstrated that fibers obtained from air gap spinning of sulfuric acid solutions of PPD-T are far superior to those processed via normal wet spinning. It follows that the extension of this process to other polymer systems could he equally as beneficial and possibly produce alternate candidates to PPD-T for tire cord (NP-9), as well as composite (PRO-44-III) and body armor (PRD-59) materials. 'Based on earlier performance in wet spinning (PR-68-65; PR-68-110) and investigation into the properties of copolymers (PPD-B)-T and PPD:T:B (X:X:Y) seemed appropriate. Furthermore, the characterization of these polymers was needed to assist the definition of new process and product patents. (RX-79 p. D019064)

> The spinning of (PPD-B)-T and PPD:T:B (up to 30 mole % B) from sulfuric acid with an air gap produced fibers with improved properties relative to those obtained from normal wet spinning. (RX-79 p. D019064)

> At room temperature anisotropic spin dopes can be prepared from 20% solids in 99+% sulfuric acid. (RX-79 p. 0019071)

> The best filament properties obtained were T, 17.4,; E, 3.9; Mi, 618 and WTB, 0.406. The tenacity and modulus values are much higher than those obtained from normal wet spinning, i.e., T, 6.4; and Mi, 173. Even polymer with low molecular weight (2.0) produced improved fibers T, 13.7; E, 3.2; Mi, 611; and WTB, 0.233. (RX-79 p. D019072)

1. Spin Dopes

When prepared at room temperature, two types of spin dopes were observed. The first type, from polymer with $.0, were stiff, non-fluid putty-like substances which became fluid uniform dopes only upon heating and mixing. When examined on a hot stage microscope, the uniform dopes remained anisotropic up to 125° at which temperature the observation was terminated. The second type of dope resulted from polymer with 4.5. When preparation was initiated at room temperature (actual dope temperature -60°), these dopes were fluide and showed a pearlescent sheen when stirred. After mixing, uniform dopes were obtained in which the anisotropy was equally persistent. (RX-79 p. D019073)

2. Spinning

Air gap spinning from sulfuric acid of these polymers was consistently smooth and produced fibers with high-to-superior tensile properties (15 or = or = 34g/d). ... Spin stretch factors (SSF) varied from 1.0 to 10.0. For polymer with ninh 5.0 SSF of 5 to 6 produced superior properties. Coagulation of the fibers was accomplished by jetting into water at an average temperature of 4°C. (RX-79 p. D019074)

3. Fiber Properties.

Polyer compositions ranging from 5.0 to 30.0 mole t 1,4B gave high-to-superior fiber properties when air-gap spun from sulfuric acid. (RX-79 p. D019074)

189. It was known within Du Pont before December 1969 that the tenacity of p-aramid. fibers was related directly to the spinning stretch factor (SSF) at which they were prepared. (Mukamal report PR-68-140, RX 463 p. D023555-6) The relationship between tenacity of such fibers and the spinning stretch factor (SSF) was also known to be linear, i.e., that tenacity increased with increase in SSF, prior to December 1969. (Schaefgan Laboratory Notebook P-3471, RX 2170 p. D018907).

190. Du Pont included copolymers like 4,4'DABT in its aramid development program. V.S. Foldi prepared such copolymers in 1968. She spun fibers from anisotropic dopes using 100% sulfuric acid and obtained tenacities and moduli of 6.4 and 171, and 10.0 and 827, for as-spun and heat-treated fibers, respectively. (Foldi Report No. PR-68-65, RX 258 p. D025840, Table III). Folli's work was incorporated in Kwolek's '542 and '587 patents as Example 31. (cf. Rx 258, Table III, with Kwolek ;542, RX 164, Examples 31-35, col. 51, line 21, et. seq.) Bair prepared random copolymers like 4,4'-DART in sulfuric acid in 1968. Bair spun."high" tenacity and "super-high" modulus fibers from 4,4'-DABT/H_2SO_4' His properties ranged from 11.3/243 (tenacity/modulus) for as-spun fibers to 20.1/1069 for heat-treated fibers. (Bair Report No. PR-68-110, RX-135 p. D014957-8, 0014970 and Table VII, notebook code P3381-88A). Bair's copolymers like 4,4'DABT were also incorporated into Kwolek's '542 and '587 patents as Examples 12, 13, and 14. (Bair Report PR-68-110, RX-135 at D014959, and cf., e.g., Table IV, notebook code P3381-84, with Kwolek '542, RX-164, col. 35, 1. 62; and Table VII, notebook code P3381-88A, with Rx 164, col. 35, 1. 69).

191. A Du Pont report (PR-70-114) for the period April 25, 1970 to December 1970, dated February, 1971 by J. A. Picard,stated in part:

> **INTRODUCTION**
>
> When PPD-T (the polymer of PRD-58) powder is mixed in about a 20/80 ratio with 100% sulfuric acid, a doughy mass is formed. By jetting or extruding this dough back and forth between two heated piston-cylinder sets, H. Blades refined it into a liquid spin dope. Before larger hydraulic cylinders could be installed to scale up the process, F. L. Killian showed that continued hot stirring in a resin kettle (100 °C), could also refine the dough to a spin dope consistency. But, severe polymer degardation was observed due to prolonged heating needed to make a fluid dope with the low shear

stirrer used. The objective of the work described in this report was to identify suitable equipment for PRD-58 dope mixing and spinning needed for rapid scale up of yarn . preparation for product assessment.

***

SUMMARY AND CONCLUSIONS

Equipment was successfully demonstrated to mix PRD-58 dope and to spin yarn required for product evaluation. (1) A kitchen type cake mixer used in a dry box was found workable for quick incorporation of sulfuric acid and PPD-T polymer powder into a roughly mixed dough. The W & P twin screw extruder at EDL was found to be capable of refining the roughly mixed dough into a good spin dope. A nylon melt pump was found satisfactory for pumping PRD-58 dope through a filter pack and spinneret (Tower 10). "Dynalloy" stainless steel filter sheeting was found to be an effective filter and provided significant improvement in spinning continuity. These elements, were successfully combined by M. T. Waroblak who used the kitchen mixer to prepare PPD-T/H2SO4 "premix" which after freezing and granulating was fed to the EDL extruder to give a continuous stream of smooth uniform dope. The dope was pumped via a nylon melt pump to a spinning head connected with the extruder, filtered through "Dynalloy" filter sheeting and extruded to give poundages of PRD-58 yarn of good quality. (2) A Ross planetary batch mixer was shown to be effective for preparing PRD-58 spin dope, and able to mix the dope under vacuum. These deareated dopes were spun by C. Shambelan and G. D. Forsythe using the above pump and filter system, yielding poundages of uniform high quality yarn.

On the basis of experience with the above mentioned equiPment, the requirements for good PRD-58 spin dope mixing may be summarized as follows: (1) The mixing action must be intermeshing or self-cleaning with no dead zones, otherwise some large lumps of polymer or dough will remain undissolved or unmelted, regardless of temperature. (2) The mixing must be under vacuum or followed by an effective deareating stage in order to avoid spinning discontinuities and filament defects. (3) The mixing shear must be as intensive as the best quality kitchen and bakery dough mixers provide. Less intensive action will not provide a smooth dope quickly enough to avoid serious degradation.

Additional metering, mixing and windup equipment specifically designed for PRD-58 has been tested and will be described in a forthcoming report.

(Rx-2151, pp. 1-2).

192. A Du Pont report NF-9-71-47 for the period Jan. 1971 to August 1971, dated March 15, 1972 by D.E. Plorde and B.R. Breslaw stated in part:

ABSTRACT

> NP-9 spin solutions must be deaerated prior to spinning in order to achieve spinning continuity and defect-free yarn. Yarn properties and defect ratings are a function of extent of deaeration. The density of solidified spin solution is a sensitive measure of extent of deaeration.
>
> Continuous deareration of NP-9 spin solution was demonstrated with a simple stirred, evaluation tank, and an in-line deaerator-blender was specified for the Spruance Market Development Facility. Two other types of thin film evaporators - Artisan's "Rototherm" and Cornell "Versator" were found to be less satisfactory in this application.
>
> As Artisan Industry "Rototherm", a wiped film evaporator, was evaluated as a back-up candidate for continuous NP-9 spin solution deareration in the Z-1 MDF. This equipment was successfully tested at a variety of conditions and resulted in consistently well deaerated spin solution (densities in 1.77-1.79 gm/cc in many cases). One problem with this equipment is the high temperatures resulting from the high shear rates (about 4000-7000 sec^{-1}) leading to significant inherent viscosity loss (6-10% ninh loss in the best case). This problem appears solvable with proper balance of jacket temperatures (10-15°C coolant was the lowest used in these tests), throughput, and rotor to wall clearances. This equipment would involve relatively higher investment compared to the simpler Blender-deaerator and therefore was dropped.

(RX-347, abstract; p. 2).

193. A Du Pont report for the period March 18, 1971 to November 10, 1971 (part time) dated February 25, 1972 by L. W. Gulrich stated in part:

ABSTRACT

> The effects of potential variables in the NP-9 process on yarn defects have been investigated. The most significant cause of defects is air or other gas in the spin dopes. Degassing to a spin dope density of 1.70 $g\text{-}cm^{-3}$ (solid dope at room temperature) leads to yarn with acceptable defect

> ratings, but degassing to as high as 1.75 g-cm $^{-3}$ may be needed longer range. Totally degassed dope density = 1.78 g-cm^{-3} may be needed longer range. •Totally degassed dope density = 1.78 g-cm^{-3}. Of possible polymer contaminants, only Na2SO4 and, possibly Fe2(604)3 have been shown to cause defects. However, presence of Na2SO4 has been determined to be unlikely because the reaction NaCl + H2SO4 to form Na2SO4 apparently does not occur in spin dopes (NaCI would be a contaminant resulting from underwashed polymer). Fe2(S03 will be minimized because of low solubility leading to excessive filter blinding and will not be significant as a defect-producing agent. Incomplete drying (5% H20) at high temperatures (160°C) is also a source of defects which appear as longitudinal. slits resulting from differential shrinkage between a "wet" core and arid skin. No defects of this type have been observed' thus far with current MDF drying conditions (145°, 10% H20) but these conditions are close to those which can cause defects and should be watched carefully.

(RX-322, title page).

The Z-Market Development Facility Basic Date Manual dated December 10, 1970 and referring to the "Spruance Fibers Plant" and in a section "Z-1 Basic Data PPd-T polymer/PS-3 Mixing" dated Feb. 10, 1971 referred to-polymer from the polymer blending tanks and filtered acid from the acid storage area being metered into a Readco continuous processor, mixed, deareated and then transferred to the spinning booster pump. It states in part:

> Deaeration of spin dope is required based on tests conducted. Deaeration is necessary from the standpoint of both spinning continuity and yarn defect content.

(11X-445, pp. TC52346, TC52461, TC52466).

194. The MDF-T Market Development Facility Basic Data Manual in a section dated May 29, 1971 provides a design of a blender deaerator (RX-445, p. TC 52478. Du Pont's Guirich recommended to management and to Janis a

minimum bulk density (Gulrich Dep., RX-33 pp. 25, 31), specifically that a dope density of 1.76 be used as a specification.. (Gulrich Dep., RX-33 p. 83). He testified further that degasification vacuum means were employed on MDF-I and MDF-II facilities. MDF-II was a large pre-commercial plant. Janis, editor of the MDF-I (RX-445) and MDF-II (RX-446) data manuals, testified as to the use of degasification, i.e., deaeration means, at MDF-I. (Janis Dep., RX-36 pp. 157-158). The 1979 Commercial Data Plant Manual shows the utilization of degaification equipment as being "required' with a target density of 1.77 g/cc. (RX-447, pp. TC51797, TC52054) Gallini testified that the preent commercial plant uses degasification of dopes. (Gallini, Dep., RX-2202 p. 30). DeDominicis testified at his deposition that deaeration of spinning dopes was critical in order to assure consistent fiber properties and that Du Pont deaerates dopes before it commercially produces the PPD-T filaments. (DeDominicis Dep., TX-31 p. 174).

195. Inventor Blades testified at the hearing that "there were reports or conclusions reached in reports made during the development stage when it was asserted that it was necessary.to deaerate the dope at least down to some minimum level," but that he did not find deaeration "necesary in laboratory experiments." (Blades, Tr. p. 821) Blades indicated that he believed MDF-I and MDF-II "had deaeration facilities." (Blades Tr. p. 821). Dr. Magat agreed that it was recognized inside Du Pont that it was either desirable or necessary to deaerate the spinning dope before extruding it but he said it was a "standard thing one does". (Magat, Tr. p. 576).

196. The Blades '756 patent provides that:

> It has been found advantageous in some instances to dearerate the liquid dope at reduced pressure prior to spinning.

(CX-6, RX-57, col. 6, Is. 73-75).

197. Du Pont's John B. Callini who worked on Du Pont's plant designated MDF-1 and has worked on the present commercial plant for "KEVLAR" testified in deposition:

Q. The spinning rate, wind up'rate, if }you know?

A.Well,-right now we're --- our most common denier product is 1,500 denier and that's being wound up at yards a miniute.

Q Is that what the plant was designed to produce?

A Eventually we'll be running at yards a minute.

Q Is the plant operable at yards per minute?

A Well, I think the mechanical equipment is not capable of going YArdaa_minute,as _Ws constructed right' now.

Q -Di4 you say-itls designed' to go but

But it's presently going Is that correct?

Q All right. Was it your testimony that you were involved in HDF-1 but not MDF-2 or do-I have that backwards?

A That's correct.

Q Was pressurized quench used in ?DP-1?

A No.

Q Is pressurized quenctrused in the present commercial?

A No.

Q All right. So pressurized quench was used in the MDF-2?

A That's correct.

(Gailini, Dep., RX-2202, pp. 6, 35, 37).

VIII. BLADES INVENTION

198. Inventor Herbert Blades is employed at Du Pont's Pioneering Research Laboratory. He has worked there for thirty years and presently has the rank of Research Fellow. He has a B. Sc. in Physics & Chemistry, an M. Sc. in Chemistry and a Ph.D in phYsical chemistry. (Blades, CX-827, p. 1).

199. One of Blades' first assignments at Pioneering Research Laboratory was to work on a method of making a paper-like, non-woven product which is now sold commercially by Du Pont under the Trademark "Tyvek° . He became a co-inventor of the spinning method which made the product commercial. It involved dissolving polyethylene in a low boiling solvent at relatively, high temperatures and spinning the solution through a relatively large diameter spinneret to form many small filaments which were later formed into a sheet and heat bonded together. He received United States patent No. 3,081,519 on March 19, 1963 for this work. "Tyiek" is now in widespread use for a number of different products including tear resistant mailing envelopes, book covers and disposable industrial clothing. (Blades, CX-827, p. 2).

200. About January 1969, inventor Blades joined Dr. Magat's group. His initial assignment was the measurement of the compressive strength of PRD-27. At that time, PRD-27 (1,4B polymer) was the leading candidate for development at Du Pont as a high tenacity, high modulus industrial fiber. PRD-44 (PPD-T polymer) was a backup candidate still being developed on a smaller scale as an alternative in case PRD-27 encountered serious problems. In both systems the polymer was polymerized in an amide solvent solution and the resulting polymer solution used directly as the spinning dope. In both cases the spinning solutions were wet spun. Around mid-1969 he was assigned the broad task of examining the wet spinning process, the rational being that both PRD-27 and PRD-44 developments used wet spinning, and a better knowledge of the basic process was desirable. (Blades, CX-827, p. 3).

201. One of Blades' first objectives in his new assignment was to develop a model which would describe the coagulation process for PRD-27 and PRD-44/spun from amide dopes into water. (CX-03, p. 10).

202. Inventor Blades examined all aspects of the wet spinning process, including in detail the swelling of the filaments in the bath. He also made calculations of solvent diffusion sates in the bath and made other observations which are supported by notebook data. Then he began work with an apparatus for wet spinning the amide dopes where he could observe the spun filament in the coagulation bath through a microscope. Using these results he formulated **a** conceptual model which would describe the coagulation process for PRD-27 (1,4B) and PRD-44 (PPD-T) being spun from amide dopes into water. He concluded that the coagulation process for these para-positioned polymers was completed within a few milliseconds in the bath beyond the spinning orifice. (Blades,'CX-827, pp. 3-4); CX-828, **pp**. 121-150; CX-829, pp. 1-57).

203. In his direct testimony Blades testified that extrusion of PRD-27 (1,48) and PRO-44 (PPD-T) liquid crystalline solution dopes through thn spinning orifice into water caused molecular orientation but stresses were developed which caused unwanted filament shrinkage and reduced orientation; that immediate windup tension before coagulation occurred was necessary to resit the stress formation. It was Blades' testimony that as the extrusion rate increased, the stresses increased and so did the need for higher windup tension; that when the windup tension exceeded filament strength, the filament broke usually at the force of the spinneret. (Blades, CX-827, p. 4).

204. Inventor Blades presented the results of his wet spinning studies, including the model, at an internal Du Ponta Research Review in November, 1969. After the Review discussions, a co-worker, Dr. Peter Boettcher, suggested that an air gap between the spinneret and the bath would be one way of influencing this early stage of coagulation. (Blades, CX-827, p. 4).

205. Inventor Blades on cross examination agreed that prior to the time that Dr. Boethcher brought to Blades attention the concept of an air-gap between the spinneret and the coagulation bath, Blades had no knowledge of that procedure in wet spinning; that he "in recent months" also learned that Dr. Boettcher received that idea of an air gap from a patent. (Blades, Tr. p. 660, 1. 10).

206. In deposition, Dr. Boettcher, regarding his suggestion to Blades to use an air gap, testified that he told Blades he had seen mentioned in a patent a spinning method which Boettcher thought would be useful in Blades' studies to determine the point at which the orientation occurs in Blades' spinning process Boettcher did not recall giving Blades a patent number. The patent was the tlorgan '645 patent. (Boettcher, Dep. RX-27, p. 7, 1. 8- p. 11, 1. 20).

207. At the hearing Blades testified that he remembered the Morgan '645, patent being given to him sometime after he made "my first spins with an air gap using amide solvents and beforeI did any work with sulphuric acid" Ind that the7Morgan.'645 patent" didn't tell anything about KEVLAR".

208. On November 7, 1969 inventor Blades experimented with an air gap using PRD-44 (PPD-T) amide dopes and succeeded in making fiber. He found that using the PRD-44 dopes and spinning through an air gap into a coagulating bath produced higher windup speeds and spin stretch (CX-829, pp. 124-27). He also got higher speeds using an air gap with PRD-48 (C1PPD-T) and PRD-27 (1,4B) amide dopes (CX-829, pp. 128-29). The air gap spinning did not improve the tenacity of any of these fibers. Based on the lab tests he concluded on November 26, 1969 and wrote. in his notebook that "The tenacity of filaments from EPRD744(P.PD'-T)1 with an .air gap was very poor,"and as regards PRD-48 (C1PPD-T), "There was no real difference between tenacity of filaments **as spun** with an airgap and the control" without an air gap (CX-829, **p**. 134). In fact as regards PRD-27 (1,48) Blades wrote in hit notebook on Nov. 26, 1969 that the tensile strength without an air gap was "slightly higher than the experiment which was spun with an,air gap". JCX-829, p. 136; Cx-827, p. 5).

209. With respect to Blades! experiment with the **air** gap on Nov. 7, 1969, Blades in tis notebook wrote:

> Following my review P. Boettcher made the suggestion that an air gap between the spinneret and the bath might have interesting results. I ,consider this a good idea because it will giye orientation produced by shear in the spinneret orifice time to relax and the fiber can then be stretched as a-solution first before it enters the bath. In this way, it will be possible to separate the orienting effects of shear in the orifice and spin stretch. (Blades Notebook P-3855, RX 166 p. D007806)

> This experiment demonstrates the feasibility of spinning with an air gap. Some precipitation occurred in the dope and this probably limited speed and spin stretch. The control was wound up at the maximum rate for this orifice velocity as were the air gap examples. The air gap clearly alleaws grater wind-up speed and spin stretch. (Blades Notebook P-3855, RX 166, p. D007808)

210. Confirming the notebook entry, and looking back on the situation approximately a year later Blades stated among other things, in a document entitled "Highlights of My Part in the Development of PRD-58" and dated Dec. 4, 1970:

> <u>Basic Study of Wet Spinning</u> (Begun about June 1969)
>
> The first objective was to develop a model which would describe the coagulation process for PRD-27 and PRD-44 which were being spun from amide dopes into water. At a review early in November, I presented results of experiments and theoretical arguments which indicated that the coagulation process was completed in a few milliseconds and the portion of the bath most involved was the first few millimeters beyond the orifice. Following the discussion at thit review, P. Boettcher suggested that dry-wet spinning where a small air gap is introduced between spinneret and bath would be one way of. influencing this early stage of coagulation.
>
> <u>First Air Gap Spinning</u> (Nov. 7, 1969)
>
> The first air gap spin was made Nov. 7. I called it air gap to distinguish from dry-wet spinning where the objective is to evaporate a portion of solvent before coagulation. The first experiments revealed that the air gap permitted great increases in spin-stretch, jet velocity and wind-speed. Improved orientation was forecast. During November PRD-27 and PRd-48 were air gap spun and the technique improved. The first bath with a flume was obtained from Boyer who had used it to quench PRD-10. It was established that multiple holes could be managed and that very high speeds would be possible. (RX 155 p. D132321)

211. Du Pont's position as to conception of the Blades' invention is that the "available information" does not permit an exact determination of the conception date but that "available information" does show that conception occurred in or about December 1969 Du pont response to Order No. 10, RX-2219 p. 137).

212. Anisotropic spinning dopes of PPD-T in sulfuric acid of 98 percent or more concentration were, well-known within Du Pont before Blades' first air-gap spinning of such a dope. (Blades, Dep., RX-26, p. 263, 1. 13- p. 264, 1. 16).

213. When Blades began to work with concentrated sulfuric acid, he unlerstood the concensus within Du Pont as to the preferred concentration of sulfuric acid when used as a solvent for PPD-T to be 100 percent sulfuric acid. (Blades, Dep. p. 41, Is. 3-8).

2114. On direct testimony Blades testified that it was the common wisdom at Pioneering, Research Laboratory that PPD-T polymer reacted with and was degraded by sulfuric acid at higher temperatures, and prior research efforts with PPD-T had been careful to carry out the mixing and spinning procedures at about room temperature. He further testified that he was the first person at Du Pont to prepare a spinning dope containing more than 12 percent PPD-T by heating. (Blades, Tr. pp. 783-784).

215. In a memo dated September 3, 1971 from inventor Blades to E.E. Magat entitled "Supplement To Highlights Letter" (Highlights of my part in the development of PRD-58, H. Bides to E.E. Magat, December 4, 1970), Blades stated that in June 1969, he was assigned by Magat to a basic study of wet spinning with the rational that PRD-27•was likely to become commercial so a. better understanding of the spinning process would be valuable. It was said

that out of this work came an understanding of the speed recitation in wet spinning and the idea of using an air gap to remove it. Under the subheading "PRD-44 in H_2SO_4-A. J. DeDominicis" was the following:

> PRD-44 offers lower ingredient cost vs. PRD-27 or -48; however, difficult solubility requires expensive mixed solvents and causes polymerization problems. Spinning from sulfuric acid might avoid these problems.
>
> Execellent properties have been obtained by spinning anisotropic solutions from 100% sulfuric acid 9T/E/M/Denier/dpf - 12.0/5.9/360/942/1/8). After heat treatment, properties of T/E/M/Denier 17.6/1/5/1082 were obtained. High molecular weight polymer (inherent viscosity 6.4) must be used to attain these properties.
>
> - This process is not attractive for scaleup:
> - PRD-44 must be polymrized in organic solvents, separated, then dissolved in 100% sulfuric acid.
> - Both solvent and sulfuric acid must be recovered.
> - Processing of spin dope at bulk viscosity 30M poise is difficult.
>
> Spinning rate must be very low (20 feet/minute) to attain desired physical properties.

The idea of using sulfuric acid was not new and at least two people had been assigned to try it. Although four reasons are listed as making the process unattractive, the general feeling outside the committee was that the main problem was the low spinning speed.

As a result of these committee meetings, R. E. Wilfong suggested more attention be given to sulfuric acid dopes. He was more impressed by their high viscosity than by the low spinning speed.

It was suggested by E. E. Magat that I include sulfuric acid dopes in my studies of wet spinning. In subsequent discussion with him, it was realized that an exciting opportunity existed. The major obstacle to the use of acid dopes had been very low spinnin4 speeds and we believed that an air gap would make high speeds possible. Many of the other advangates of acid dopes which have subsequently been realized were also recognized at this time.

> The preparation of spin dopes proved very difficult and an apparatus [a twin cylinder mixing device] was designed to do this more effectively. Because of the priority of PRD-27 development, construction was delayed and two and a half months passed before it was completed. The first experiments fin March 19701 confirmed the expected high speeds and as dope preparation was perfected,the superior properties also were obtained.
>
> The response to these findings was also mixed. There was skepticism on the part of the PRD-27 development group and from those, involved in othe spinning projects. There was immediate acceptance by E. E. Magat and other members of management. A supervisor and several research people were assigned and development proceeded rapidly in very favorable atmosphere.

216. Blades notebook page entry dated March 19, 1970 shows a sketch of his twin cylinder mixing device. The sketch was made on March 18, 1970 because that "was the first day I recorded an experiment using it". Blades testified that it took some time for the device to be built. The notebook page dated March. 18, 1970 stated "In the present experiment a ten percent by weight solution of PRD-44 polymer solution was mixed. This solution was prepared on 1/12/70, but due to poor mixing it was stored and not used. Blades testified that Jan. 12, 1970 was the date on which he had tried to make a dope in other equipment and not being successful he had saved it in a jar. (Blades, Tr. pp. 778, 779; CX-830 p. 25; CX-827, p. 7).

217. Blades designed the twin cylinder mixer which is shown in a sketch his notebook page dated March 18, 1970. He waited from mid-December 1969 into March 1970 for Du Pont's shop to make some parts he needed to assemble the mixer. (Blades, Tr. pp. 779-780; CX-830, p. 25).

218. Blades' twin cylinder mixer shown in his notebook entry of March 19, 1970 was used with a waterbath and had a spinneret holder. Because of the water bath, Blades had to remove the spinneret at the time he was making the dopes. The twin cylinder mixer with water bath allowed Blades to

mix lopes at higher temperatures than room temperature but not to spin the dopes. (Blades, Tr. p. 782).

219. Blades used sulfuric acid of about 100% concentration in his first air-gap spins of PPD-T/H_2SO_4 dopes. (Blades Notebook P-5016, RX-183, p. D007863, et. seq,; Blades, Tr. pp. 762-63). Blades reported his first air-gap spins of PPD-T/sulfuric acid dopes in report PR-70-131. (BX-191). That report does not disclose a sulfuric acid air-gap spin using less than about 100% sulfuric acid. '(Rx-191, Tables I through VIII). Notebook P-5016, covering Blades' work from February 10, 1970 to April 16, 1971, and thus Blades' first year of air-gap spinning, discloses the use of acids of about 100% concentration. (RX-183).

220. Inventor Blades recorded his first experiments with the twin cylinder mixing device on pages 25 and 26 of his notebook dated March 18, 1970. (CX-830).• A previously prepared 10% PPP-T sulfuric acid dope was mixed and spun, at room temperature, through an air gap into a coagulation bath of water and also by conventional wet spinning. The experiments demonstrated that sulfuric acid solution can be spun using an air gap and that high windup speeds can be attained with high spin stretch. He did not check the fiber properties. (Blades, CX-827, p. 8).

221. The next entries in Blades' notebook (CX-830, pp. Z7-33) indicate that he prepared dopes similar to those used by Dr. Killian in Killian's earlier efforts - 10% PPD-T in 100% sulfuric acid. He used the twin cylinder mixing to mix and spin the dopes at room temperature, but he spun them through an air gap rather than directly into the water bath as Dr. Killian had. The results showed Blades that an air gap provide higher spinning speeds (CX-830, p. 28), but the as-spun properties of the fibers were

"not good" - tenacities being only 3.5 - 5.4 gpd compared to Killian's high of 12 gpd. Blades also noted that the fiber modulus was "suprisingly low and may indicate poor orientation". (CX-830, p. 29). Blades repeated this experiment spinning with a 10% PPD-T sulfuric acid dope and an air gap making an effort to remove air bubbles Erom the dope which he throught might be causeing the poor fiber properties. But the properties did not improve and he concluded that the air bUbbles were "not responsible for the poor properties". (CX-830, p. 31, dated March 23, 1970; Blade's CX-827, p. 9).

222. Then Blades made a 10.2% PPD-T sulfuric acid dope in his twin cell mixer by first stirring the mix in a beaker with a rod which formed a "tacky dough". Thereafter he cut the dough into chunks and mixed it in my device by numerous cycles of flow from one vessel to another. He then spun fiber both with an air gap and withOut an air gap. (April 2, 1970 notebook entry CX-830, p. 32). The fiber properties with no air gap "were comparable to the air gap experiments" (CX-830, p. 33; Blades, CX-827, p. 9).

223. Up to this point in the work Blades had mixed and spun the sulfuric acid dopes at about room temperatue as Killian and others before him at Pioneering had done. Now Blades experimented with a 12.3% PPD-T sulfuric acid dope. This time as he mixed the dopes in is twin cylinder device (notebook CX-830, p. 34, April 3, 1970 entry), Blades applied heat at 55°C and 85°c through the water'bath surrounding the cylinders. Then he cooled the dopes to room temperature and spun immediately using air gap spinning. Blades found that heating the dope during mixing "greatly facilitated the mixing". and he got improved as-spun properties with the dope that was mixed at 55°C (tenacity, 11.8; modulus, 356) (CX-830, p. 35). Blades became convinced, that 12.3% PPD-T was not the maximum concentration possible in sulfuric acid dopes. (CX-830, p. 35; Blades, CX-827, p. 10).

224. In Blades' next notebook entry dated April 3, 1970 (CX-830, p. 36), attempted to mix a higher concentration of PPD-T in sulfuric acid using heat to facilitate mixing. He made a 14.5% PPD-T dope by first mixing in a beaker with a rod to form a dough. The he put the dough in the cylinder of his mixer; cycled if for about half a day at 43°C; let it sit overnight and then mixed the next day for 3 hours at about 55°C. He then cooled the dope to room temperature and spun it using an air gap. The dope mixed readily but spinning was very erratic, the filaments broke frequently and behaved as though there were particles in the dope. In spite of this, some small samples were collected and one had an as-spun tenacity of 14.5•gpd and an alongation of 4.6% and modulus of 466 (CX-830, p. 37) which were the highest as-spun properties measured on a single specimen by Du Pont's physical testing lab. (Blades, CX-827, p. 10; Blades, Tr. 7%-791).

225. Blades in a notebook entry dated April 3, 1970 Blades made up a dope of concentration of 14 1/2 percent in 100.2% sulfuric acid and mixed it in his mixing device at a temperture of about 54 degrees C. (CX-830, p. 36).

226. Blades testified that in his experiment with 14.5,percent PPD-T dope (CX-830, p. 36), where the dope was mixed at a high temperature and then cooled to room temperature he had a great deal of trouble making the dope spin at all because the spinneret holes would plug repeatedly and he tried several spinnerets and concluded that the trouble was that the polymer was not

in fact in solution at 14.5% at room temperature and that undissolved polymer was plugging the'spinerets and the conclusion from that was that the dopes had a melting point and Blades'was going to have to heat the dopes to higher temperatures to make sure that all the polymer dissolved. (Blades, Tr. pp. 789-790).

227•. Blades testified that as a result of his experiment with 14.5 percent PPD-T sulfuric and dope, he would have to spin at temperatures higher than room temperature so that the dopes would be properly molten during the spinning operation. This involved eelocating the spinnerets so that the vessel could be kept in the water bath during the spinning operation. (BladeS, Tr. pp. 791-792).

228. Blades recognized that to spin higher concentrations of PPD-T/sulfuric acid solutionS, spinning temperatures far greater than room tempecturewere required in order to keep the system above its melting point and fluid at the spinneret. To dd this, it was necessary to make modificationd to the eqUipment. A short piece of copper tubing was to be added between the mixing appaiatus and the spinneret so that the hot water bath could be kept in place around the mixing vessesls during spinning. In additon,an electric heater was to be fitted to the spinneret to maintain the spinning dope hot and thus fluid during spinning. (Blades, CX-827, p. 11).

229. The modifications to the equipment were carried out during early April 1970 and Blades used this time to do further experiments. He found that the melting point of a dope increased as its PPD-T concentration . increased. This was done by preparing dopes of various concentrations at . temperatures from 80-90°C in the mixing device then slowly lowering the temperature and determining the temperature at which the dope solidified.

Using this information Blades constructed a rough melting point curve which related melting point and dope concentration. (Blades, CX-827, p. 12).

230. As soon as the equipment was modified it was ready for both mixing and spinning at elevated temperatures and Blades on April 16, 1970 ran the experiment described at page 41 of his notebook (CX-830). Blades used PPD-T, of 4.4 inherent viscosity at a concentration of 20% by weight in 100.2% sulfuric acid. He used 20% PPD-T as a concentration substantially higher than what had been used previously for spinning but where its melting point did not exceed the maximum temperature that the water bath could provide (100°C). The water bath was heated to 95 °C during mixing, and spinning was carried out through the heated spinneret at approximately 100°C. Spinning was trouble-free and a number of samples were collected. These sameples were sent to the Physical Testing Labortori for standard stress-strain tests. A copy of the data 'sheet is at page 42 of his laboratory notebook. The as-spun tenacity of the filaments was 18 gpd with a modulus of 500. These were said by Blades to be extraordinary values and it was recognized immediately by Blades that his fiber-marking method produced a completely new fiber with remarkably high as-spun tenacity and excellent modulus. (Blades, CX-827, pp. 12-13; CX-830, pp. 41, 42).

231. By comparing the inherent viscosity of the polymer in the spun fiber which was 4.1 with the inherent viscosity of the polymer before making the solution which was 4.4 Blades noted in a notebook entry dated April 20, 1970 that the small change implied "little or no degradation" of PPD-T

during the mixing and spinning process. This was confirmed by an analysis for sulfur in the fibers which showed they contained a low level of sulfur. (Blades, CX-827, p. 13, Tr., 797-98; CX-830, p. 43).

232. The filaments from the April 16, 1970 20% PPD-T experiment, with respect to particular samples were: #1 had an average tensile strength of 17.9 grams/denier with a 3.9 percent elongation and a modulus of 499. The average tensile strength for sample #2 was 16.40 with a 4.1 percent elongation and a modulus of 438. (Blades, Tr. pp. 795-796; CX-830, pp. 42-43).

233. Blades testified that Example 1 in col. 10 "PPD-T of 4.4 IV is mixed ..." of his '756 patent is taken from the April 16, 1970 experiment recorded in his notebook for 20% PD-T at pp. 41-43 of CX-830. (Blades, Tr. p. 798).

234. In a Du Pont report for the period March - Dec. 1970 and dated March 17; 1971. Blades at p. D013995 shows the modified apparatus. (Blades, Tr. 792-793).

235. Blades after modifying the equipment recorded on the experiment with 20% PPD-T in concentrated sulfuric and where the bath was heated to 95°C. The water bath (coagulation) was 15°C. In spinning with the air gap Blades noted that it was more like a melt spinning system than like dry spinning; that all 20 spinneret holes functioned properly. (Blades, Tr. pp. 794-797; CX-830, pp. 41-42).

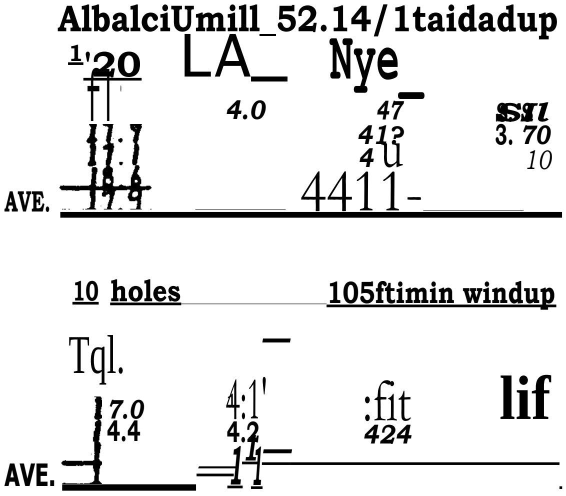
236. Inventor Blades testified that it has now been confirmed that the mixture of PPD-T in sulfuric acid are not ordinary polymer solutions but rather that a chemical complex is formed between the polymer and the acid; that it is belived that his complex occurs at a PPD-T concentration of about 20% by weight with a melting point at about 70-80 C at he testified that at

compositions of less than about 20% polymer, the complex dissolves in the excess acid to give a system with lower melting points; that at a 12% composition, the "melting poont" is about room temperature and the mixture is a viscous liquid; that at compositions between 12 and 20% polymer, the mixture must be heated to fluid. He believed that prior Du Pont researchers, as Dr. Killian, when they tried to stirr solutions of PPD-T in sulfuric acid, they reached a barrier at 10-12% PPD-T since they did not raise the mixing and spinning temperatures of the solutions above the melting point of the dope. (Blades, CX-827, pp. 13-14).

237. Blades' discovery that PPD-T sulfuric acid dopes had definite melting points was said by Blades to lead to the recognition that higher concentrations of PPD-T were possible. It is said by Blades that it is now known that another consequence of the complex formation is that the acid is . bound to th'e polymer and is essentially deactivated in a chemical sense. The result is that when about 20% PPD-T by weight is realized, the hot concentrated sulfuric acid solution does not have the "expected degrading" effect on the polymer and the systems are surprisingly stable. At low concentrations of polymer where there is excess acid, degradation ismore rapid and as the polymer concentration is increased the rate of degradation is reduced. (Blades, Cx-827, p. 14).

238. At a Du Pont internal Research Review on April 16, 1970, inventor Blades started out by showing the physical properties of the fibers he had spun up to that date. The best among them was said by Blades to be the one having as-spun 18 gpd with a modulus of 500. This was said by Blades to be a dramatic improvement over anything available at the time. In

fact it was said by Blades that this as-spun tenacity was roughly twice what had been obtained in Killian's experiments using PPD-T and to be shown in the following chart used at the Research Review:



AlbalciUmill_52.14/1taidadup

1'20 LA_ Nye_

4.0 47 SI1

17.7 41? 3.70

17.1 4u 10

18.6

AVE. 17.9 4411-

10 holes 105ftimin windup

Tql.

17.0 4:1' :fit lif

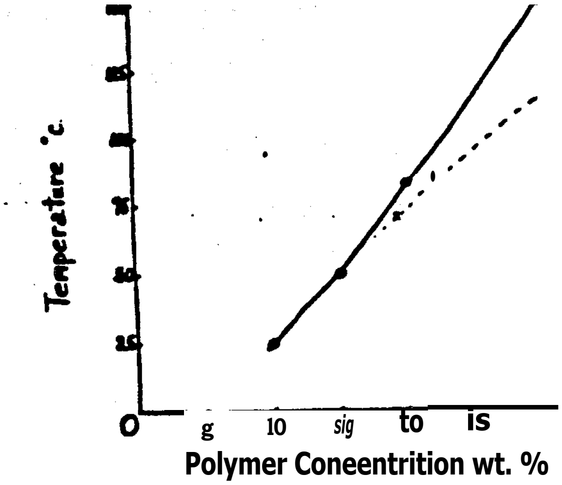
14.4 4.2 424

AVE. 11

(Blades,'CX-927, pp. 14-15).

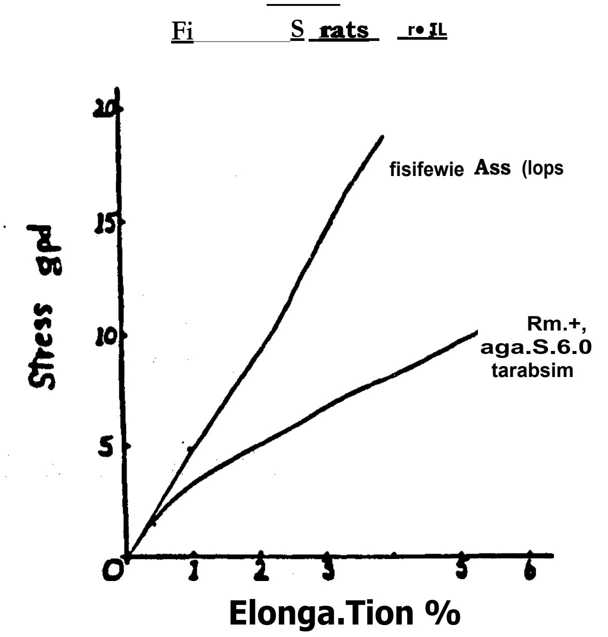
239. Another chart Blades used at the Research Review showed the following relationship between polymer concentration in the sulfuric acid solution and the melting point which Blades had discovered:

Dope Mr'tie& Print



At this time Blades had two sets of data as represented by the solid and dashed lines; the difference between them representing the uncertainty he had about behaviour at concentrations greater than 20%. This data was said to examine why prior workers were not able to operate successfully at concentrations of PPD-T of above 12%. The above chart shows that at a 12 percent composition, the "melting point" is about room temperature and the mixture is a viscous liquid. (Blades, CX-827, pp. 13, 15-16).

240. The following chart used at the Research Review on April 16, 1970 showed the comparative stress strain curves of fibers made by Blades' new process with those made by the PRD--44 amide solvent system, and demonstrated the higher yield point of his fiber.



(Blades, CX-827, p. 16).

241. In the following used at the Research Review on April 16, 1970 inventor Blades tabulated the merits of his system over the then-existing systems as they. appeared to Blades at that time:

ADVANTAGES OF S. ACID

HIGH SOLIDS

NO CHLORIDE

NO SOLVENT RECOVERY

HIGH SPEED

NEUTRALISE RESIDUAL ACID

REDUCED DEMAND ON POLYMERISATION

SUPERIOR PROPERTIES

The above, according to Blades, showed that he could spin from a solution of relatively high concentration or high solids, meaning that less solvent is required to produce a given amount of fiber. Sulfuric acid used by Blades is said to be a cheap material and hence it was not necessary to recover it from an economic point of view. It was said it could be simply discarded following its use as a solvent. Also because high speeds were possible, speed was said not be a significant limitation in the process. It was said that it would not be necessary to remove all the acid from the fiber and the last traces of acid could be neutralized in place with a base. Another advantage listed above was said to be the reduced demand on the polymerization process; that Polymerization could be carried out in an amide solvent to form a polymer of high molecular weight; that in PRD-27, 44 and 48 processes, where in situ polymerization takes place, there was a compromise in the polymerization process which resulted in less than optimum polymer molecular weight and concentration and thus the fiber properties were limited; that in Blades' sulfuric acid process, where the spinning is carried out independent of the polymerization, a compromise is not necessary and the polymerization and spinning processes can be independently optimized. The last item listed above was said to indicate that superior as-spun properties were possible; that

Blade's fiber had an as-spun tenacity of almost twice that of PRD-27 (1, 4B) which was then being scaled-up. High as-spun tensile properties were said to be valuable in contrast to similar properties obtained by a post heat treatment because they resulted in better economics for the system. In Blades' projected program set forth at the April 16, 1970 Research Review he indicated the intention of exploring heat treatment of the fibers to determine what effect it would have on their properties (CX-831, p. 3). (Blades, CX-837, pp. 17-19).

242. In a memorandum dated April 24, 1970, shortly after his first air gap spin using PPD-T in sulfuric and Blades described what he believed were the following advantages in the use of air gap:

> The air gap has several demonstrated or potential advantages:
>
> (0 Higher linear speeds are possible. There is no theoretical upper limit and speeds ten times those of conventional wet spinning seem reasonable to expect.
>
> (ii) The product may be improved. Higher spin-stretch is possible and this may produce a better quality of orientation. Also less demand is placed on solution properties and solutions designed more for properties and less for spinnability could be used.
>
> (iii) The spinneret can be at a temperature different from the bath. This has allowed the spinning of sulfuric acid dopes which melt above the boiling point of water. It allows optimum temperature for both solution and bath.

(RX-2225, p. TC1120001).

.243. There are five primary Blades laboratory notebooks which disclose air gap spinning experiments of PPD-T in concentrated sulfuric acid between April 1970 (the time of the filing of the first Blades patent application, S.N. 138,210, RX-2042) and June 1972 (the time of the filing of the fourth and final Blades patent application, S.N. 268,052, RX-2045): (1) p-5016 (RX-183), (2) P-5137 (RX-2220), (3) P-5198 (RX-184), (4) P-5304 (RX-185), and (5) P-5450 (RX-186). The chart below sets forth spinning experiments from those notebooks (excluding expriments where the wind-up speed was greater than about 1500 feet per minute) and the tenacity of the fiber produced from'the experiment.

BLADES LABORATORY NOTEBOOK P-5016 (RX 183)

Number	Notebook Code	Fiber Tenacity (gpd)	*SSF*	Bath Temp. (°C.)
1	P5016-41-1	17.9	2.2	15
2	P5016-41-2	16.4	2.4	15
3	P5016-52-1	10.2	3.2	**27**
4	P5016-68-1	8.0	1.6	**25**
5	P5016-68-2	12.8	2.5	25
6	P5016-68-3	11.8	2.5	25
7	P5016-68-4	12.1	3.2	25
8	P5016-54-2	6.7	2.0	30
9	P5016-54-4	8.6	3.9	30
10	P5016-56-2	17.7	1.3	14
11	P5016-56-3	21.1	5.1	14
12	P5016-56-4	20.8	3.0	15
13	P5016-56-5	12.0	1.9	15
14	P5016-56-7	12.4	3.6	17
15	P5016-58-8	12.4	5.0	17
16	P5016-59-1	7.2	4.1	22
17	P5016-59-2	7.8	4.1	24
18	P5016-59-3	6.7	3.5	24
19	P5016-59-4	9.5	4.2	24
20	P5016-70-2	16.3	5.2	21
21	P5016-70-4	16.7	6.0	21
22	P5016-70-5	16.9	4.9	21
23	P5016-70-6	18.3	4.9	21
24	P5016-74-1	18.4	3.5	22
25	P5016-74-3	9.0	8.9	22
26	P5016-79-1	20.6	6.7	23
27	P5016-79-2	21.0.	6.7	23
28	P5016-79-3	18.4	6.7	23
29	P5016-79-4	17.6	6.7	23
30	P5016-79-5	18.5	6.0	23
31	P5016-79-6	18.4	6.0	23
32	P5016-79-7	18.9	6.0	23
33	P5016-79-8	16.0	6.0	23
34	P5016-83-1	25	4.7	2

35	P5016-83-2	26	4.7	2
36	P5016-83-3	19.5	6.0	2
37	P5016-83-5	17.9	5.6	23
38	P5016-83-6	20.8	7.1	23
39	P5016-93-1	20.6	6.7	23
40	P5016-93-2	21.6	6.7	23
41	P5016-93-3	18.4	6.7	23
42	P5016-93-4	17.6	6.7	23
43	P5016-93-5	18.5	6.0	23
44	P5016-93-6	18.4	6.0	23
45	P5016-93-7	18.9	6.0	23
46	P5016-93-8	16.0	6.0	23
47	P5016-97-1	12.8	2.7	25
48	P5016-97-2	15.1	3.8	25
49	P5016-97-3	14	3.4	25
50	P5016-97-4	13.4	3.1	25
51	P5016-97-5	14.2	3.0	25
52	P5016-97-6	13.8	3.2	25
53	P5016-97-7	13.7	3.2	25
54	P5016-100-1	26	4.8	4
55	P5016-100-2	27.3	4.8	4
56	P5016-100-3	25.4	4.8	4
57	P5016-100-4	24.7	8.3	4
58	P5016-102-1	23	8.1	4
59	P5016-102-2	23.6	7.3	4
60	P5016-102-3	23.2	7.3	4
61	P5016-102-4	24.3	7.3	4

BLADES LABORATORY NOTEBOOK P-5137 (RX 2220)

Number	Notebook Code	Fiber Tenacity (gpd)	SSF	**Bath** Temp. (C°.)
1	P5137-4-1	11.7	4.0	25
2	P5137-4-2	13.7	3.5	25
3	P5137-4-3	13.3	3.5	25
4	P5137-4-4	13.7	3.5	25
5	P5137-4-5	13.2	3.3	25
6	P5137-4-7	12.8	3.2	25
7	P5137-4-8	13.0	3.3	25
8	P5137-4-10	15.0	3.8	25
9	P5137-8-1	11.8	3.1	24
10	P5137-8-2	12.5	3.7	24
11	P5137-8-3	14.3	3.7	24
12	P5137-8-4	13.6	4.0	24
13	P5137-8-5	13.7	4.0	24
14	P5137-8-6(a)	13.1	4.2	24
15	P5137-8-9	13.2	4.2	24
16	P5137-8-10	14.2	4.5	24
17	P5137-8-11	14.7	5.9	24
18	P5137-8-12	14.0	5.2	24
19	P5137-16-1	8.9	3.9	61
20	P5137-16-2	9.1	3.7	60

21	**P5137-16-3**	**14.3**	**4.5**	26
22	**P5137-16-4**	**14.0**	4.8	26
23	P5137-16-5	18.8	4.8	5
24	**P5137-16-6**	**19.0**	4.8	5
25	**P5137-16-7**	**10,4**	5.0	60
26	P5137-16-8	10.6	5.1	60
27	P5137-16-9	14.3	4.5	26
28	P5137-16-10	15.2	6.5	26
29	P5137-16-11	16.1	6.5	26
30	P5137-16-12	10.8	7.6	60
31	P5137-20-1	11.4	8.8	26
32	P5137-20-2	14.0	8.8	4
33	P5137-20-3	7.3	8.8	60
34	P5137-20-4	6.7	5.8	60
35	P5137-20-5	10.4	6.2	26
36	P5137-20-6	12.7	6.2	3
37	P5137-20-7	11.3	4.9	3
38	P5137-20-8	11.1	4.9	26
39	P5137-20-9	14.7	5.6	26
40	P5137-24-1	15.9	2.9	7
41	P5137-24-2	18.9	4.0	7
42	P5137-24-3	16.1	3.8	3.5
43	P5137-24-4	18.4	3.6	10
44	P5137-24-5	16.4	2.1	10
45	P5137-24-6	14.8	2.0	10
46	**P5137-24-7**	**14.5**	**2.0**	**10**
47	P5137-25-2	23.1	5.4	4
48	P5137-25-3	21.4	3.4	4
49	P5137-25-4	20.5	4.3	4
50	P5137-25-5	21.2	5.4	4
51	P5137-25-6	19.0	2.7	4
52	P5137-25-7	20.4	4.3	4
53	P5137-25-8	21.6	3.2	4
54	P5137-26-2	21.8	4.0	4
55	P5137-26-3	23.0	4.1	4
56	P5137-26-5	23.0	0.6	4
57	P5137-27-1	26.2	0.8	4
58	P5137-27-2	26.5	7.1	4
59	P5137-27-4	26.3	7.0	4
60	P5137-27-4	26.9	7.0	4
61	P5137-28-1	20.0	3.0	2
62	P5137-28-2	21.1	3.0	2
63	P5137-32-1	27.1	**8**	3
64	P5137-32-2	27.0	4	3
65	P5137-32-3	22.6	4.8	3
66	P5137-38-1	22.2	10	4
67	P5137-40-1	26.9	10.8	4
68	P5137-40-2	21.9	11.4	3
69	P5137-40-3	21.4	11.4	4
70	P5137-40-4	26.2	8.8	4
71	P5137-47-1	25.4	8.3	4
72	P5137-47-2	27.4	8.6	4
73	P5137-47-3	27.0	7.3	4

74	P5137-48-6	24.6	4.7	4
75	P5137-55-2	24.0	3.2	4
76	P5137-69-2	22.5	3.4	10
77	P5317-69-3	22.0	3.4	10
78	P5137-57-1	17.2	6.9	4
79	P5137-57-2	11.7	6.9	4
80	P5137-70-1	19.0	6.0	4
81	P5137-73-1	14.7	3.7	10
82	P5137-73-2	14.7	4.0	10
83	P5137-80-1	22.0	8.5	5
84	P5137-81-1	20.9	4.5	4
85	P5137-92-1	22.4	3.9	4
86	P5137-92-2	21.3	4.8	4
87	P5137-92-3	17.8	3.7	24
88	P5137-92-4	11.7	4.0	55
89	P5137-92-5	10.0	4.0	55
90	P5137-92-6	19.2	3.9	4
91	P5137-92-7	17.6	4.5	4
92	P5137-93-1	20.0	2.9	2
93	P5137-94-1	24.8	3.1	2
94	P5137-96-1	20.2	2.4	27
95	P5137-96-2	18.2	2.4	3
96	P5137-96-3	10.6	2.4	59
97	P5137-96-4	11.8	3.9	60
98	P5137-96-5	22.1	3.9	27
99	P5137-96-6	24.5	3.9	5.5
100	P5147-96-7	10.7	1.12	5
101	P5137-96-8	10.4	1.12	23
102	P5137-96-9	9.4	1.12	59
103	P5137-98-1	24.8	11	4
104	P5137-98-6	24.5	4.6	4
105	P5137-98-11	20.4	8.0	4
106	P5137-98-12	18.4	7.0	4
107	P5137-98-13	19.5	5.3	4
108	P5137-98-14	15.1	3.8	4
109	P5137-117-2	24.7	4.8	5
110	P5137-117-3	25.1	3.2	5
111	P5137-117-4	20.5	3.2	5
112	P5137-123-1	24.8	4.4	5
113	P5137-123-2	23.4	3.2	5
114	P5137-123-3	25.9	6.5	5
115	P5137-123-4	12.9	1.9	27
116	P5137-123-3	18.1	1.5	27
117	P5137-123-6	19.7	2.3	27
118	P5317-127-1	16.9	2.1	26
119	P5317-127-2	17.3	2.1	26
120	P5137-127-3	15,9	2.9	26
121	P5137-127-4	13.1	3.1	49

BLADES LABORATORY NOTEBOOK P-5198 (RX 184)

Number	Notebook Code	Fiber Tenacity (gpd)	SSF	Bath Temp. (°C.)
1	P5198-1-1	22.7	3.2	1
2	P5198-1-2	21.1	2.8	1
3	P5198-1-3	24.1	1.9	1
4	P5198-1-4	22.9	1.9	1
5	P5198-2-2	25.9	8.5	3
6	P5198-2-3	24.1	7.4	3
7	P5198-2-4	20.7	7.4	3
8	P5198-3-1	21.7	4.9	3
9	P5198-3-2	23.6	5.5	3
10	P5198-3-3	25.3	8.6	3
11	P5198-3-4	18.7	11.6	3
12	P5198-4-1	21.9	9.2	4
13	P5198-4-2	23.6	6.2	4
14	P5198-4-3	20.9	6.8	4
15	P5198-5-1	20.3	3.5	3
16	P5198-6-1	20.3	3.5	4
17	P5198-6-2	16.8	3.5	4
18	P5198-7-1	21.3	3.5	3
19	P5198-8-1	23.1	3.5	3
20	P5198-9-2	21.4	3.5	3
21	P5198-9-1	22.5	3.0	5
22	P5198-9-2	21.8	3.0	5
23	P5198-3-3	21.4	3.0	5
24	P5198-108-1	15.7	3.1	12
25	P5198-108-2	14.5	3.0	12
26	P5198-108-3	18.1	2.9	12
27	P5198-131-1	4.8	1.5	6
28	P5198-131-2	8.4	2.4	6
29	P5198-131-3	9.6	3.8	6
30	P5198-131-7	4.3	1.3	6
31	P5198-134-1	9.4	1.1	6
32	P5198-134-2	11.5	2.0	6
33	P5198-134-3	14.8	1.6	6
34	P5198-134-4	15.6	3.1	6
35	P5198-134-5	20.4	5.5	6
36	P5198-134-6	18.1	8.3	6
37	P5198-134-7	14.3	9.5	6
38	P5198-134-8	23.7	4.9	6

BLADES LABORATORY NOTEBOOK P-5304 (RX 184)

Number	Notebook Code	Fiber Tenacity (gpd)	SSF	Bath Temp. (°C.)
1	P5304-31-1	18.8	3.9	13
2	P5304-32-1	13.5	3.96	14
3	P5304-32-2	14.0	3.96	14
4	P5304-32-3	13.6	3.66	14
5	P5304-32-4	12.5	3.10	14

6	P5304-32-5	13.7	3.60	14
7	P5304-43-1	22.6	3.5	14
8	P5304-43-2	21.9	5.2	14
9	P5304-43-3	19.4	3.7	14
10	P5304-4305	21.9	3.8	14
11	P5304-46-1(pg.	9.8	1.3	15
12	P5304-46-2	10.7	1.5	15
13	P5304-46-3	10.1	1.5	15
14	P5304-46-7	13.9	1.7	15
15	P5304-56-1	21.4	7.5	14
16	P5304-58-1	19.6	4.3	15
17	P5304-58-2	18.1	4.1	25
18	P5304-58-3	19.8	4.1	21
19	P5304-58-4	19.8	4.1	10
20	P5304-58-5	21.6	4.3	3
21	P5304-58-6	15.8	4.5	32
22	P5304-59-1	18.3	4.35	20
23	P5304-59-2	15.8	4.6	30
24	P5304-49-3	14.0	4.4	36
25	P5304-59-4	12.3	4.4	40
26	P5304-59-5	12.0	4.6	50
27	P5304-59-6	11.2	4.7	60
28	P5304-59-7	9.2	4.3	69
29	P5304-59-8	13.1	7.2	65
30	P5304-59-9	17.8	4.7	14
31	P5304-59-10	20.8	4.3	9
32	P5304-59-11	21.9	4.4	0
33	P5304-59-12	9.2	3.9	75
34	P5304-80-1	20	2.9	3
35	P5304-80-2	13.3	2.8	27
36	P5304-80-3	11.4	3.4	49
37	P5304-80-4	10.3	3.2	51
38	P5304-80-5	7.1	3.1	82
39	P5304-85-6	23.8	3.3	3
40	P5304-119-1	19.3	2.8	21
41	P5304-119-2	18.5	4.3	21
42	P5304-119-3	21.3,	3.8	21
43	P5304-135-1	23.3	3.5	1.5
44	P5304-135-2	22.4	5.7	1.5
45	P5304-140-4	18.0	3.0	1
46	P5304-140-5	16.9	5.6	1
47	P5304-140-8	15.1	6.8	1

BLADES LABORATORY NOTE800K P-5450 (RX 186)

Number	Notebook	Fiber Tenacity (gpd)	SSF	Bath Temp. (°C.)
1	P5450-1-11	10.4	4.3	1
2	P5450-1-12	8.6	4.3	1
3	P5450-4-1	23.7	2.9	1
4	P5450-4-2	23.0	4.5	1

5	P5450-4-3	21.6	6.6	1
6	P5450-4-5	21.6	3.0	1
7	P5450-4-6	17.9	7.7	1
8	P5450-4-7	17.1	2.4	1

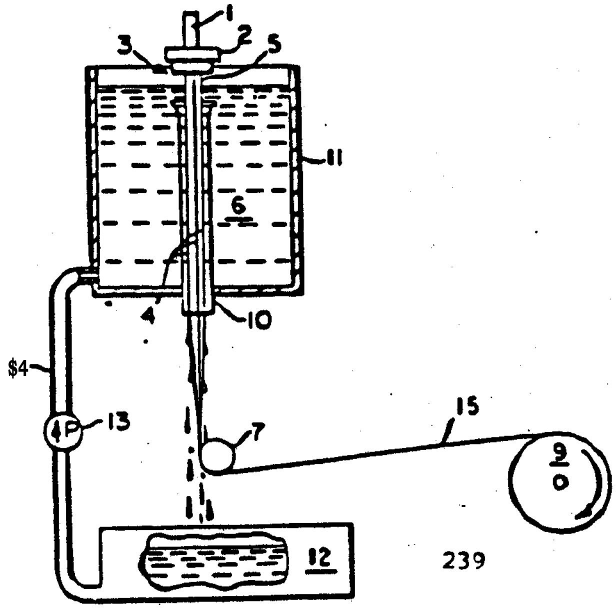
Respondents summarizing the data listed above from Blades' laboratory reported the following:

Lab. Notebook No.	Total Runs	No. 15 gpd	No. 18 gpd	No. 20 gpd
P-5016 (RX 183)	61	40	24	16
P-5137 (RX 2220)	117	73	57	48
P-5198 (RX 184)	38	29	26	23
P-5304 (RX 185)	47	27	22	12
P-5450 (RX 186	8	6	4	4
	271	175	140	103

Thus respondents state that 64.6% of Blades' runs resulted in fibers possessing tensile strengths over 15 gpd, 51.71 resulted in fibers possessing tensile strengths over 18 gpd and 38.0% resulted in fibers possessing tensile strengths over 20 •gpd. (RPFFR 806, 808).

244. Work on Blades' invention was coded at Du Pont as "PRO-58". (Blades, CX-827i p. 19).

245. In late July and early August 1970 Blades designed additional mechanical parts of the coagulation bath as shown in the sketch below:



Ile positioned in the bath and just below its surface a tube, frequently referred to as a spin tube, which facilitates the passage of the fiber through the bath. Using this ***device,*** enough yarn was produced to produce yarn to make tire cords with exceptionally good properties (tensile strenghts of 17 gpd) (CX—P18, CX—R°1; Blades, CX-127, p. 2n).

24̄6. According to Magat the breakthrough in the Blades process which allowed the preparation of an "outstanding fiber" was **the** combination of five features. viz. (1) 7PD-7 of (2) inherent viscosity ahove3, (3) an concentration of 20 percent PIT—T in (4) le) to in percent concentrated sulfuric acid and spinning the said sulfuric acid dope solution through (5) an air gap. Magat agreed that each of these'five features were present within Du Pont prior to Blades' first spinning of a sulfuric acid dope on March 18, 1!)70 except for the 20 percent concentration. (Magat, Tr. p. 557, Is. 1-14)

24'. In a nu Pont Textile Fiber repartnent report dated September 21, 1¹'7'1, it Sias said that ; that the early work of—Morgan and Kuolek had demonstrated that an aromatic polyanide having a 1,4 ring linkage configuration could be formed into anisotropic solutions which then could he spun to fibers with exceptional strength and rigidity; that in ::arch In'n, following a review at the corporate level, a venture effort based on this wort: was established and task forces were orgainized at both nichnond and at Pioneering ".esearch Laboratory with the objective of acbieving formal Mew Venture status './ithin In months. The selected candidate was poly 1,4—benzamide and the process involved wet spinning from an organic solvent. An alernative, poly 1,k—phenyleneterephthalanide (1'1'1)—T) had been rejected as the candidate of choice because of polymer intractability and. resultant difficulties in the spinning process including loss of anisotrophy.

It was said that while supporting the development program for poly 1,4-benzamide, Du Pont's John Gritting recognized that a venture based on an intermediate containing two interactive groups would require a complicated monomer preparation process which, in turn, would make the venture more expensive than one based on PPP-T; that he further recognized that the tensile properties attainable with this polymer coupled with the anticipated cost, were probably insufficient to break into the important tire, cord market; that based on this analysis, Gritting concluded that a program based on PIT-T had a much improved chance of commercial success if the difficulties stemming from polymer intractability could be overcome; that he convinced his management that efforts to develop PPP-T as an alternative should not be terminated, but that a small group should work concurrently to explore possibilities that a spinning process needed to make it a viable candidate could be developed; that the objective was to define with extreme rapidity the potential of PPD-T versus that of the chosen poly 1,4-benzamide; and that Blades was given a key responsibility in this effort. (P_7-2152, p.

24'1. The September 21, lnfil Du Pont Textile Fibers Department report further stated that as the first part of the alternative program, glades was assigned the objective of developing a practical route to a high-tenacity tire cord candidate based on ?PD-T; that found that concentrated spinnable solutions of this polymer could be prepared in hot, anhydrous sulfuric acid; that within a month after assignment, Blades demonstrated that these solutions could be spun from a heated spinneret through an air gap and coalesced without loss of anisotropy to form unusually strong filaments with uniform cross-sectional orientation; that he then refined the apparatus and demonstrated a thigh-speed laboratory process which produced filaments having

12 gpd tenacity; that over the next three months, others assigned to expand this development achieved strengths above 30 gpd; that this accomplishment is the basis for three key patents for which Blades was the inventor: U.S. Patent 3,767, 756, Pry Jet Spinning Process; U.S. Patent 3,P69,429, nigh Strength Polyanide Fibers and Films; and U.S. Patent 3,16%430, nigh rodulus, nigh Tenacity Poly (p-phenylene terephthalanide) fiber. It was said that Criffing recognized that this was the breakthrough required to demonstrate the superior potential of PPP-T; that he then persuaded management to allocate additional manpower to exploit the higher property levels; that by August, ten researchers were directly assigned to PPP-T, a level approaching that of poly 1,4-benzamide fibers; that the clear objective was to demonstrate the practical potential of PPP-T versus poly 1,4-benzanide prior to the formal new Venture decision to be nade the following year. Thereafter PPP-T replaced poly 1,4-benzamide for development. ".evlar" fiber was adopted as a corporate *new* Venture development progran mn January 1, ltrl. (m-'151, pp. 2^{-3}).

24^. •A Pu Pont Textile Fibers Pepartnent report dated September 21, 1^{0}01 showed that

(PX-^{1}152, D. 1).

Tr. PPI(T APT

250. At the tine of Pr. Blades' invention, there were two approaches to producing polymer fibers with high tenacity and modulus. They were the traditional approach which employs extensive drawing (stretching) of fibers in pst-spinning operations to impart orientations in the fiber !ragat,. Tr., pp. 557-50; Trhlmanm, Tr., pp. ^17-00, $^{0}7^{0}$; Bailey, Tr., pp. 7245-46) and

the Du Pont approach using liquid crystalline (i.e., anisotropic) solutions of certain para-positioned aromatic polyamides to form fibers which have high as-spun properties. (Uhlmann, CX 835, pp. 29-31; Flory, CX-1141, pp. 2-3).

251. In the traditional approach of making fibers (which did not involve liquid crystalline solutions), one starts with molecules that are highly irregular; they are commonly referred to as randomly coiled, long molecular chains. The lengths may be 100 or 1000 times their diameters. The fibers are extruded from **a** polymer melt or solution in which the molecules are entangled with one another. Ideally, however, one wishes to align the moleculus in a fiber so that they lie parallel to one another rand are straightened out to rectilinear form. To that end, in the conventional approach, orientation and partial ordering of the polymer chains are achieved by drawing or stretching the fiber to a very high degree after the fiber is coagulated or solidified. (Uhlmann, Tr., pp. 937-38; Bailey, Tr., pp. 2245-48). While such drawing does provide an increase of strength and modulus, even after such drawing there remains disordered regions in such fibers which may constitute 10, 20 or 30% of the material. These are sources of weakness in conventional fibers and set limits on their strength. (Flory, CX-1141, pp. 2-3).

252. In using the traditional approach, post-spinning stretches of 2x-10x were commonly employed, with stretches in the range of 5x being typical. The use of sJch extensive drawing of fibers to produce commercially attractive products dates :pack at least to the pioneering work of Carother7 on nylon in the 1930's. Because such extensive drawing is **an** integral part of the process, the characteristics desired in the as-spun fibers include low

crystallinity, small crystallities and minimum orientation. (Uhlmann, CX 835, p. 30). The process of the Morgan '645 patent employs this conventional approach to fiber making. (CX 852-22, RX 58; Magat, Tr., pp. 557-58; Uhlmann, Tr., p. 977).

253. In contrast, in the DuPont approach, certain polymers which have moleculed whose molecular structure dictates highly extended configurations are conducive to the formation of the liquid crystalline phase when dispersed in a solvent. This liquid crystallinity is the consequence of their high asymmetry of shape. Molecules such as PPD-T are so highly elongated that, above a certain concentration, they are forced to adopt a semi-parallel arrangement with one another. In adopting this organization, the entanglement of conventional polymers is eliminated. When such solutions are acted upon by external forces such as shear or flow in extruding a fiber, polymer fibers can be spun with an exceptionally high degree of molecular orientation. (Flory, CX-1141, p. 3; Bailey, Tr., pp. 2245-48).

254. In spinning solutions in accordance with the DuPont approach, Liquid crystalline domains in the spin dope are preferentially oriented along the fiber axis, resulting in as-spun fibers with attractive strength and modulus. The rigid Para-positioned molecules in the as-spun fiber show a strong preferential alignment along the fiber axis. (Uhlmann, CX-835, p. 30). The as-spun fibers cannot be appreciably stretched or drawn. (Magat, CX-801, p. 6, Tr. p. 620; Uhlmann, Tr pp. 940, 943-44; Bailey, Tr. pp. 2248-249).

255. The Du Pont approach to making fibers was developed at DuPont's Pioneering Research Laboratory in the mid 1960's. (Uhlmann, CX-835, p. 30). This was the first instance in which liquid crystallinity in polymers

was exploited for the purpose of producing fibers of high strength and modulus. (Magat, CX-801, pp. 5-6).

256. "High tenacity" and "high strength" are relative terms and must be interpreted in their context of use. At the time of the Blades invention, "high tenacity", "high strength" meant 12 gpd. (Magat, Tr. pp. 1367-68).

257. In the wet spinning of para-aramide, there is a stretching or drawing of a fiber; in contract in the Blades' process there is a stretching or drawing of the dope. (Uhlmann, Tr. p. 938, 1. 18, p. 939, 1. 2).

258. In the Blades' process orientation is frozen as soon as the dope solution hits the coagulation bath or very soon thereafter. (Bailey, Tr. 2246, ls. 13-20).

259. While poly(m-phenylene isophthalamide) and poly (p-phenylene terephthalamide) have identical chemical formulas, the "Nomex" and "Kevlar" fibers respectively made from them have dramatically different properties. Besides affecting chain stiffness, the change from meta-positioned to para-positioned aromatic rings has a profound effect on solubility. For example, while the meta-positioned poly(m-phenylene isopthalamide) is highly soluble in dimethylacetamide/$CaC1_2$, and is spun commercially from such solutions containing about 18% polymer, the para-positioned PPD-T comparable molecular weight is effectively insoluble in this solvent. The change from meta-positioned to para-positioned aromatic polyamides, and its accompanying effect on chain stiffness, has another dramatic effect on solution behavior. The meta-positioned polymers form isotropic solutions at all concentrations of polymer. In contrast, with the para-poSitioned PPD-T, anisotropic solutions can be Formed above a critical concentration. Anisotropic solutions contain

liquid crystalline domains, while isotropic solutions do not. Within each liquid crystalline domain, the molecules are aligned in a given direction, but the direction of alignment is different in different domains. Such anisotropic solutions exhibit pronounced optical birefringence. (Uhlmann, CX-835, p. 8).

Morgan U.S. Patent No. 3,414,645

260. U.S. Patent 3,414,645 issued to Herbert S. Morgan Jr. (Morgan '645) on December 3, 1968 from an application filed June 19, 1964 (Serial No. 376,363). It is assigned to Monsanto Company. (CX-852-53, RX-58, col. 1, Is. 1-17).

261. The Morgan '645 patent relates to a process of extruding a wide range of wholly aromatic polyamides in spinning dopes from an orifice through a layer of gas into a coagulating bath to form fibers. (CX-852-22, RX-58, col. 1, Is. 11-15; Davis, RX-2,pp. 7-8; Bailey Direct, RX-3, p. 7). There is no disclosure on the Morgan patent of development of orientation and desirable mechanical properties in as-spun fibers. (Uhlmann, CX-835, pp. 33, Tr. p. 977; CX-1147, p. 4).

262. The Morgan '645 process leads to the preparation of high-strength, thermally resistant fibers from wholly aromatic polyamides. RX-58, col. 1, is. 22-25, an'.: :ol. 3, Is. 8-11).

263. In Examples Er and III of the Morgan '645 patent, it is shown that dry-jet wet spinning of wholly aromatic mixed meta- and para-oriented polyamides results in a filament having about twice the tensile strength of a filament wet spun from the same solution. (Davis, RX-2, p. 15; Morgan '645 patent, RX-58, col. 8, Is. 5-33, and Table 2).

264. In Examples II and III of the Morgan '645 patent. PPD-T is not employed and the fiber from the aqueous spin bath was stretch and drawn a plurality of draw times. (RX-58, col. 8, ls. 6-32).

265. The specification and all of the examples of the Morgan '645 patent call for post-coagulation drawing of the fibers to produce orientation and the desired mechanical properties. Morgan discloses, as integral parts of his process following coagulation, an orientation stretch in a hot bath. (CX-852-22, RX-58, col. 5, Is. 33-37; col. 7, Is. 3-5; Figure 1 stretch bath 9) and thereafter another hot drawing step. (CX-852-22; RX-58, col. 5, ls. 66-69; Is. 6-8; Figure 1 hot pin 13, shoe 14 and drawing rolls 15). (Bailey, Tr., pp. 2250-52; Uhlmann, Tr., pp. 942-43). In Figure 1 of Morgan the orientation stretch bath 9 and draw rolls 10 provide the first post coagulation stretching and then hot pin 13, shoe 14 and drawing rolls 15 provide a second post coagulation stretch. (CX-852-22; RX-58, Figure 1; Uhlmann, CX-835, pp. 38-39).

266. The examples in the Morgan '645 patent use total post-coagulation draws of 1.7x to 5.62x, with most of the examples using total post-coagulation draws of about 3.6x (i.e., orientation stretch 2.1x plus a hot draw 1.7x which Table 1 represents as optimum conditions). (CX-855-22; RX-58, col. 7, Table 1, "Optimum Conditions"). Such post coagulation draws are in the range of those conventionally employed in the processing of textile fibers such as nylon, polyacrylonitrile and polyethylene terephthalate. In such processing, the achievement of a high degree of orientation and crystallinity in the as-spun fibers is not a desireatum of the process since they would render difficult the subsequent drawing operation and lead to filament breakage in the drawing. (Uhlmann, CX-835, pp. 39-40).

267. The combination of properties in the Fibers produced by Morgan, even after the extensive post-coagulation drawing, is very different from the properties of Blades' as-spun Fibers. Morgan reported the highest tenacity as 7 gpd and an elongation of 33%, compared to Blades' which can be as high as 20 gpd and 3-4% elongation. (Uhlmann, CX-835, p. 40).

268. The highest tenacity of any fiber described by Morgan in the '645 patent is notably inferior to the tenacity of drawn nylon filaments available at the time (about LO gpd). (Uhlmann, CX-835, p. 40).

269. Nowhere does the Morgan '645 patent disclose a specific example where makes a fiber of PPD-T. All the examples refer to meta-positioned polymers. Meta-positioned polymers form isotropic solutions at all concentrations of polymer and do not form liquid crystalline solutions. (Uhlmann, CX-835, p. 8). Nowhere does the Morgan '645 patent disclose the spinning of fibers using liquid crystalline (i.e. anisotropic) solutions or dopes. (Uhlmann, Tr., p. 968).

270. The only para-positioned polymer that is named in the Morgan '645 patent, excluding the reference to other patents in col 1, is the co-polymer poly (4,4'-diaminobenzanilide terephthalamide) pictured in col. 2, which has been designated 4,4'-DABT. The 4,4' DABT polymer mentioned in the Morgan '645 patent is a specific limited order copolymer (Davis, Tr. pp. 2187-88). It is not a group of co-polymers. (Magat, Tr., --. 429, 589; Davis, Tr. pp. 2187-88).

271. 4,4'-DA3 7 is structurally different from the random co-polymers made up of PPD, 1,48 and T monomers. (Davis, Tr., pp. 2192-93). The number of random polymers made up of PPD (paraphenylene diamine) monomers, 1,48 monomers and T monomers are almost infinite and their properties vary depending on monomer content. (Davis; Tr., pp. 2185-86).

272. The term "4,4'-DABT type copolymers" is not an art recognized term. (Magat, CX-1143, middle p. 2 to middle p. 3). The Morgan '645 patent does not describe a group of "DABT type" co-polymers. (Davis, Tr., p. 2188).

273. Morgan '645 patent has no example disclosing how spin doped containing 4,4'-DABT might be prepared, how fibers of this polymer might be spun nor what-the resultant properties may be. (Uhlmann, CX-835, pp. 33; Flory, CX-1141, pp. 5-6).

274. All the examples in the Morgan '645 patent dissolve the meta-positioned aromatic polyamidea in amide/salt solvents. Further, according to Morgan, "it is desirable and convenient to use the same solvent For polymerization and spinning." (CX-852-22, RX-58, at col. 3, Is. 65-66); and dimethylformamide and dimethylacetamide containing up to 10% by weight of dissolved metal salts are regarde'd as "especially useful." (CX-852-22; RX-58, col. 1, 1. 71). Morgan also discloses the use of particular solvent extraction agents to help remove the solvent from the coagulated fibers for large diameter fibers spun from polymers with modest inherent viscosities. (Uhlmann, CX-835, p. 8; CX-852-22 (RX-58) at col. 6, Is. 3-46).

275. Also consistent with Morgan's focus on amide/salt solvent systems in his concern about eliminating salts from the fibers (Cx-852-22, Rx-58, col. 4, 1. 50, col. 5, 1. 50) and his selection of specific solvent extraction agents - both of which are specifically directed to amide/salt solvents. (Uhlmann, CX-835, p. 35).

276. Morgan suggests the use of solution concentrations of 10-30% of polymer and preferably 12-20% in his spin dopes. (CX-852-22, RX-58, col. 4, Is. 24-27). In 1964, at the time of the filing of the Morgan patent application, solutions of para-positioned wholly aromatic polyamides with

concentrations of 10-30% were unknown. (Flory, CX-1141, p. 7). In fact, in 1964 even the manifestation of liquid crystallinity on the part of para-positioned polyamides had not been demonstrated. (Flory, CX-1141, p. 6). Morgan's 10-30% polymer concentration range is consistent with his focus on meta-positioned polyamides in amide/salt solvents which are typically dissolved in such concentrations. (Magat, Tr., p. 562). It was well known that para-positioned polyamides, and particularly PPD-T, are much Less soluble than meta-positioned polyamides; there is no reference in the literature to para-positioned aromatic polyamides being dissolved and spun into fibers at the time the Morgan '645 patent application was filed in 1964. (Uhlmann, CX-835, p. 36).

277. Morgan does not disclose forming concentrations of 12-20% for any para-positioned polyamide, and there is no teaching as to how they could be achieved for the highly intractable PPD-T. (Uhlmann, CX-835, p. 36; CX-852-22, RX-58).

278. Morgan's reference at column 4, lines 5-6 to a broad range of elevated temperatures of 30 to 120°C. refers to the extrusion temperature. Since it was well known to adjust the temperature of extrusion as a means of varying the viscosity of the solution for spinning, this was simply a teaching of adjusting spinning conditions. This mention of extrusion temperature is not a disclosure of mixing conditions for preparation of the dope since the mixing and extrusion operations are carried out separately with different apparatus and conditions. (Uhlmann, CX-835, pp. 36-37). Nowhere in the Morgan '645 patent is there any specific disclosure as to how his spin dope solutions are prepared. (Weijland, Tr., p. 3282).

279. There is no disclosure in the Morgan '645 patent that the "as-spun" tenacity of dry jet wet spun fibers is higher than that of wet spun fibers. The tensile strengths reported in the Morgan '645 patent refers to fibers which were drawn extensively after spinning. (Uhlmann, CX-1147, p. 12). On the contrary Dr. Blades' first work with spinning amide dopes using an air gap did not result in improved fiber properties over corresponding wet spun dopes. (Blades, CX-827, p. 5). In addition, following H. Blades' initial use of an air gap in the spinning of PPD-T amide solutions in 1969, J. McBride, another Du Pont research at Pioneering Research Laboratories, reporting to Blades, undertook a program aimed of assessing the use of an air gap in the spinning of amide dopes of 1,48, C1PPD-T and PPD-T. (CX-1144-1145). Fiber B (1,4B) wet spun had consistently produced fibers with as-spun properties T/E/M = 12/6/500. McBride using an air gap with the same 1,4B amide lopes (PRO-27) was unable to get better properties -- his best properties as-spun for these amide dopes were T/E/M - 11.0/8.1/371. (CX-1144, Table I). McBride could not get any better as-spun properties using an air gap with PPD-T amide solutions (PRD-44) - his best properties as-spun for these amide dopes were T/E/M - 7.7/4.3/380. (CX-1145, table I). McBride's work with an air gap and C1PPD-T-amide dopes resulted in lower tenacities than PRD-27 (1,4B) (T/E/H = 8.5/6.4/306). (CX-1144, Table III). ('4agat, CX-1143, p. 8, Tr. p. 581).

280. The enph_1313 In the Morgan '654 patent is on wholly aromatic polyamides that are of ı. Ixe'.3 meta- and para-orientation. (RX-58, cols. 1, 2).

281. The Morgan '645 patent discloses that:

> There has recently arisen a need for shaped articles of improved high temperature resistance. The need has been partially filled by the provision of wholly aromatic polyamide compositions such as those prepared and described in U.S. Patent 3,006,899 to Hill et al., 3,049,518 to Stephens et al., 3,068,138 to Beste et al., 3,079,219 to King and 3,094,511 to Hill et al. Other wholly aromatic polyamide compositions of unique structure such as those in our copending applications Ser. No. 222,930 to Preston, now U.S. Patent 3,240,760, Ser. No. 222,932 to Preston et al., now U.S. Patent 3,232,910, Ser. No. 298,467 to Smith et al., now U.S. Patent 3,354,125, Ser. No. 347,392 to Preston, now U.S. Patent 3,376,268 and Ser. No. 347,385 to Preston, now U.S. 3,376,269, provide additional unique wholly aromatic polyamide structures and compositions of very high thermal stability. (RX-58, col. 1, ls. 25-41).

282. The Morgan '645 patent discloses that:

> The patents and patent applications previously mentioned disclosed methods of preparing the wholly aromatic polyamides of the invention. Generally the wholly aromatic polyamides of the invention may be prepared conveniently and preferably by combining an aromatic diacid chloride and an aromatic diamine in the lower aklylamide solvent to produce the desired polyamide and the by-product, hydrogen chloride. The hydrogen chloride must be neutralized or removed to prevent its harmful effects to the resulting articles. Neutralization of the hydrogen choloride may be conveniently accomplished by adding in alkali, or alkaline earth, metal base to form a salt acid water.

(CX-852-22, RX-58, col. 3, is. 39-51).

283. The Morgan '645 patent discloses seven solvents that may be used as the solvent for the polyamides to be spun via the Morgan '645 process. One of the solvents disclosed is "concentrated sulfuric acid." The other six solvents are organic solvents. (CX-952-22, RX-58, col. 3, 1.. 65, .col. 4, 1. 4).

284. The gap in the Morgan '645 process comprises a gas, e.g., air, and is 1/8 to 1-1/2 inches (0.3 to 3.8 cm.) thick, and preferably about 1/2 an inch (1.3 cm.) thick. (RX-53, col. 4, Ls. 18-20, and col. 16, 1. 67).

285. The temperature of the coagulation bath in the Morgan '645 process may be from 10°C. to 50°C., preferably 15°C. to 25°C. (CX-852-22, RX-58, col. 5, Is. 26-27).

286. The coagulation bath in the Morgan '645 process may be aqueous. (CX-852-22, RX-58, col. 4, ls. 67-68, col. 5, Is. 11-14, and col. 7, Is. 33-34).

287. The Morgan '645 patent further discloses that after a fiber is formed in the coagulation bath, the fiber may undergo various post-spinning treatments, e.g., stretching, washing, finishing, drying, and/or hot drawing. (CX-852-22, RX-58, col. 5, 1. 33: col. 6, 1. 47, and col. 6, 1. 72, col. 7, 1. 50).

288. The wholly aromatic polyamides disclosed in the Morgan '645 patent have inherent viscosities of from about 0.6 to 3.0 or higher and preferably above about 2.0. (CX-852-22, RX-58, col. 4, Is. 36-37).

289. The polyamides disclosed in the Morgan '645 patent are present at a concentration of from about 10% to about 30% by weight of the solvent, preferably 15% to 22% by weight of the solvent and, most preferably, 20% by weight of the solvent. ICX-852-22, RX-58, col. 4, Is. 24-27 and col. 7, 1. 30).

290. The Morgan '645 spinning dope may be prepared and extrudedat temperatures of 30°C. to 120°C. (RX-58, col. 4, 11. 5-6). In Table 1 of the Morgan '645 patent, the preferred "Dope temperature at jet" is given as 40°C. to 130°C., while the optimum temperature is said to be 70°C. (CX-852-22, RX-58, Table 1).

291. The Morgan '645 patent states"

> The fibers produced according to the process of this invention have excellent strength, outstanding thermal stability and are highly lustrous. Fibers with such properties are particularly useful in shaped articles which find applications in uses requiring exposure to elevated temperatures. In the form of fibers, filaments and other shaped articles they are useful in applications such as electrical insulations, industrial filters, conveyor belts, tire cord, heat resistant parachutes, protective clothing and the like.

(CX-852-22, RX-58, col. 12, 11. 12-21).

292. H.S. Morgan, Jr., the patentee of the Morgan '645 patent, was an employee of the Monsanto Company. Monsanto owned the Morgan patent and the Smith '125 patent. Three years after the filing of the Morgan '645 patent, Morgan's coworkers at Monsanto presented a paper in 1967 at the International Symposium on Macromolecular Chemistry in Brussels-Louvain on Monsanto's actual making of 4,4'DABT fiber. This'paper was published in 1969: "Thermally Stable Fiber and Film from the Poly Terephtalamide of 4,4' -Diaminobenzanilide" and was authored by J. Preston, R.W. Smith, W.B. Black and T.L. Tolbert. (CX-1148).

293. The authors of the paper (FF 292) expressed "their appreciation to H.S. Morgan for spinning the fiber samples." (CX-1148 p. 865). They reported their actual in situ preparation of 4,4'DABT in HPT (the amide solvent HMPA). (CX-1148,p. 865). Referring to 4,4'-DBT, the same paper pointed out that "This fiber is the only one that has been reported from a wholly aromatic polamide in which all the phenylene units are para-oriented." (CX-1148 p. 856). There was no suggestion of sulfuric acid as a solvent. Rather, HPT (EMPA) was preferred and used. Moreover, fibers made from 4,4'-DABT were reported to have tenacities of only 5 gpd. at room temperature. (CX-1148 p. 858).

294. Magat agreed that a 20 percent concentration is specifically identified as the optimum concentration in the Morgan '645 patent but testified that the 20 percent in the Morgan '645 patent applies to an entirely different fiber process where fiber is spun by a conventional process; that in the Horgan patent there is an additional step or two not used in the Blades' process because in the latter there is obtained a fiber that is fully-drawn right in the spinning step. (Magat, Tr. p. 557, p. 15-p. 558, p. 6).

Hill et al U.S. Patent Nos. 3,006,899 and 3,094,511

295. The Hill, et al. '899 and '511 patents referred to in the Morgan '645 patent each discloses a method for preparing polyamides including poly (p-phenylene terephthalamide) IPPD-T1 and the respective monomers, p-phenylene iiamine and terephthaloyl chloride, required for such preparation. (Hill, et al. '899 patent, RX-2203, col. 2, Is. 15-119, col. 4, Is. 40-43, and col. 5, ls. 42-45; Hill, et al. '511 patent, RX-2204, col. 2, Is. 47-52, col. 3, Is. 44-47, and col. 4, Is. 49-52; Davis, Tr., pp. 2179-80, 2184-96). However in the Hill patents, the substituents on the aromatic rings of the polymers can be meta or paraoriented. (RX-2203, col. s; RX-2204, col. 2) .

Smith et al. U.S. Patent No. 3,354,125

296. The Smith, et al. '125 patent assigned to Monsanto Co. referred to in the Horgan '645 patent discloses a process for preparing various polymers from diaminobenzanilides, including specifically poly-4,4'-diaminobenzanilide terephthalamide 14,4'-GABTI, the copolymer explicitly set forth at col. 2, Is. 44-49, of the Horgan '645 patent. Tables

II and III of Smith, et al. show that 4,4' -DABT is preferentially soluble in sulfuric acid. (Morgan '645 patent, RX-58, col. 1, 1. 32, and col. 2, ls. 44-49; Smith, et al. '125 patent, RX-59, col. 10, ls. 19-27).

297. No 4,4' -DABT spin dopes are made in the Smith patent. (CX-852-20, RX-59).

298. The Smith, et al. '125 assigned to Monsanto referred to in Morgan '645 discloses in Tables II and III that the wholly aromatic para-oriented polyamide poly-4,4' - diaminobenzanilide [UMPA1. 4,4' - DABT is shown in Table III as being insoluble or only slightly soluble in three of the six organic solvents disclosed in Morgan '645. (RX-59, Table III).

Kwolek U.S. Patent No. 3,671,542

299. U.S. Patent No. 3,671,542 assigned to DuPont issued to Kwolek (Kwolek '542) on June 2n, 1972 from an application filed May 23, 1969 (Serial No. 827,345), which was a continuation-in-part of a patent application filed June 12, 1968 (Serial No. 736,410), which was a continuation-in-part of a patent application filed June 9, 1967 (Serial No. 644,851), which in turn was a continuation-in-part of a patent application filed June 13,1966 (Serial No. 556,934). (CX-852-31, RX-64, p. 2).

300. The Kwolek '542 patent relates to anisotropic spinning dopes consisting essentially of carbocyclic aromatic polyamides in suitable liquid media, which can be used to prepare high-strength fibers in the as-spun state. (CX-852-31, RX-164, col. 1, ls. 11-16).

301. The Kwolek '542 patent pioneered the fiber making approach wherein liquid crystalline solutions of para-positined aromatic polyamides are

formed into fibers by dry spinning or wet spinning, and where the as-spun fibers have high orientation and attractive mechanical properties. (Uhlmann, CX-835, p. 51).

302. The Kwolek '542 patent which has 84 columns contains two claims, with claim 2 dependent on claim 1. Whereas claim I. claims a spinning dope consisting essentially of a defined polyamide and a solvent selected from the group of amides and ureas, concentrated sulfuric acid, hydrofluoric acid, and chloro-, fluoro-, or methane-sulfonic acids, claim 2 further limits claim 1 to a spinning dope wherein the solvent is "concentrated (greater than about 98% by weight) sulfuric acid which may contain free $S0_3$." (CX-852-31, RX-164, col. 84, Is. 25-59).

303. The Kwolek '542 patent discloses, that: "The fibers prepared from the anisotropic compositions :%r dopes of this invention and related isotropic dopes are characterized by a unique internal structure and exceptionally high tensile properties, either as extruded or after being heat treated. ... The fibers of this invention possess excellent chemical and thermal properties. ... the excellent tensile properties of the fibers of this invention make them especially useful as reinforcing agent for plastics, tire cord, V-belts, etc." (CX-852-31, RX-164, col. 15, ls. 27-31, and col. 16, ls. 48-59).

304. The Kwolek '542 patent states that "an anisotropic dope can be used to produce an as-extruded fiber with properties superior to those of fibers produced Erom an otherwise similar dope which is isotropic or less anisotropic." (CX-852-31 RX-164, col. 16, ls. 74-75, col. 17, Is. 1-2). The use of anisotropic spin dopes of para-positioned aromatic polyamides, as taught by Kwolek in the '542 patent, leads to the development of higher orientation and crystallinity in the as-spun fibers. (Uhlmann, CX-835, p. 52).

305. The carbocyclic aromatic polyamides of the Kwolek '542 spinning dopes are those in which the chain extending bonds from each aromatic nucleus are essentially coaxial or parallel and oppositely directed. (CX-852-31, RX-164, col. 2, Is. 7-12).

306. Among the wholly aromatic polyamides disclosed in the Kwolek '542 spinning dopes are 4,4' - DABT. (CX-852-31, RX 164, col. 2, Is. 43-50).

307. Highly preferred wholly aromatic polyamides for the Kowlek '542 spinning dopes specifically include PPD-T. (CX-852-31, RX. 164, col. 2, Is. 21-30).

308. The disclosure of the Kwolek '542 patent states:

> "Dope of the invention may be conveniently prepared e.g., oy combining polymer and the liquid medium (and additives, if any, in t he conventional manner (e.g., with stirring). Some dopes are foamed at room temperature conditions and are useful (e.g., spinnable under these conditions. Other dopes require specific heating techniques, i.e., flowable compositions may be obtained at room temperature in many instances while heating, preferable with stirring, and sometimes heating and cooling cycles are required in a few instances. The amount of heating and/or cooling required to form a useful dope or composition varies with the liquid medium, the polymer (the composition, the inherent viscosity, the crystallinity, and the particle size of the polymer sample employed) and the quality of the stirring action. In the preparation of these dopes, care must be taken to avoid local overheating and formation of a "dry" or gelled spot at the meniscus of this composition or on the walls of the vessel being employed. Such portions of polymer frequently do not readily redissolve. Numerous suitable techniques using in preparing specific dopes of this invention are illustrated in the Examples."

(CX-852-31, RX-164, co.. 7, 1. 69, col. 8, 1. 14).

309. Solvents Jseful for forming the Kwolek '542 spinning dopes include selected amides and ureas, concentrated sulfuric acid, hydrofluoric acid, chloro-, fluoro-, or methanesulfonic acids, and mixtures thereof. (CX-852-31, RX-164, col. 6, 1. 69, col. 7, 1. 30).

310. The Kwolek '542 patent discloses that the concentration of the

concentrated sulfuric acid solvent shuld be "greater than about 90% by weight, usually greater than 98-100% by weight H_2SO_4 or oleum (i.e., concentrated sulfuric acid containing up to 20% or higher of free SO_3)." (Cx-852-31, RX-164, col. 7, ls. 6-9).

311. Examples 1, 2 and 72 of the Kwolek '542 patent relate to sulfuric acid/PPD-T dopes. Examples 1 read in part:

> This example illustrates (1) the preparation of poly(p-phenyiene terephthalamide), (2) the preparation of anisotropic and isotropic oleum dopes thereof, and (3) fibers thereof.
>
> Polymer Preparation: Powered terephthaloyl chloride (71.1 g.. 0-35 mole) is added at once to a solution of p-phenypenediamine (37.8 g.. 0.35 mode) in a mixture of hexamethyiphosphoramide (420 mi.) and N-methyl-2pyrrolidone (210 mi.) contained in a 1-liter resin-making kettle equipped with an air-driven stirrer and a calcium chloride drying tube. The temperature of the reaction mixture is moderated with a water bath at room temperature. A solid mass is obtained within minutes and allowed to stand at room temperature for 4 hrs. The mass is then combined with water and stirred at high speeds in a gallon-size (3.785 liter) blender. The polymer is washed three times with water by being stirred in a blender and isolated by being filtered on a sintered-glass coarse-pore Buchner funnel. The polymer is dried overnight in a vacuum oven at about 70°C. The inherent viscosity, measured as a solution of 125 mg. polymer in 25.0 mi. of 95-98% (by weight) sulfuric acid is 2.64.
>
> Anisotropic Dope Preparation: A mixture of 36.0 g. of the above polymer and 264 g. of fuming (3% free SO3) sulfuric acid is nixed anhydrously with an air-driven disc-type stirrer in a 500 mi. resin-making kettle while cooling with an ice/water bath. The mixture is stirred overnight and is allowed to stand for 15 days at room temperature. The resulting dope exhibits stir-opalescence and depolarizes plane polarized Light.
>
> Fiber Preparation by Wet Spinning Anisotropic Dope: A portion of the spin dope prepared above is centrifuged to remove entrapped air. It is then extruded by means of a mechanically drive syringe through a 0.010 in. (0.254 cm.) thick precious metal spinneret having 20 holes of 0.003 in. (0.076 mm.). diameter into an aqueous coagulating bath at 41° C. The bath is about 2 in. (5.1 cm.) wide and about 1 in. (2.54 cm.) deep. After passing through the bath for about 2 ft. (0.61 m.) the yarn is snubbed out of the water at about a 45° angle to an electrically driven wind-up device. The yarn is collected on a perforated bobbin at 65 ft./min. (19.9

> m/min.), It is then washed in cool running water for several (i.e. 3 hr.) hours and dried in air at room temperature. The filaments exhibits low crystallinity and an orientation angle of 34° and a sonic velocity of 4.56 km/sec. Filaments (boiled off) exhibits the following T/E/Mi/Den values: 5.3/10,4/171/5.0.
>
> Heat Treatment of Fibers from Anisotropic Dope: The above yarn is passed at 25 ft./min. (7.63 m./min.) through a tube [Devices A) heated to 600°C. and collected at 27.5 Et./min. (8.34 m./min.). The resulting fibers exhibit high crystallimity, an orientation angle of 15°, and a sonic velocity of 8.37 km./sec. Filaments (boiled off) exhibit the following T/E/Mi/Den. values: 12.8/1.9/817/4.84.
>
> Isotropic Dope Preparation: A mixture of 9.0 g. of the above polymer and 111.0 g. of furning (2% free S03) sulfuric acid is mixed anhydrously with an air-driven disc-type stirrer in a 500 mi. resin making kettle while cooling with an ice/water bath. The mixture is stirred overnight or until a cleare viscous dope is obtained during which time the cooling bath is allowed to warm to room temperature.

(CX-853-31, RX-164, cols. 24, 25).

312. Example 2 of the,Kwolek '54 patent reads in part"

> This examples illustrates (1) the preparation of poly(p-phenylene terephthalamider), (2) an anistropic oleun dope thereof, and (3) high modulus fibers thereof.
>
> Polymer Preparation: Powered terephthaloyl chloride (101.55 g., 0.5 mole) is added to a solution of p-phenylenediamine (54.09., 0.5 mole) in a mixture of hexamethylphosphoramide (600 mi.) and N-methyi-2-pyrrolidone (300 mi.) and stirred at high speeds in a blender. A solid mass is obtained within minutes. After 20 min. the mass is combined with water and stirred at high speeds in a gallon-size (3.735 liter) blender. The polymer is washed four times with water, once with alcohol, and finally with acetone by being stirred in a blender and isolated by being filtered on a Buchner funnel. The polymer is dried overnight in a vacuum oven at about 100°C. The yield of polymer is 116 g. (97.5 % of theoretical). The inherent viscosity, measured as a solution of 125 mg. polymer in 25.0 mi. of 95-98% (by weight) sulfuric acid, is 3.8.
>
> Anisotropic Dope Preparation: A mixture of 50.0 g. of the above polymer and 450.0 g. of furning (0.8% free SO_3) sulfuric acid is mixed anhydrously with an air-driven disc-type stirrer in a 500-mi. resin-making kettle while cooling with an ice/water bath. The mixture is stirred overnight during which time the cooling bath is allowed to warm to room temperature. The resulting dope exhibits

> stir-opalescence and depolarizes plane polarized light. It exhibits a solution viscosity at room temperature of 5000 poise, measured by a Brookfield (model RVF) viscometer employing a No. 7 spindle, at a spindle rate of 2 r.p.m.; at a rate of 20 r.p.m. the dope exhibits a solution viscosity of only 1,660 poise.
>
> Fiber Preparation by Wet Spinning: The spin dope prepared above is centrigued to remove entrapped air. It is then extruded at the rate of about 0.8 mi./min under a pressure of 370 lb./in.° .... through a 0.025 in. (0.064 cm.) thick preciolis metal spinneret having 20 holes of 0.002 in. (0.0051 cm.) diameter into an aqueous coagulating bath maintained at 43°C. The bath is about 16 in. (40 cm.) wide. 5.5. in. (14 cm.) deep and 37 in. (94 cm.) Long with stainless steel rollers placed about 2 fll (0.61 cm.) from each other, The yarn is drawn through the bath and around the rollers such that it makes three passes through the water bath. It is then snubbed out of the bath at about a 45° angle to an electrically driven wind-up device. The yarn is collected on a perforated bobbin at 27 ft./min/ (8.24 m./min.) while being wetted on the bobbi by passing through a water reservoir located at the lower portion of the collection bobbin. It is then washed in cool running water overnight and a portion is removed for heat treatment. The remainder is dried on the bobbin in air at room temperature. The dry filaments exhibit low crystallinity and an,orientation angle of 31° and a sonic velocity of 5.00 km./sec. Filaments exhibit the following T/E/M, Den. values: 7.0/9.1/173/1.93 (10% of extension).

(:X-852-31, RX-164, cols. 25, 26).

313. Example 72 of the Kwolek '542 patent reads in part:

> This example illIstrates the preparation of poly(p-phenyiene terephthalamide), together with anisotropic oleum dopes and fibers thereof. The DDA value is shown for the dope.
>
> To a solution of 43.2 g. (0.4 mole) of p-phenylenediarnine dissolved in 480 mi. of dry hexamethylphosphoramide and 240 mi. of dry N-methylpyrrolidone-2 contained in a blender are added, with stirring. 81.2 g (0.4 mole) of finely ground terephthaloyl chloride. A gel forms in about 20 seconds. After 20 minutes te gel is broken up an washed three times with water, twice with alcohol and twice with acetone to give 93 g. of air-dried polymer of... (viscosity) = 3.13. Several batches of somewhat higher and lowerinherent viscosity polymer are prepared similarty as above and combined to give a polymer of ...(viscosity) = 3.16.
>
> Thirty grams of the blended polymer are dissolved at room temperature in 270 g. of 100.4% sulfuric acid to give a fluid composition containing 10% polymer by weight. It is anisotroic as determination by its degree of depolarization

> anisotropy (DDA value of 93.6)
>
> The room temperature dope is extruded at 865 lb./012 (60.7 kg./cm ^{3}) pressure through a 60 hole spinneret each hole of 0.0025 in. (0.0635 mm) diameter, into a water bath maintained at 4°C. The filaments are wound up at 21 ft./min. (6.8 m./min.). They exhibit the following filament tensile properties after being dried: T/E/Mi/Den - 7.0/10.7/197/4.9.

As can be seen from Examples 1, 2 and 72 sulfuric acid/PPD-T dopes were informally treated at room temperature or at in ice water bath temperature. (CX-852-31, RX-164, col. 74).

314. The largest PPD-T concentration used in Example **1**, 2 and 72 was about 12%. The tenacities of the as-spun PPD-T fibers in these example ranged from 5.7 to 7 gpd; and the moduli of the as-spun fiber ranged from 171 to 197. The inherent viscosities of the PPD-T in Examples 1, 2 and 72 are 2.64.3.8 and 3.16 respectively in sulfuric acid of greater than 98% concentration. (CX-952-31, RX-).64, cols, 24, 25, 26, 74; Uhlmann, CX-835, pp. 53-54).

315. Example 75 of the Kwolek '542 patent relates to heating sulfuric acid spinning solutiod'u. It reads:

> This example illustrates the effect of temperature and weight percent of polymer on the critical concentration points for poly(p-benzamide) and poly(p-phenylene terephthalamide).
>
> Polyp-benzamide), having an inherent viscosity of about 2.72 is prepared in a manner similar to that previously described. Dopes **are** prepared of various concentrations namely 9.2, 10.0 and 12.0% in 99.5% by weights H_2SO_4 at room temperature. Each of these dopes are anisotropic at that temperature. As the temperature is gradually increased, the three dope samples convert to essentionally isotropic dopes at 29°C., 53°C., and 77°C., respectively.
>
> PoLy(p-phenylene terephthalamide) having an inherent viscosity of about 3.L6 is prepared in a manner similar to that previously described. Dopes are prepared of various concentrations,namely, 9.2, 10.0 and 12.0% in 100.3% by weight H2SO4 at room temperature. Each of these dopes are anisotroic at that temperature. **As** the temperature is gradually increased, the three dope samples convert to essentially isotropic dopes at 41°C., 67°C. and 109°C., respectively.

> The points where each of the above samples convert to an essentially isotropic dope is the critical volume concentration point for each. As the example indicates, this point for a particUlar polymer/liquid medium is dependent on the temperature of the dope and the weight percent of polymer therein.

(CX-852-31, RX-164, cols. 78, 79).

316. Example 79 of the Xwolek '542 patent illustrates the preparation of poly (3.3', dichloro-4,4' -biphenylene terephthalamide) from 3.3', dichlorobenzidine and terephthaloyl choloride, and fibers therefrom. It reads in part:

> The polymer (10 g.) is dissolved in 100 g. of concentrated (95-98%) sulfuric acid to form a clear, viscous dope at about 45°C. At 26°C. the dope become stiff and opaque. The dope is extruded from a warmed cell through a spinneret having 20 holes of 0.003 inch (0.07 mm.) diameter into a water bath maintained at 45°C. The filaments are wound up at 72 Et/min. (22 m./min.). The yarn is soaked on perforated bobbins in two changes of distilled water Eor a total of 24 hours and is then air-dried. The as-extruded filaments then exhibit the following tensile properties: T/E/Mi/Den.: 1.8/32,3/68.8/8.3: sonic velocity is 2.71 km./sec. After being extended 1/75X while being slowly hand drawn over a 300°C. hot bar (0.5 inch (1.27 cm.) contact surface), the filaments exhibit the following properties: T/E/Mi/Den.: 2.07/0.6/326/6.3: 2.A. = 12° and medium crystallinity. After the as-extruded yarn is drawn as just described except that the bar is at 400° C., the following filament properties are observed: T/E/Mi/Den.: 3.35/0/9/372/5.9: O.A. = 12°, and high crystallinity.

(CX-852-3L, RX-164, col. 81).

317. The Ewolek '542 patent provides one example in which fiber is wet spun from spin dopes of 4,4'-DABT in sulfuric acid (example 31). (CX-852-31, RX-164, col. : 1, is. 25-46; col. 52, is. 15-26). The 4,4'-DABT concentration was 10 wt. percent. The dopes were mixed at room temperature. (CX-852-31, RX-164, col. 51, Is. 72-76). The as-spun tenacity was 6.4 gpd.'

which increased to 10 gpd after heat treatment (Table IV). (CX-852-31, RX-164, col. 52, is. 27-40).

318. In Example 74 the Kwolek '542 patent solubility of PPD-T in sulfuric acid increases with the concentration of H_2SO_4. The largest value for a polymer of inherent viscosity of 3.32 is given as 11.7 wt.%. To achieve this concentration sulfuric acid containing 100.5% H_2SO_4, was employed. For the next lower sulfuric acid concentration of 99.2% Kwolek indicates the maximum solubility of PPD-T is 7.8%. (CX-852-31, RX-164, cik, 77, Is. 30-35).

319. In column 17, Is. 60-62, the Kwolek '542 patent describes that the dopes of her invention are extruded into fibers by conventional wet and dry spinning techniques and equipment. Neither here nor in any of the examples does Kwolek disclose the use of dry jet wet spinning (i.e., air gap). (Allmann, CX-835,p. 55).

320. The Kwolek '542 patent discloses the spinning of anisotropic dopes comprising 4,4'-DART in sulfuric acid of greater than 98% concentration in Examples 12 to 14 and 31 to 35. Polymer inherent viscosities were 6.22, 3.73. 3.77, 3.6 (col. 38, 1. 12, and col. 51, 1. 21, col. 52, 1. 43; Karshall. RX-4, p. 11).

321. The Kwolek '542 patent discloses spinning dopes containing 14 wt. % or more polymer which respondents state are of the type encompassed by the Blades '756 patent claims in Examples 3, 20, 21, 22, 23B, 71, 74 and 81. (CX-852-31, RX-164, col. 26 Is. 40-75; col. 41, 1. 32, col. 45, 1. 32; col. 73, 1. 32, col. 74, 1. 2; col. 76, L. 31, col. 78, 1. 51, and col. 82, 1. 46, col. 83, 1. 16).

322. The Kwolek '542 patent discloses a typical wet spinning process for preparing fibers. That process differs from the Morgan '645 air gap spinning process in that in Kwolek '542 the spinneret is immersed in the coagulation bath while in the Morgan '645 process the spinneret is separated from the surface of the coagulation bath by a short distance. (CX-852-31, col. 14, 1. 73, col. 15, 1. 9; CX-852-22, RX-58, col. 3, is. 18-29).

323. The Kwolek '542 patent discloses:

> One spinnable group of anisotropic dopes comprises about 6-15% by weight poly(p-phenylene terepthalamide) whose inherent viscosity is in the range of about 0.7-3.5 from 0.5% to up to 5% by weight Lithium chloride, and the balance an amide mixture of hexamethylphosphoramide and N-methylprrolidone-2 containing greater than 45% by volume of hexamethylphosphoramide. The relative amounts of these ingredients, particularly those of the hexamethylphosphoramide and N-methylpyrrolidone-2, contribute to the ease with which these spin dopes are obtained. For instance, as illustrated in the examples which follow, a spin dope fluid at room temperature is obtrained from thses ingredients when a particular amide mixture is employed. However, when a different amide mixture containing more hexamethylphosphoramide is employed with the same amounts of the polymer and salt, the combined ingredients must be heated to at least about 35°C. to achieve a liquid anisotropic dope whose birefringence may be observed. Preparation of the dopes is preferably undertaken by vigorous mixing of the ingredients at low temperatures, e.g., as low as 0° to -10°C.

(CX-852-31, RX-164, col. 9, Is. 46-67).

324. The benefits of good mechanical properties in as-spun fibers are describe in the Kwolek '542 patent as follows:

> "As-extruded fibers of this invention are preferred for particular end uses e.g., tire cord. For such uses, it is generally desirable that, in addition to high modulus and tenacity value, the fiber exhibits elongation of about 5%. However, post-shaping treatments (e.g., heat treatment) which improve the modulus and tenacity, often do reduce the elongation (e.g., to below 5%). Since particular preferred fibers moduli and tenacities as-extruded, and exhibit elongation values of at least about 5%, these as-extruded fibers are well suited for such end uses."

(CX-852-31, RX-164, col. 16, Is. 28-37).

325. In deposition Blades admitted that the 100.65 percent concentrated sulfuric acid used in Example 23B of the Kwolek '542 patent fits within the definition of nutable dope solvents appearing in co. 5, 1. 24 and following lines of the Blades' 756 patent. (Blades, Dep. RX-26, p. 213, ls. 17-24).

326. In deposition, Blades admitted that the dope in Example 21 of the '542 patent falls within the definition of the dope of claim of Blades '756 patent. (Blades, Dep. RX-26, p. 215, 1. 22 - p. 216, 1. 4).

327. In deposition Blades admitted that the dope of Example 81 of the Kwolek '542 patent fits within the definition of the dope in claim 1 of the '756 patent. (Blades, Dep. RX-26, p. 217, Is. 4-11).

328. An article Polymer Engineering and Science, March 1975, vol. 15, No.3, pp. 199-296 entitled "High-Strength/High Modulus Organic Fibers" by J. Preston of Monsanto showed the tenacity of PABH-T (X-500) which is a para-oriented polymer e.g. polyterephthalamide of p-aminobenzhydrazide (4,4-'DABT) to be 8-9 for the development fiber and 12.1 for the experimental fiber Du Pont's "Kevlar" commercial fiber was said to have a tenacity of 24.9 (CX-1150, pp. 203-204).

329. When respondents' expert technical witness Bailey was asked, "Would you believe twice as nJch for DABT (than the cost for PPD-T)", he testified "Oh, **yes**, certainly". (Bailey, Tr., p. 2197).

Bair and Morgan U.S. Patent No- 3,817,941

330. U.S. Patent 3,817,941, assigned to Du Pont, issued to Bair and Morgan **(Bair et a1 '941)** on June 18, 1974 from an application filed August 23, 1971 (Serial **No. 174,201), which** was a divisional of **a** patent application

filed June 24, 1970 (Serial No. 49,539), which was a continuation-in-part of a patent application filed May 21,1960 (Serial No. 39,566), which is turn was a continuation-in-part of a patent application filed December 27, 1967 (Serial N. 174,201). (CX-852-32, RX-124, col. 1, ls. 1-15).

331. The Bair et al '941 patent relates to high-strength fibers comprised of PPD-T, Cl PPD-T, and copolymers thereof. (CX-852-32, RX-124, col. 1, ls. 1-15).

332. The Bair et al '941 patent disclosed various solvents for use with PPD-T, in preparing the fibers of the 3air & Morgan '941 patent, incluidng °concentrated (95-98%) sulfuric acid or oleum." (CX-852-32, RX-124, col. 4, L. 37).

333. Bair et al. '941 patent discloses polycarbonamide preparation and sulfuric acid spin dopes as 'follows (CX-852-32, RX-124, col. 3, 4:

> Polycarbonamide Preparation
>
> The polycarbonamide useful in this invention may be prepared from appropriate coreactants by low temperature solution polymerization procedures (i.e., under 60°C.) similar to those shown in Kwolek et al. U.S. Patent 3,063.966 for preparing poly (p-phenylene terephthalamide). These polycarbonamides may be prepared by causing one or more aromatic diamines selected from the group of p-phenylenediamine and 2-chloro-p-phenylenediamine to react with polyamide-forming derivatives of terephthalic acid, together with comonomers, if any....
>
> Dope Preparation
>
> The above-identified polycarbonamides are processed into useful dopes by several techniques. The polycarbonamide is generally isolated after its formation and then dispersed in a suitable medium to form a composition or dope (such embodiments will hereinafter be referred to as "isolated" polymer dopes). In particular embodiments, the polymerization media may be used in forming such compositions or dopes (such embodiments will hereafter be referred to as "in situ" polymer dopes).

> (A) Isolated Polymer Dopes.-Isolated polycarbonamides useful in this invention having inherent viscosity in the range of 0.7-5.0 and even higher, may be combined with concentrated (95-981) sulfuric acid or oleum at room temperature to form dopes with from about 1 to 25% polymer content which may be wet extruded into films or extruded into fibers by wet-spinning procedures.

Magat testified that the "1 to 25%" range refers to certain co-polymers and not to PPD-T. (Magat, Tr. pp. 381, 382). The largest concentration of PPD-T described in the Bair et al. examples is about 10% (Example 17) (CX-852-32, RX-124, col. 29, 1. 69, col. 31, 1. 4) and in that example the PPD-T is mixed with fuming sulfuric acid while cooling with an ice water bath. (CX-852-32, RX-124, col. 30, ls. 34-37).

334. The Bair et al. '941 patent does not disclose heating PPD-T and sulfuric acid to form a spin dope. (Uhlmann, CX-1147, p. 15; Magat Tr., pp. 373-386).

335. The Bair et al. '941 patent describes that the dopes of their invention are extruded into fiber by conventional wet and dry spinning techniques and equipment. (CX-852-32, RX-129, col. 12, Ls. 21-22). None of the examples of the Bair et al. '941 patent disclose the use of dry jet wet spinning (i.e. air gap). (CX-842-32, RX-124).

336. The Bair et 31 '941 patent includes several examples of spinning PPD-T/concentrated sulfuric acid dopes, viz., examples 5 and 6 which employs 95-98 percent sulfuric acid, and contains another example, Example 21, which relates to the spInnin; DE 12 wt. % of random copoly (p-phenylene terephtalamide) containin3 non-conforming aromatic para-oriented amide units in 100.64 sulfuric acid. (RX-124, 22, Is. 1-75), and col. 33, Is. 27-59).

337. Under the heading "Description of the Preferred Embodiments," and subheading "High Strength Fibers," the Bair et al Morgan '941 patent states:

> The modulus and orientation of the fibers of this invention are unexpectedly higher than that suggested in the prior art. Desirable modulus and orientation values are also characteristic of a class of novel fibers of carbocyclic aromatic polyarnides, referred to above, which is disclossed and claimed in copending, commonly assigned application Serial No. 827,345, now U.S. Patent 3,671,542 of June 20 1972 [the Kwolk '542 patent). However, the fibers of this invention additionally possess further unique characteristics not possessed by the entire class of fibers of (Kwolek '542].

(CX-852-32, RX 124, col. 14, 1. 68, col. 15., 1. 3).

338. Akzo presented two witnesses who testified on the obviousness of the Blades invention. Dr. William J. Bailey is not an expert in the spinning .of.-Eibers or in liquid'crystals. Bailey, CX-1168 pp. 14, ls. 11-16 and p. 15, ls. 4-10, Bailey, Tr. 2263, ls. 15-21). Akzo's other expert Dr. Robert B. Davis has not experience with anisotropic or liquid crystalline solutions or the handling of anisotropic PPD-T solutions. (Davis, CX-1167, p. 10, 1. 22-12, 1. 8).

339. As to claim 13 of the '756 patent Dr. Bailey proposed combining the Morgan '645 patent (CX-852-22, RX-58), the Kwolek '542 (CX-852-31, RX-164), Bair et al. '941 (CX-852-32, RX-124) or Cipriani '793 (CX-852-16, RX-2005) patents. (Bailey, RX-3 p. 14). Thus Dr. Bailey proposed combining the Morgan '645 method which used the conventional or traditional approach of fiber Making with the Kowlek '542 and Bair et al. '941 methods which used the liquid crystalline approach of fiber making. Dr. Bailey, however, did not show how the teachings of Morgan's process using the

traditional fiber making approach and the Kwolek and Bair et al. processes using the liquid crystalline approach could be brought together or combined without completely redesigning and reconstructing the teachings of such patent, nor did he show where he found a direction in these patents, or elsewhere in the prior art, for his proposed combination. (Bailey, RX-3 pp. 1-16).

340. Du Pont's expert Dr. Uhlmann, an expert in the field of spinning polymer solutions particularly para-aramids (Uhlmann, Tr. pp. 837-39), demonstrated that one would be directed by the teachings of the Morgan '645, Kwolek '542, and Bair et al. '941 patents not to combine them. (Uhlmann, Tr. pp. 977-78). Dr. Uhlmann pointed out that Kwolek wanted to produce highly oriented fibers as-spun and that Morgan '645 wanted just the opposite, namely isotropic, largely unoriented Fibers as spun. Dr. Uhlmann testified the objectives of the Morgan '645 patents are very different from objectives of the Kwolek '542 and the Bair et al. '941 patents. (Uhlmann, Tr. pp. 977-78).

341. Dr. Bailey did not show how, even when combined, the Morgan '645, the Kwolek '542, the Bair et al. '941 and the Cipriani '793 patents would result in the method as set forth in claim 13 of the '756 patent. (Bailey, RX-3).

342. As to claim 13, hiczo's other expert witness Dr. Davis did not show how the teachings of Morgan's process could be brought together or combined without completely redesigning and reconstructing the teachings of such patents, nor did he show where he found a direction in these patents, or elsewhere in the prior art, for this proposed combinatin. Dr. Davis did not show how, even when combined, the Morgan '645 and Kwolek '542 patents would

result in the method of claim 13 of the '756 patent wherein concentrations of at least 18 wt. percent PPD-T in sulfuric acid are employed. (Davis, RX-2 pp. 1-23, RX-2199 pp. 1-13).

<u>Cipriani U.S. Patent No. 3,227,793</u>

343. U.S. Patent 3,227,793 issued to Cipriani (Cipriani '793) on January 4, 1966 from an application filed January 23, 1961 (Serial No. 83,981) It is disigned to Celanese Corp. CX-852-16, RX-2005, col. 1, Is. 1-8).

344. The Cipriani '793 patent relates to a process of wet spinning solutions of polyamides in concentrated sulfuric acid into aqueous sulfuric acid coagulation baths or aqueous formic acid. (CX-852-16, RX-2035, col. 3. Is. 24-37).

345. While the emphasis in Cipriani '793 is on poly(polymethylene) terephthalamide, the disclosure of the Cipriani '793 patent is not limited to such polyamides and discloses that para-oriented aromatic polyamides may be used in accordance with the teachings of the Cipriani '793 patent. (2X-852-16, RX-2005, col. 2, Is. 19-42.

346. The Cipriani '793 patent discloses that PPD-T is a member of an "important group of polyamides" to be used in accordance with the Cipriani '793 teachings However te equates PPD-T to m-phenylene terephthalamide. (CX-852-16, RX-2005, 2 is. 19 and 32).

347. The Cipriani '793 patent states:

> The polyterephthalamides (which includes inter alia poly-o, m, and p-phenylene terphthalamides1 when shaped in accordance with the invention exhibit a particularly good combination of

> properties, e.g., mechanical properties such as tenacity and elongation, water insensitivity as indicated by high wet stiffness and low shrinkage, and high sensitivity to disperse and (sic) acid dyes. (CX-852-16, RX-2005, col. 2, is. 37-42).

348. With respect to the solvent for dissolving such polyamides, Cipriani '793 patent only discloses concentrated sulfuric acid. The Cipriani '793 patent states:

> In accordance with one aspect of the invention a difficultly meltable polymer from the class described above is dissolved in concentrated sulfuric acid suitably having a concentration of 90 to 100, preferably 95 to 100 percent by weight. It has been found that this range of concentration of sulfuric acid is important in obtaining solutions which do not gel and which can be easily and stably formed into useful shaped articles. (RX-2005, col. 1, is. 59-66)
>
> , In addition to concentrated sulfuric acid having a concentration within the,range specified above, fuming sulfuric acid, e.g., containing up to 6 or 7% by weight or even higher of free sulfur trioxide, may be used as the spinning solvent. (RX-2005, col. 3, ls. 71-75; CX-852-16, RX-2005, col. 2, Is. 37-42).

349. The Cipriani '793 patent discloses that the polymer concentration in the concentrated sulfuric acid may be used as high as 30 wt.% and that the concentrated sulfuric acid solvent may be heated to attain such a polymer concentration. Specifically, the Cipriani '793 patent states:

> A suitable concentration of polymer in the spinning solution is in the range, for example, of 5 to 30% by weight and the temperature of the soLution which is extruded may be, for example, in the range of 20 to 10t° C. (RX-2005, col. 3, lines 48-52).

(.X-852-16, RX-2005, coL. 3, ls. 49-52).

350. As to polymer degradation in the sulfuric acid solvent, the Cipriani '793 patent states:

> The wet spinning process of this invention, especially when the spin bath is aqueous sulfuric acid, results in little or no degradation of the polymer as indicated by its inherent viscosity, particularly when the concentration of H_2SO_4 in the solvent is at least 90% and the spinning solution is not subjected to elevated temperatures for long time periods.

(CX-852-16, RX-2005, col. 4, ls. 25-31).

351. With respect to the coagulation bath into which the dope is extruded, the Cipriani '793 states:

> Moreover, it has been found that the properties of the resulting shaped articles such as filaments which are formed depend on the concentration of the sulfuric acid in and the temperature of the coagulating or spin bath.
>
> The concentration of sulfuric acid in the spin bath may be varied considerably depending on various modifications of the process. However, such concentration, especially when spinning polyterephthalamides such as polyhexamethylene terephthalamide, will in many cases be below 60% by weight, and, in some cases may be as low as 40%. However, concentrations lower than 40% may be used in the presence of additivies. The temperature of the spin bath into which the spinning solution is extruded may be, for example, in the range of 20 to 100°C., preferably 40 to 60° C.

(CX-852-16, RX-2005, col. 3, Is. 33-48).

352. The Cipriani '793 patent involves a wet spinning process, and especially when the spin bath is aqueous sulfuric acid, there is little or no degradation of the polyner. (CX-852-16, RX-2005, col. 4, Ls. 25-30).'

353. The Cipriani '793 patent contemplates a wide range of polymers including high melting autocondenmation polymers and polyurethanes. The '793 patent is entitled "Spinning of a Poly(polymethylenes terephtalamide" and aLl

examples and all claims are directed to such an amide. (CX-852-16, RX-2005, col. 2).

354. There is no suggestion in the Cipriani '793 patent that dry jet wet spinning could be used to any advantage in the spinning of polyamides from sulfuric acid solutions. (Uhlmann, CX-835, p. 49).

355. Nowhere in the Cipriani '793 patent is there any mention of spin dopes which are solid at room temperature nor any suggestion of heating the mix of solid polymer and acid sulfuric acid to obtain spin dopes. (Uhlmann, CX-835, p. 48).

356. Post-coagulation stretches up to 5x are taught by Cipriani in the '793 patent (e.d. claims 2, 4, 5 and 8). Such stretches are essential to obtaining attractive mechanical properties with the Cipriani process but are impossible for fibers produced by the process of the '756 patent. (Uhlmann, CX-835, Pp.50-51).

357. The Cipriani '793 patent is directed to poly (polymethylene) terephthalamides (see title of patent, all examples and all claims). Not only are such polymers characterized by highly flexible-chains, but also they are not aromatic polyamides of the type discussed by Blades. The patent discloses (CX-852-16, Rx-2035 at col. 2, 1. 32) poly o-, m- and p-phenylene terephthalamides, but gives no teaching as to how spin dopes of these polymers could be made or how they could be employed with the present spinning process to make fibers. There isno indication of differences in behavior expected with rigid-chairn poly(p-phenylene terephthalamide) and the more flexible poly(o-phenylene terephthalamide) and (m-phenylene terephthalamide), and the decidedly flexible poly(polymethylene) terephthalamides which are disclosed in the patent. (Uhlmann, CX-835, p. 47).

358. Nowhere in the Cipriani '93 patent is there any disclosure of heating to mix the polymer and sulfuric acid to obtain spin dopes. Cipriani does note that the temperature of the solution which is extruded may be in the broad range of 20 to 100 C. (CX-852-16, RX-2005 col. 3, Is. 50-52). Such reference to extrusion conditions cannot be taken as a teaching of mixing conditons, since the two processes are carried out separately with different apparatus and different conditions. In all examples where Cipriani comments on the temperature of mixing, the mixing was carried out at room temperature. (Uhlmann, CX-835, pp. 48-49).

Morgan U.S. Patent No. 3,642,706

359. U.S. Patent 3,642,706 assigned to Monsanto issued to H.S. Morgan Jr. (Morgan '706 patent) on Feb. 15, 1972 on an application filed March 3, 1970. (CX-852-30, RX-104).

360. The '706 patent relates to a process for extruding a spinning solution of wholly aromatic polyamide which contains a small but effective amount of a wax melting above 25°C into at least one stream that passes through a coagulating bath. (CX-852-30, RX-104 col. 1, Is. 15-20).

361. The method of the '706 patent uses the conventional approach where post-coagulation drawing is employed to obtain fibers. (Ulhmann, CX-875, p. 41).

362. The Morgan '706 patent teaches that the alleged improvements in the spinning process is in the use of a wax. The '706 patent states:

> The presence of the wax additives in the spinning solution is thought to prevent the polymer solution from coagulating too rapidly in the spin bath. Although the exact mechanism

> is not known presently, it is believed that the wax additives reduce the rate of coagulation by controlling the rate of diffusion of water and solvent into and from the coagulating filaments, which are maintained in a substantially amorphous state. As a result of the controlled coagulation and diffusion rates, the major portion of the residual salt in the spinning solutions is thus removed by the coagulation bath.
>
> Extruded streams of solutions of wholly aromatic polamides containing no wax additives are believed to coagulate rapidly at the surface in the vicinity of the extrusion nozzle resulting in an undersireable skin-core effect in the filaments. The rapadily coagulated skin reduces the diffusity of water into the filaments and inhibits the removal of salt and solvent thereform. The differing rates of coagulation between the skin and core are believed responsible for preorientation and random crystallization. As a result of the skin-core effect, filaments emerging from the bath have a high degree of orientation, some random crystallization and retention of considerable amounts of salts. These factors are responsible for poor fiber structure and void formation, both of which reduce the maximum orientation stretch obtainable.

(CX-852-30, RX-104, abstract, col. 1; col. 4, Ls. 20-45).

363. The Horgan '706 patent was not seeking orientation and crystallinity in as-spun fibers; and, the patent is directed to minimizing such orientation and crystallinity. (Uhlmann, CX-835 p. 43).

364. There is no disclosure in Morgan '706 of using PPD-T and no disclosure of using liquid crystalline (i.e., anisotropic) spin dopes or solutions. Morgan discloses the para-positioned 4,4'-DABT but there is no disclosure in Morgan of how spin dopes containing 4,4'-DABT might be prepared, how fibers of this polymer night by spun, nor what their properties might be (Uhlmann, CX-835, p. 44).

365. All of the examples in Morgan '706 dissolve the polymers in amide/salt solvents; and it is indicated that "preferably the same solvent is used for both polymer preparation and spinning." (CX-852-30, RX-104, col. 2 1 . 71-72). Only amide/sale solvents are used in preparing the Morgan

polymers. Concentrated sulfuric acid is cited as a solvent "for redissolving polymers which have been isolated and purified as, for example, when interfacial techniques are used to prepare polymers." (CX-852-30, RX-104 col. 2 Is. 67-71).

366. Morgan's reference at column 5, ls. 26-30 that the solutions cin he extruded over a broad range of temperatures of 40 to 120°C., preferably 60-90°C, refers to the extrusion temperature. This mention of extrusion temperature is not a disclosure of mixing conditions, since the mixing and extrusion operations are carried out separately with different apparatus and conditions. (Uhlmann, CX-835 p. 46).

Other Patents and Publications

367. Commonly assigned Celenese U.S. Patents 3,154,610 to Denyes and 3,154,613 to Epstein, et al: contain similar disclosures to that **of the** Cipriani '793, (RX-2235; RX-255; RX-2004).

367a). Celanese 7ritish Patent 979,342 (published January 1, 1965) a partial counterpart of 2ipriani '793, states the following:

> This invention relates to an improved process for the production of filamentary materials from sulphuric acid solutions of difficulty meltable condensation polymers. (RX 21q0, p. 1, Is. 11-14)

> According to the invention, filamentary material is made from a sulphuric acid solution of a difficulty meltable synthetic linear polymer containing repeating -CO.MR- groups in the molecule, where R is.hydrogen •or a 'monovalent organic radical, by a process wherein a solution of such a polymer dissolved in sulphuric acid of at least 90% by weight concentration is extruded through ¯an orifice into an acidic liquid coagulant to form filamentary material which is then stretched while still swollen with sulphuric acid and thereafter washed free from sulphuric acid and drieJ.

The process of the present invention not only enables the satisfactory conversion of the difficulty meltable polymers referred to into filamentary material to be carried out as an industrial operation but also avoids any substantial degradation of the polymer and thus enables filamentary materials, including filaments suitable for textile purposes, to be produced having unusually good physical properties. This is especially the case when the polymer is dissolved in sulphuric acid of a concentration by weight of more than 90%, e.g., 95 to 100%, and care is taken to avoid subjecting the solution to elevated temperatures for long periods. (RX 2190, p. 1, ls. 60-82 and p. 2, Is. 1-6).

The invention has particular value in connection with those of the above polyamides ... (such as) poly-o, m- and p-phenylene terephthalamides ... The polyterephthalaatides when shaped in accordance with the invention exhibit a particularly good combination of properties, e.g. mechanical properties such as tenacity and elongation, water insensitivity as indicated by high wet stiffness and low shrinkage, and high sensitivity to disperse and (sic) acid dyes. (Rx 2190, p. 2, ls. 31-32, 47-48, and 54-61)

* * *

As already states, th; process of the invention enables the filamentary materials to be made with little degradation of the polymer. (RX 2190, p. 2, ls. 110-113).

It is preferred to dissolve the polymer in sulphuric acid of 95 to 100% by weight concentration, for instances in ordinary concentrated sulphuric acid, but fuming sulphuric acid containing, for instance, 6 to 7% by weight free sulphur trioxide can be used iE desired. The best concentration of polymer in the solution depends somewhat on the particular polymer being Jissolved out, in general, the solution may contain from 5 to 30% by weight of polymer, and may be extruded at temperatures between 20° and 100°C.

Aqueous sulphuric acid of a concentration well below that used for dissolving the polymer, e.g. of between 40 and 60% by weight concentration, is the preferred coagulant, but aqueous formic a:i ! and aqueous acetic acid may also be used. The properties of filaments and films produced by the process are much affected by the coagulation conditions. With aqueous sulphuric acid of 40 to 60% concentration as coagulant it its (sic) preferred to use temperatures betwen 60 and 40°C... (RX 2190, p. 3, ls. 10-34)

368. Celanese British Patent 1,006,673 (published October 6, 1965) constitutes an improvement patent over Celanese British '342 patent and contains the following disclosure:

> This invention relates to an improved process for the formation of filaments and other extruded products from condensation polymers and is an improvement in or modification of the invention described in Patent No. 979,342. (RX 2167, p. 1, Is, 12-17)
>
> In our Patent No. 979,342 it has been shown how these difficultly meltable polymers can be converted into extruded products such as filaments and films by extruding a solution of the polymer dissolved in sulphuric acid of at least 80% by weight concentration through an orifice into an acidic liquid coagulant to form the extruded product, stretching it while still swollen with sulphuric acid and thereafter removing the sulphuric acid from and drying the stretched product. This process yields excellent results but on occasions it is found that the spinning solutions contain insoluble gels which interfere with the extrusion process, particularly in the production of filaments where the gels can lead to spinning instability accompanied by frequent rupture of the filaments and can, in some cases, result in a complete cessation of the spinning operation. While it is possible to reduce substantially the gel content of the solutions by filtration, this is an expensive and difficult operation to carry out effectively.
>
> According to the present invention, a solution of a difficulty meltable synthetic linear polymer contain repeating -CO,NR- groups in the molecule, where R is hydrogen or a monovalent organic radical, is prepared by dissolving the polymer in sulphuric acid of at least 80% by weight concentration and the solution is heated for a period of time, whereby its gel content is reduced, before it is forced through an orifice into an acidic ldiquid coagulant to produce a filament, film or other extruded product.
>
> It is preferred to heat the polymer solution to a temperature between 70 and 100° C. At these temperatures a noticeble reduction in the gel content of the solution soon becomes appararent, even ten minutes' heating in some cases reducing somewhat the gel content as shown by improved filterability. It is preferred to maintain the polymer solution at the chosen temperature for a period of time of between thirty minutes and five hours and, in general, this produces eminently satisfactory results. While a longer period of heating may be used, if desired, it is seldom

necessary so to do, although the difficulty meltable polymers do not appear to undergo substantial degradation even during such longer periods of heating which, with the most stable polymers, may extend to a period of some days, e.g. up to one week. (RX 2167, p.1, is. 43-80, and p. 2, ls. 1-20).

The invention has particular value in connection with those of the above polyamides in which Y and/or U^1 is or contains a para-or meta-phenylene-radical or a 1,4-cyclohexylene acid, e.g. terephthalyl chloride or a diakyl terephthalate. Some specific polymers with this latter group are poly (polymethylene) terephthalamides where in the polmethylene groups contain 2 to 10 carbon atoms, e.g: polyhexamethylene terephthalamide, polythetramethylene terephthalalamide, polyethylene terephthalamide and polypiper azylene terrphthalamide. Other polyterephtalamides are poly-o, m- and p-phenylene terephthalamides, poly-o-, m- and pxylene terephthalamides and poly-o-, m- and p-diethylene-phenylene terephthalamides and poly-o-, m- and p-diethylene-phenylene terephthalamides, the latter produced, for example, condeensing an ester-forming derivative of terephthalic acid with para-bis (beta-aminoethyl) benzene. The polyterephthalamides when shaped in accordance with the invention exhibit a particularly good combination of properties, e.g. mechanical properties such as tenacity and elongation, water insensitivity as indicated by high wet stiffness and low shrinkage, and high sensitibity to disperse and acid dyes.

The invention may also be applied to linear condensation polymers melting above 275°C. of aminocarboxylic acids or lactans or other deivatives of such acids, e.g. polymers of 1-carboxymethyl-4-aminocyclohexane or its lactam, 1-carboxy-4-aminocyclohexane or its lactam or 1-carboxymethyl-3-aminocyclopentane or its lactam.

Polyurethanes which may be employed have repearting structural units of the formala

resulting, for example, from the condensation of a di-iso-cyanate with a dihydric alcohol or phenol or the condensation of a diamine with a bis (chioroformate) of a dihydric aichohol or phenol, and melt at above 179°C. preferably above 210°C. Particularly useful are polyurethanes prepared from dihydric alcohols or phenols containing a meta. or paraphenylene or a 1,4-cyclohexylebe radical. Some specific polyurethanes which may be used and which melt at above 210°C. are the condensation product of piperazine with the bis (chioroformate) of bis (p-hydroxyphenyl) propane-2,2; the condensation product of piperazine with the bis (chloroformate) or cis-trans-1,4-cyclohexylene glycol; the condensation product of pip'•razine with the bis (chloroformate) of hydro-ˉ'inone and the condensatic.)roduct of tetramethylene diami with the his (chloroformate0 of butanediol-1,4.

rolyureas which may be used have repeating structural units of the formala

$$--CO—NR—Y—NR— \\ CO—NR'—Y'—NR—$$

resulting, for example, from the reaction of di-isocyanate with a diamine, the condensation of a diurethane with a diamine, the condensation of a carbon oxyhalide as for example, phosgene with a diamine, or by heating an alpha/beta diucea with a diamine, and melting above 179°C., preferably above 210°C. Some specific polyureas which may be used and which melt at above 210°C. are those obtained from hexamethylene di-isocyanate plus hexamethylene diamine and from m-phenylene di-isocyanate plus m-phenylene diamine. (PX-2167, p. 2; ls. 45-120, p. 3, Is. 1-3).

Preferably the solutions which are heat treated in accordance with the invention are formed by dissolving the polymer in sulphuric acid of 95 to 100% by weight concentration. Acid of lower concentration of fuming sulphuric acid, e.g. containing up to 6 or 7% by weight free sulphur trioxide, nay, however, be used. Xsuitable concentration of the polymer in the solution to be heat treated is, for example, in the range •f 2n to ton' C. (P.X 21117, p. 3, ln. 2^-141

A particularly suitable liquid coagulant is an aqueous solution of sulphuric acid having a concentration considerably lower than that of the acid in which the polymer is dissolved, e.g. from 40 to 60% by weight or lower, such concentrations being quite satisfactory when spinning polyterephthalanHes, such as polyhexamethylene terephthalamide. The temperature of the liquid coagulent may he, for exampl'., in the range of 20 tr' lnh'r., proferably 40 to 60° C. (fIX 2167, p. 3, Is. 4n-5I)

The heat tre.ated solutions may he spun very satisfactorily at a take-up spec-1 of, for example, 30 to 150 metres per minute to obtain filaments having a denier in the rante of, roc example, 0.1 to (RX 21(7, p. 3 lines 44-68).

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369. Although finding 368 shows that a large number of polymers are mentioned in the Celanese British patent 1,006,673, the only two examples in in the patent are limited to polyheamethylene terphthalamide. (RX-2167, pp. 3-4).

370. U.S. Patent No. 3,080,210 to Ucci which issued March 5, 1963 discloses that:

> In general, these objects are accomplished in accordance with the invention by continuously extruding a solution of an acrylonitrile polymer through a desired number of orifices in a spinneret disposed in air or other inert gaseous medium and continuously directing the thus-formed streams of the solution for a short distance through the medium, wherein only a very small amount of the solvent, if any, is evaporated into the ambient medium as a gas. The streams then are passed into a Liquid which is a precipitant for the polymer and an extractant for the solvent, such as an aqueous coagulating bath. In the liquid bath the streams of polymer are coagulated into fila9ents by a substantial removal therefrom of the solvent as a liquid. ...By employing such preferred solvent and bath composition while maintaining the bath temperature between the critical temperature range of 10°C. to -40°C., preferably between 10°C. and -15°C., the filaments produced possess most advantagesous physical properties and :lifter in'structure from other acrylonitrile polymer. filaments heretofore known in the art. The extrusion rate of the polymer and the speed of withdrawal of the filaments from the coagulating bath are correlated so that the filaments are subjected to a draw ratio ususally of .8-20. (RX 2002 at col. 3, is. 29-55)

> Most of the attenuation, if attenuation of the filaments is desired, occurs while the streams of polymer pass through the short air gap separating the face of the spinneret and the upper surface of the liquid inthe coagulating bath, with little, if any, stretch taking place in the coagulating bath. (RX 2002, at col. 3, 1. 71 col. 4, 1. 1)

> An advantage of the present invention is the fact that spinning solutions having much higher temperatures can be employed than ordinarily used in wet spinning. Hence, a greater percentage of polymer in the solution can be used with success. (RX 2002 col. 9, ls. 1-5)

> In conventional wet spinning this is not possible because the maximum jet stretch that can be imparted to the freshly spun filaments is usually less than two times, and in most cases is less than one time due to the anisotropic condition of normally wet spun filaments. On the other hand, it is possile to stretch the freshly spun filaments of the present invention to the extent of as high as 15 times. That is to say, that the first take-up linear velocity may be up to 15 times the extrusion velocity of the polymer. By disposing the spinneret above the coagulating bath, it is possible to attain spinning speeds as high as 100-1500 feet per minute using apparatus with which a maximum speed of only 75 to 150 per minute can be attained in normal wet spinning. (RX 2002 col. 9, Is. 42-56)

371. U.S. Patent No. 3,412,191 to Kitajima et al. which issued on Nov. 19, 1968 discloses that:

> The spinning solution to be directly extruded into the coagulating bath and the spinning solution to be first extruded into a gaseous medium may be the same or different. Ih case a spinning solutfon having high coagulating velocity and low jet stretchability is first extruded into a gaseous medium (ordinarily air or other inert gaseous atmosphere, the same shall apply hereinafter) from orifices disposed outside of the coagulating bath and is then directed into the coagulating bath, it is possible to greatly improve the jet stretchability of said spinning solution, in general, with the result that the spinning velocity or artificial fibers as a whole can be markedly improved and fiber bundles having excellent fiber property can be obtained. (RX 2006, col. 2, Is. 3-16)

372. U.S. Patent No. 2,318,704 to Moncrieff et al. which issued on May 11, 1943 discloses that:

> It is naturally essential that the solution should be in a fluid or.highly plastic condition while it is being shaped. It the nature of the components and the composition of the solution is such that it is solid at ordinary temperatures, the solution must be heated to a temperature suitable for shaping; for example, the solution may be heated to a temperature of about 10-15°C. up to 120°C. or more above the

> melting point of the solution. Thus, a solution which melts at about 100°C. may advantageously be shaped as a temperature of about 180°C. (RX 200 at p. 1, col. 2, lines 28-39, emphasis added)

> while it is generally necessary to shape the polymer solution at elevated temperature, e.g., at a temperature of 70-200°C. or more, it is preferable to maintain the setting medium at a relatively low temperature, e.g, 15 or 20 to 30°C., though higher temeperatures may be empolyed insome instances. It is important to maintain the shaping device, e.g., the spinning orifice in filament formation, at the temperature of the polymer solution, and for this purpose it is preferable, more especially when the polymer solution is shaped at a high temperature, to maintain it at or about 1/2 to 1 inch or more above the surface of the setting medium in an atmosphere of an inert gas„ e.g., nitrogen, hydrogen or carbon dioxide, the shaping device itself being kept at the desired temperature by an elecrical heating coil or other suitable heating device. (RX 2000 at p. 2, col. 1, ls. 54-68)

373. U.S Patent No. 3,523,150 to Vigneault based on an application filed Dec. 12, 1966 discloses that:

> • This invention involves a novel process for the manufacture of high tenacity filament of acrlonitrile at unusualy high spinning rates. Insofar as the principal object -f this process is to produce a synthetic filament of acrylonitrile for industrial purposes, as oppossed to apparel and carpet fiber end use, the critical features of the instant invention are the combination of steps required to produced filament having high tenacity at unusually high rates of speed.
>
> These objects are accomplished by dry jet-wet spinning a solution of an acrylonitrile polymer from multiple orifices into air or other inert gas for a distance of from 1/8 to 4 inches and then passing the shaped extrudate into a coagulation bath comprising a solvent for the polymer solvent which is a non-solvent for the polymer. (RX 2008, col. 1, ls. 34-47) .

> The percentage of polymer based on the weight of the solution will depend upon the particular polymer and solvent employed,

as well as upon the temperature at which the polymer is spun. It is desriable to employ a solution containing a high percentage of polymer for obvious reasons.

An advantage of the present invention is the fact that spinning solutions having much higher temperatures can be employed than ordinarily used in wet spinning. Hence, a greater percentage of polymer in the solution can be used with success. The spinning solution may be maintained prior to and at extrusion at temperatures from about 20 to 180°C. Room temperature is highly satisfactory from an operational standpoint. Ordinarily a solution containing at least 10 percent acryonitrile polymer is desirable.

Since the viscosity of the acrylonitrile polymer solution varies directly with its temperature, advantage of employing the high spinning temperatures permitted in the instant process may be taken with the result that low extrusion pressures are required for a given percentage of polymer. Normally, the polymer solution temperature for successful wet spinning should be closely correlated with the temperature of the coagulation bath. In order to spin acrylonitrile polymer solution by the conventional wet spinning method, it is necessary to avoid elevated coagulating bath temperatures, since such temperatures substantially reduce the solvent ektraction efficiency to a point where it is not possible or feasible to utilize the advantage of spinning a solution containing a high percentage of polymer (RX 2008 at col. 5, ls. 2-32)

* •

The distance that the spinneret is disposed above the coagulating bath may be varied. Ordinarily, the spinneret is positioned so that its face is between 1/8 and 1-1/2 inches above the bath. However, one can increase this distance by taking precaution that adjacent polymer streams do not come in contact with acid cohere to each other. For example, a cell through which the streams coaxially pass may be provided to minimize any disturbance thereof. Ordinarily, the gas between the spinneret and the coagulating bath and through which the streams of polymer travel is air, although any other gasesous medium that does not adversely affect the filaments may be used. The temperature of the gas may be regulated; however, the temperature normally present during spinning is satisfactory. For best results the spinning variables should be correlated so that less than one percent of the solvent basedon the weight of the solution is exaporated into the gaseous medium from the extruded stream.° (RX 2008, col. 5, 1s..2-32, 62; col. 6, 1. 4)

374. U.S. Patent No. 2,988,418 to Finlayson et al. which issued on June 13, 1961 discloses that:

> In view of the necessary difference in temperature between the spinning jet and the liquid, it will often be convenient to have a small air gap, for example a gap of between about 1/4 and 2 inches, between the face of the spinning jet and the surface of the liquid. In the immediate vicinity of the spinning jet the air will of course become warm or hot, but otherwise it is kept at a temperature below 50°C., and especially below 30°C. While in this method of working the filamentary material will be cooled to some extent in the air gap, the gap is not sufficiently long to cool it completely, so that the filaments enter the liquid while they are still more or less soft and thus before they are fully set. The gap may if desired contain a gas other than air, for instance nitrogen or carbon dioxide. (RX 2001, col. 2 ls. 18-32)

375. Canadian Patent No. 711,166 to Stoy et al. which issued on June 8, 1965 discloses:

> The spinning method according to the invention, used for electrolyte-containing polymer solutions, has many advantages. Either the polymer concentration or the polymerization degree or both can be substantially increased. The coagulation is then more even and the obtained filament more uniform since the amount of the solvent to be extracted or neutralized is decreased. For the same reason the method is more economical, and the quality of the fibre is better. The take-off rate may be substantially increased reaching values *usual* in dry-spinning. Large spinneret orifices require low pressure only; therefore no substantial variations of the titre-denier occur. The spinnerets remain a very Long time in the service without cleaning, and usual frequent interruptions for changing spinnerets are avoided. It may be said that the new method adds advangates of the dry-spinning to the wet-spinning methods for electrolyte-containing spinning dopes; highly concentrated polymer solutions, low pressure, high spinning speed and Low trouble incidence. (RX 240, p. 76, ls. 10-27-p. 8, 1. 1)

376. French Patent No. 902,826 to Sachsische Zellwolle kktengesellschaft published in 1945 discloses that:

> Now, it has been found that it was advantageous to interpose between the spinneret and the precipitation bath a layer or strip of gas, particularly a strip of air for the purpose of not allowing the yarn to penetrate directly into the bath upon leaving the spinneret.
>
> Such a method of procedure offers a very important advantage, in that the selection of the material from which the spinneret or nozzle is made is no longer limited, since there is no longer any need to take into consideration the risk of corrosion by the precipitation bath, a risk which formerly necessitted the use of spinnerets of precious metals.
>
> with the process, which is the object of this' invention, these disadvantages do not occur, and furthermore, there is the advantage of being able to carry out an extremely high drawing which, calculated according to the rate at which the spinning solution passes out of the spinneret, and according to the wind-up rate of the receiving part, can attain more than 500% and even more than 1,000%. (RX 2010, pp. 2-4 of translation)

377. U.S. Patent 3,414,645 to Morgan discloses that:

> In accordance with this invention outstanding improvements are provided in the extrusion of wholly aromatic polyamides by using a dry jet-wet spinning process wherein the polymer solution immediately after extrusion is led through a gaseous medium for a short distance, about 1/8 to 1-1/2 inches and preferably about from 1/4 to 1 inch before being led into the coagulating bath. The gaseous medium allows for instantaneous skincore formation to begin before the fiber enters the coagulation bath. The expression 'dry jet-wet spinning' refers to the fact that in the process of the invention the spinnerette or jet face is suspended above the coagulation bath liquid. After coagulation the fiber, depending. on the type of polymer used, is either washed or advanced to the next step of the process. The remaining sequential steps are orientation, washing, a finish application if desired, drying, and an additiona thermal stretching step referred to herein as a 'hot draw'. Surprisingly, 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. (RX 58, col. 3, ls. 18-38)

*

> The superiortity of the dry jet-wet spinning technique over dry spinning is obvious on the basis of ease and completeness of salt removal, superior orientation, and crystallinity in the drawn fibers. In terms of wet spinning versus dry jet-wet spinning another distinction is readily demonstrable. The same polymer as described in Example III was dry jet-wet spun except that the jet stretch was restricted to 1.31 times. After collecting fiber under the stable dry jet-wet spinning conditions, the spinnerette was lowered into the spin bath and the sample wet spun without changing any condition other than summerging the spinnerette. The fiber cross section obatained by the dry jet-wet spinning technique is shown in FIGURE 2. The cros section obtained by the wet spinning technique is shown in FIGURE 3. The dry jet-wet spun fiber was void free and is much preferred over the highly voided structures shown in FIGURE 3. During the dry jet-wet spinning the distance from the faCe of the spinnerette to the point along the thread Line where the fiber appeared to be coagulated or delustered was approximately 7 inches. This same point was observed only 0.5 inch from the spinnerete face with the fiber when wet Spun. (RX 58, col. 9, Is. 45-66)

378. Other patents which teach increased spinning speed which follow from using an air gap include U.S. Patent Nos. 3,048,465 to Jurgeleit which issued Aug. 7, 1962 (RX-2180, co. 2, Is. 7-10); 3,088,793 to Knudsen et al. which issued May 7, 1963 (RX-2181, col. 10 Is. 10-11), 3,415,922 to Carter, et al. which issue,: Dec. 10, 1968 (RX-2007, lines 11-13), and 3,507,943 to Bentin which *was* based on an application filed Sept. 29, 1967. (RX-2124, ls. 21-24).

379.- The fa'.2t an air gap allows increased polymer 'concentration in the spinnInj solution is taught in U.S. Patent No. 3,088,793 to Knudsen, et al. which is:3,1e.) May 7, 1963. (RX-2181, col. 9, ls. 51-53).

380. The increase in spin stretch factor which can be a consequence of spinning through an air gap is ilustrated in U.S. Patent Nos. 2,957,748 to Lieseburg which issued on Oct. 25, 1960 (RX-2179, col. 2, ls. 10-15), 3,088,793 to Knudsen, et al. which issued May 7, 1963 (RX-2181, col. 3, Is. 65-72), and British Patent No. 1,091,947 to Mitsubishi Rayon Co., Ltd. published Nov. 22, 1967. (RX-2192, p. 1, ls. 76, p. 2. 1. 4).

381. The fact that the air gap may permit the temperatures of the spinning solution to be high and coagulation bath low is exemplified in U.S. Patent Nos. 2,323, 383 to Dreyfus which issued July 6, 1943 (RX-2178 p. 1, col. 1, ls. 10-21, and col. 2, ls. 10-18), 3,048,465 to Jurgeliet which issued Aug. 7, 1962 (Rx-2180, col. 2, Is. 38-41, and col. 3, ls. 8017), 3,088,793 to Knudsen et al. which issued May 7, 1963 (RX-2181, col. 3 is. 58-65 and col. 9, Is. 5354, 58-65), 3,095,636 to Scott which issued July 2, 1963 (Rx-2182, col. 4, 1. 76, col. 5, line 3), and 3,126,434 to Berger which issued March 4, 1964 (RX-2183, col. 4, Is. 53-69, and col. 5, Is. 13-21 and 47-55).

382. Air gap spinning can produce fibers of higher properties, as illustrated in U.S. Patent Nos. 2,323,383 which issued July 6, 1943 (RX-2178 at 1, col. 2, Is. 18-22), 3,088,793 to Knudsen, et al. which issued May 7, 1963 (RX-2181, col. 18, ls. 44-47), and 3,126,434 to Berger which issued March 24, 1964. (RX-2183, col. 1, ls. 43046 and col. 4, Is. 29-36).

383. Other patents disclose the use of an air gap in a wet spinning process include U.S. Pate.nt Nos.. 1,619,768, issued in 1927 to Schubert for the spinning of artificial silk (RX-2176); 2,130,948, issued in 1938 to Carothers for spinning fibers from polyamides (RX-239); 2,246,990, issued in 1941 to wupperman Eor rayon spinning (RX-2177); 3,354,125 issued in 1967 to Smith, et. al for spinning fibers from diaminobenzanilides (RX-59, col. 7, Example, XIV, Is. 63-720); 3,354,706, issued in 1970 to Morgan for spinning fibers from

wholly aromatic polyamides (RX-104); 3,507,948, issued in 1970 to Buntin for spinning polypropylene (RX-2124); 3,621,088 issued in 1971 to Hatcher for spinning thermoplastic fibers (RX-2188); 3,210,452, issued in 11965 to Howard for spinning polyethylene fibers (RX-2185); British Patent Nos. 919,722, issued in 1963 to Hercules for spinning fibers from polypropylene (RX-2189); and British Patent No. 1,017,855, issued in 1966 to Monsanto for spinning fibers from acrylonitrile.

384. One of Du Pont's technical experts, Donald Robert Uhlman, presently serves as the Cabot Professor of Materials in Science and Engineering at the Massachusetts Institute of Technology. He holds a B.S. degree. He has M.S. and Ph.D degrees in Applied Physics. He joined the M.I.T. facility in 19G5. In his role as a professor at MIT over the past twenty years, he has had both teaching and research responsibilities in polymers'and ceramics. For the'past ten years he has been teaching one undergraduate course and one graduate course dealing with the structure, processing and properties of polymers and an undergraduate course on the engineering of polymers and glasses. He has also been teaching two other graduate courses, one on glass and the second on polyphase ceramics. In his course on polymers, consideration is given to a broad range of polymers, both flexible-chain and rigid-chain. These include nylon, polyacrylonitrile, polyethylene, polyethylene terephthalate and polyurethanes, as well as aromatic polyamides, such as poly (p-phenylene terephthalamide) (PPD-T) and poly (1,4banzamide) (1,4 B). The discussion also includes the characteristics and uses of "Kevlar" fibers. Together with his graduate students, he also carries out research on polymeric materials, with particular emphasis on the structure and transformation behavior of polymers and their

relationship to processing history. This research has included stuuies **of** anistropic-isotropic transitions as well as crystallization and relaxation of rigid-chain polymers. It has also included strudies of the structure of "Kevlar" fibers. He also carries out research in the areas of glasses and ceramics. Prof. Uhlmann has directed much attention to identifying similiarities and differences between polymers and ceramics, to interfaces between polymers and ceramics in composites, and to the use of metal-organic polymers and precursors in the synthesis of ceramic materials. In addition to his responsibilities at MIT, Professor Uhlmann serves as a consultant to a number of industrial firms in developing new processes and materials. These firms include IBM, Du Pont, and GTE Laboratories. (Uhlmann, CX-835, pp. 1-3).

385. The dry jet wet spinning process is illustrated schematically in the figure below which **is** taken from the Ucci U.S. Patent No. 3,080,210 assigned to Monsanto (.:X-852-9).

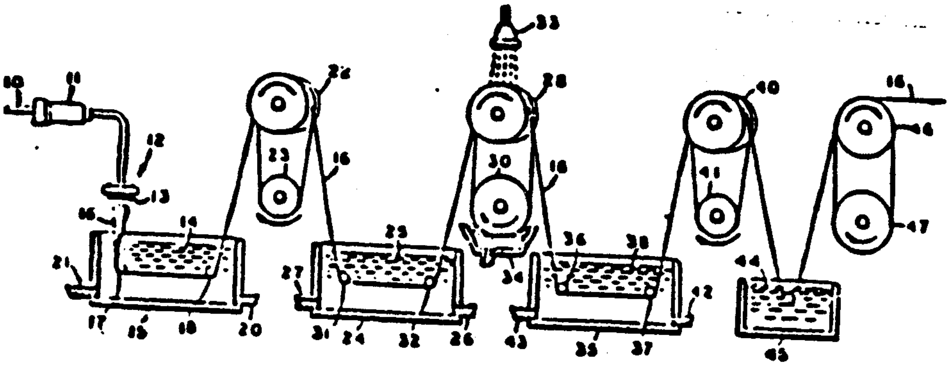

FIG.I.

As **with fibers** produced by melt spinning, dry spinning or wet spinning, **the as-spun fibers produced by dry jet wet spinning described in the literature can be subsequently drawn (stretched) to produce materials with acceptable mechanical properties. As illustrative of these properties, Ucci (CX 852-() obtained polyacrylonitrile fibers with tenacities of 4 to 5 gpd after extensive stretching. (Uhlmann, CX-835, p. 27; CX-852-9).**

386. The use of dry jet wet spinning as a technique was described in a number of patents prior to the '756 patent, and was suggested by different patentees as providing different advantages in processing. These include the production of fibers having an optimum balance of longitudinal and lateral properties (the production of isotropic filaments with a thin outer skin); an improvement in the jet stretchability or spinning velocity and the avoidance of splitting of bicomponent fibers; the accomodation of different temperatures for the spin dope and coagulation bath; the production of fibers with high affinity for dyes, suggested as associated with the generation of large numbers of submicroscopic cavities; and an improvement in the extraction of solvent and inorganic salts from the polymer solution together with a reduction or elimination of voids in as-spun fibers, (Uhlmann, CX-835, p. 28).

387. Prof. Uhlmann testified that in none of the patents which describe dry jet wet spinning prior to the '756 patent is the method taught as an approach to making as-spun fibers with high strength and modulus; in none of said patents is it taught for use with liquid crystalline solutions; and in nore is it taught for the production of highly crystalline as-spun fibers; that to the contrary, when used with rigid polymers, it is suggested to produce gel-like as-coagulated fibers (CX-852-27, col. 7 Is. 28-37: Daniels et al. U.S. Patent 3,600,269). Further, Prof. Uhlmann testified that the method is suggested in some cases to produce a large number of small cavities in the fibers; while in others, it is suggested to reduce or eliminate voids. He testified that the patents prior to the '756 patent which employed dry jet wet spinning of aromatic polyamides were concerned with producing largely isotropic as-spun fibers having a relatively low degree of crystallinity, since the orientation was developed in post-spinning drawing operations; that in contrast, the use of dry jet wet spinning with the high concentration 292

liquid crystalline dopes of the '756 patent serves to maintain and enhance the orientation developed in the spinneret, and thus contributes to the production of fibers with exceptionally high as-spun orientation. He also testified that with all of the these spinning processes, the details of the process, and indeed the selection of the process, were tailored to the characteristics of the polymer being spun; that in all cases, post-spin drawing (stretching) was employed to obtain fibers with useful mechanical properties; that in general, melt spinning was preferred over the other tehniques for reasons of throughput, avoidance of solvent handling, etc.; but the solution methods was used where processable melts cannot be obtained. (Uhlmann, CX-835, pp. 28-29).

388. One cannot generalize with regard to the tenacity as a function of the spin dope concentration even within, the field of para-aramids. (Uhlmann, Tr. p. -875).

4

X. CONCENTRATED SULFURIC ACID

399. The term "concentrated sulfuric acid" is almost universally applied to describe acids of concentrations between 95-98%, with values in the range of about 96% being commonly provided by commercial suppliers. (Uhlmann, CX-1147 p. 10; Magat, CX-1143 p. 6, Tr. pp. 615, 641; Witherspoon, Tr. pp. 1427-28). The following sources show that concentrated sulfuric acid describes acids of concentrations between 95 and 98%:

Standard Chemical Text references

rxhihit ro.	- Reference	Year	7 hy 7:e17,ht
CX 1151	Lange's Nandbook of Cheristry	1"92	"C
CX 1152	Lange's Handbook of Chemistry	1'77	,,An
CX 115:1	The nerck Index	lr"i"	n3-nr
CX 1194	Welceler's Stan"nrd nethods of Chemical Analysis	1^6?	about nt;7;
CN 1195	rackh's CI-onical rictionary	1''Y'	n5..,,,7:
CX 1174	Cm: Nandhook of Cheristry ane rhysics	1"(4	^5-n^%

Association Standards

CX 1157	American Chemical Society Specifications	1°61	rot less than "5 nor more than nn per cent
CX 11T'	American Chemical rociety Specification	1'174	rot less than ^5 nor more than ^^ per cent
C:' 119^	llanufacarine, Chemists Association	1^71	15—(^%

Commercial Suppliers

CX 1160	Ald'lrich Chemical Co.	1^^4	95%
CX 1161	Risher rcientific Co.	inr7.	95-98%
CX 1162	Catnlop C'orton Thicl7o1 Inc.)		95-98%
CX 1163	Ahzo Cherie		96%

(C::-9 47 p. 1n).

391. Uerman C. Veyland, an *employee* of respondent Ert!:a carried out the following experiments:

> (1) Experiments in which the concentration of 4,4' DABT in n 1r (12"%concentration) spinning dopes were varied from ' to **rl%** by weight and the fibers which were air-gap spun from such dopes were tested for tenacity, elongation, modulus and filament count. In these experiments, the draw ratio affording maximum tenacity was determined for each concentration, that draw ratio was employed and all variables except polymer concentration were held constant.
>
> (1) :xperiments in which identical spinning dopes comprising 2^% concentration (by weight) of 4,A' rms'' in n,5r4 (inn; concentration) were spun (a) with the face of the spinneret immersed in the coagulation bath and (b) with the spinneret separated from the surface of the coagulation bath by 12 mn. Again, with the exception of the change in location of the spinneret, all other variables in the comparable tests **were held** constant.

'2. The exr,iriments ***were sail*** to be carried out "essentially under the opt/mum conditions" discloded in Table 1 (column 7) of the norgan '645 patent. After leaving the spinning bath, the filaments were wound and washed with running water. :!owever the stretching treatment and the heat treatment used in the procedure of the '(.45 patent were omitted. It was said in accordance with the 'f1/4 specification, the winding speed (final speed) was n!min (corresponding to 121 f.p.m.); that since it was common knowledge that a higher polymer inherent viscosity will generally result in higher fiber tenacities, an inherent viscosity **of** 4.3 was used; that 4,4'-rAti having an inherent viscosity as high as ^7 had been disclosed in nonsanto publications (N'eston et al. p. n55 of Journ. <u>of nolymer Science</u> 7art C Polymer Symposin l'7"). Ueljland concluded that the results of these experiments demonstrated that there is no critical point **at** which there **Is** an abrupt rise or jump in tenacity as po1vmer concentration is increased and the solutions goes from Isotropic to anisotropic; that the fiber tenacity increases linearly with the dope concentration; that there is no special effect at a dope concentration of 14% by weight polymer in $17_2C:0_4$, the lower concentration limit sat forth in the '756 patent; that under the conditions of the experiments that '2 lope was isotropic, whereas the dopes having a concentraton of 11% and higher were all anisotropic; arl that there is an the absence of any non-linear effect on tenacity resulting from the change from isotropic to anisotropic state in the dope. It was said in the experiments that the lowest dope concentration was "7.; that at lower concentrations, spinning was found to be difficult and the results obtained unreliable; that spinning at lower dope concentrations was found to be possible, however, when the spinning temperature was lowered to 40*C. In the experiment it was said that poly 4,4'-diaminohenzanilide tereph.thalamide (4,4'-rAnT) was spun "according to the specification of U.S. Patent 3,414,645"; that a spinnirT dope was prepared by dissolyirn 4,4'PAgT in $_{-2}rr_4$ (inn% concentration) at 7r '", in a 1.67 1. rrArs Uixer. ($17-27^o1$, pp. 2 -).

1"3. In the l!eijland experiments ATTP did not *use* rorgan's Sot pin, hot shoe and draw rolls (;:eijland, Tr, p. 326n), nor any of the !!organ 'n45 elements anc 7rocessin2 steps ^ through 15 shown in FIC. 1. (Ueljland, 7r. p. 12(n, 1. '1-Tr. P. 61, 1. '5; CPX-11). experiments eliminated two third:: of the :!organ 'A45 process. (l:eijlind, 7r. p. 7i2n2 Is. 1^-27).

3'4. The ;organ '645 patent does not disclose bow the 4,4'-PA117 solutions were prepared. ('Jeljland, Tr. p. ^{1}2'1, 1. '5-Tr. p. 1217, 1. S). Akzo's experiments mixed the spinning dopes in a TrAIS mixer and applied ^{7}" legrees for two to three hours. (I:eijland, Tr. p. 1. p. 17"1, 1. 76; Tr. p. 32'2, Is. 1"-16, 1. 23 p. 7r. ^{1}2r^1, 1. 1).

295. The sulfuric acid used in the !leijland experinents *was* lrnt concentration. The ::organ '645 patent does not specify 1N'Z sulfuric acid concentration. (cx-P52-7!2,

XII. AIM(' Dr.V.r:LrT:zr.:7

1^9'6.

(CX-142, p r faintnn).

"7.

(c•.-11n A, p. 7) .

(CK-147, p. 4, Literature reference 1).

(CX$^{-\circ}$ 43, p. 4, 11. 15-2n).

400,

(CX-^41, p. 7 of translation, point 2).

(CX- ▸46, p. 1).

402.

(r?:-^tsA, p. 1, point 1).

(CX-9^{1}n, p. ?, point n).

4n4.

4n5,

(a-^56A, p. point 7).

Isn r.

(cx-Lnii, p. 2).

!!07.

30C

(CX—n q1, p. 11).

(CX—")n, p. ln, point 7).

as^.

(CX-1 61A, p. 2, **point**

h >-

41r.

(cx-nrc, 1, r.7 1).

4 1 **7.**

ln

413.

(cn-m71:., p. 17; point :

616.

irI

415.

(lest German "CS 2,21",7r1,

Cx-1c06)•

416.

'

(CX—^72).

417.

41S.

(cX,..e7n p n44n54). ••

47⁰.

`5 -

p. ¹).

421.

(a-^76A, p. 1).

6 ^{1} 3.

(CX-^141, p. 27).

(a-NaA p. ^3 (1st occurrence) :477414)

426,

47.

P -

47'%

1

(CT—^27, p.   next to past para.)

(CX-1 27, pp. 7, 11,

rm. ArrrTATIvr prrErF7s

Licensing Discussions

432. Cn January 1^, 1!,73, nr. Loudon, Akzo's ?resident, wrote a letter to '. I:. 1,rlon, DuPont's International Vice.7resident, regarding a reeting on 7ebruary 7, 1' in '.411mington wit!' 'DuPont officials. Loudon wanted to exchatr,e cone general if!eas and views on our respected aspectations and outlooks and he !:ould like to touch upon the ararid fiber problen between "our" companies Loudon stated that Atzo has taken the decision to "zo ahead" an "are conritted to tbe realization of our project, also because of the participation by the northern Development Company and the high importance the 7utc1. Coverntent attacbes to this joint venture." (C:;-3D;

4:13. ru Pont's at least as of January 1',n3 had never sought to license its aramid fiber patents. Pu Pont had invested a great deal of money and tine in the "revInr" project and believed that it was at as tbe verge of reaping rewards for tose investi•ients. Particularly in the rulte'! ntates. arl ruropean narets, 7u Pont had e strong presence in other industtial fibers and believed it would be able to service those markets adeouately without licensing Its patents to companies. (Nechert, CX-1, p. 12).

434. On February ?I., 1r3, rr. Loudon wrote to ruPOnt's rr. Jefferson, Chairman of Duront's 3oard of rirectors. His letter read in part:

> Cn the subject of aranids I have noted that your principal objection to our plans is the timing of our entry into the market in 1^r16. ¯.Zell stated that a delay of two to three years would have made natters easier. I indicated, however, that **for** technical reasons we were not in a position anymore to postpone our plants fro: coring into production in inr6. You also stressed the inportant comnitments you have nape in the past to develop 7:evlar and your obligation to shareholders to show as quickly as possible a return on this investment. I suggested that we, um¯4'r sone form of royalty agreenent, could perhaps contribute hereto and you proposed that we try to be more specific and quantify our thoughts.
>
> I understand your anxiety as to the influence our entry into the market could have on the results of 7:evinr.. However, looking at our own projection **I** believe that in further discussion **we** could alleviate such anxiety as it would take us sone tine after 1.176 to reach our full capacity.
>
> Ue have in the neantine given further consideration to how we can find a way out and I ask myself if we could not cone to **a** Settlement of our disput"e along the followino lines. Under a license agreement we would he prepare(' to pay you a reasonable fee on our sales, while we would le willing to settle a substantial part of the royalties in the fore of an advance payrent of $ 2(million on the date we enter the market. roreover, it vauld he acceptable unier an agreement with you to limit oar license durina the first years after our entry into Cie market, to rurope only. In return we expect from you that all legal proceedings against us in the field of aranids are terminated, while we, of course, would also taithdraw all objections and appeals to your patent applications and patents. In addition, we are prepared - if this would he of interest to you - to negotiate an agreenent on exchange of knowledge on e.g. raw material aspects.
>
> Fron **our** discussions r gained the inoression that this approach would in principle appear to be an acceptable basis to continue our discussions. Meanwhile I rennin convinced that an additional source of supply T4tll have a positive effect **on** the development of the market for ararid fibers. anyway, it is our firm intention to conduct our activities in an intelligent and proper fasTlion.

(.=_11).

1115. Pu Pont's nr. Jefferson in a letter dates'. :lay 2n, I'' to AI:zo rejected the proposal in Akzo's rebruary 21, 111:! letter in its *persent* form" but *said* it appears highly problematical to Pu Pont that it can he modified to be acceptable. DuPont was prepared to discuss other options. Jefferson in the :lay 2, 19C3 letter stated:

> We conclude that the impact of Akzo entering the aramid fiber marl:et in 'Europe in lr!16 - six years before the expiration of our basic patents - would have an important adverse effect on the perfornance of our 1:evlar venture. This conclusion appears to be in contrast with your own analysis.
>
> 'le believe that the reason for these different conclusions lies in a different understanding of the current size of the market and, hence, the market size in the years following your planned startup. Cased on recently published statements attributed to Akzo representatives, your organization's perception of the size of the world market in 1'112 is greater than twice the actual amount.
>
> Cur experience is that market penetration Is slow in nramid filers. Acceptance is characterized ')y fairly lengthy evaluations to demonstrate value and perfornance as *a* component in sophisticated and expensive systems. While we have planned capacity so as not to limit our growth, we expect to operate well below our capability for a number of years.

(r.-11,.

43,. !!r. Jefferson in is :Joy 2n, 1!""r letter eesignated DuPont's 71obert J. Clair, ''ice-President,. Fertile r'i'vers, to pursue further discussions with Akzo, perhaps in the :'etherlands. (M-77).

437. To prepare for a proposed meeting between ruPont and.Atzo executives, two of nr 7>lalr's assistants, nr. Henry, who testified at the hearing, and 1:r. Cer!fral :)r,pared nenoranda setting forth recommendations as to positions DuPont m! :'! (i!enry, r(-711, pp. 79-3r, 14l-h5; 'Cardinal, 7::-5r'n, pp. ln-^7).

43!'. In a memo *dated* nay 25,ln'13 DuPont's Henry wrote:

Key Points

- Akzo's motivation to negotiate primarily caused by Government/rnion questions re: viability of aramid venture.
- Significant factor is German patent court upholding Blades application. Both Blades patents now issued in netherlands for opposition.
- new ilinister of Economy *elected* after government decision to support Akzo.

Since current view of demand will not support added capacity, risks to all parties extremely large in the $1nri1t1's.

- lotton-line penalty range to DuPont $2no-oorn whether we fight or reach agreement. Probably little to choose.
- If we reach agreement with Atzo, we eliminate the chance of stopping or delaying unless delay is part of the agreement.
- rim stand signals potential challenges of our resolve to defend patents.

'.111y Talk?

- Uhile I view the likelihood of reaching agreement as very low, it gives our best chance to influence Akzo about the financial reality of our respective positions.
- Positive act on our part for further discussion with Dutch Government.
- Akzo and the Dutch Covernnent must understand our view of ierand and with the capital intensity of these fibers the criticality of value-in-use pricing in special product segrents to recover the Investment and nake modest profits.

71ements of Satisfactory Agreement:

'.'ant	lusts
. Delay - no entry until our patents expire	. License rurope only, na export of finished articles.
. use of Akzo Technology	. DuPont Supplies ingredients.

. ro Puty Change in rEC.

Upfront License Fee -
$5r'':!1.

T'.0yalty Fee - 5% 7:uhber

Special
Products

> The rusts items would restrict Akzo to turope, give us some measure of control through ingredients, and n $1001tr payment (14(11:1 ingredients) from Akzo.
>
> r!ualitatively (and quantitatively where possible) I'm coning to $10Drr seeming about right. If our best case (lowest risk) is about $7NTn, we should recover a sizable portion to make an agreement worthwhile and Akzo must have an incentive to generate maximum **dollars** for early market entry.

rx_4('6).

43. Mr. •enry's feeling as to the "rusts items" in his Nay 25,1983 memo was that if PuPont could enter into a supply contract on ingredients, where DuPont could cost the ingredients at DuPont's cost and add a profit, it would keep from looping **a(** that as an incremental cost and therefore help establish a floor on Ahzo's cost in terms of what they had to accomplish. PuPont's rr. Cardinal believed that there was no way would Akzo entertain that because cf the job:; involved; if Atzo bought ingredients from Du Pont, it would rot he (+le to erploy people that it had contracted or comr.itted to the Dutch Covernment. (nenry Pen., T'] -511, np. 364-65; cardinal cep. , nX-5^n, pp. 1r1T-T^{1}).

440. nr. Henry **made** a persentation at the June p, 1..3 meeting on the subject of .persent and **forecasted** future demand for aramids. re pointed out that, based on recent press reports, Akzo approach to hold the misconceptions that 1^{11}2 arnmid sales had been 2^{1} rillion pound while they had

in fact been less than 13 million pounds. (Henry, CX-3"1,pp. 71-r, pp. 115-11; 1"-X-4r'5; Blair, RX-52R, pp. 141-41). !!r. 7',roekmeyer suggested that the market for aramids in 1":in could he as high as 1'' million pounds, but Nr. Henry disagreed and explained it would be unreasonalle to expect the unprecedentedly high growth rate inplied by such an estimate. (1:enry, ry-511, pp. 115-1r; CX-1P1, pp. 21-22; tlair, PX-55", pp. 141-43; nroemeyer, Tr. p.

441. Ur. 3roe1neyer prepared a memorandun dated June ", recording the DuPont kzo June ',1"'t3 neetinn. If reflects, inter alia that nu Pont solicited. "Any 7nka suggestion" as the last of eight discussion ite©s which ru Pont's 31air placed in the table. It also refers to as an iten ¨Supply ingredients": 3roebmeyer in the memo stated that ru Pont's Blair " sees overcapacity situation" (TX-5't2) 3roetmeyer testified as to the Nay ", 1nr3 meeting:

> Can you tell us in your own words the substance of what tool place there?
>
> A: :That I do renenber is the fact that certain conditions have 1:een put on the table by FuPont, which conditions I, personally, really considered to be impossible ones.
>
> Q: ;That were those conditions that you considered impossible?
>
> A: I will try to reproduce what I remember. The points I an naking are not necessarily taken in that sequence. First of all,the use of ruPont raw **material**, then a lump sun royalty, no T. activities, cooperation In keeping import duties low, and the free use of the Enka patent situation. (Broameyer Dep., a-7r, p. 17').

441(a). Akzo's executive Zeppelin who was at the June ^, 1"11 Abzo - ru ?ont meeting testified:

> ("Z: nut you don't disanree the proposition that **rnka's** suggestions were solicited?

A: I think I said before that PuPont said if there are any other sulgestions -- and I nean suggestions in the direction of additional value that ErlIA put into the package -- this would be welcome and this could be discussed. That is correct.

(Zenpelin, Tr., p. 15761, 11. 11-17).

7.empelia testified on redirect examination:

Q: Nith respect to this elenent of supplying the raw materials, what was your understanding of how important that was in gettir a license form nuPont?

A: Nell, I think I described the process of the discussion just now or an hour and a half ago, and I can only repeat. This was regarded by Pu Pont and understood by us as an essential part of a would-be license agreement.

(Zenpelin Tr., p. 1r5P6, ls. n-10.

On recross Zenpelin testified:

Ti!n P:r7OrTEP: 0uestion: ¯;.,t the meeting of June !",19:13, in Arnhem between 'uPont on the one hand and Al= and EIMA on the other, do you recall approximately when the subject of ingredients cane up?¯

7o, not precisely. ilut I remember that !Ir. Flair or nr. henry listed several items as I personnaly would cell it conditions, as conditions of a license. That is, license restricted to Turope, substantially more money, and then there uns a third, and I think it was number four, if I remember correctly, that this purchase of raw materials was mentioned,

And Item after item had been discussed. It was not at the very beginning of the meeting and not at the very end of the meeting. That Is all I can say.'

Q: tell, did all the discussions between the parties cease when DuPont descrned the ingredients proposal?

A: No. ":le went on with the eiscussions,and when we cane to the raw materials the questions I mentioned before had been asked from our slie and there was a discussion of quite sone tine about the pricer, 1'ecause that was the crucial elenent or one of the crucial elements from Our side.

> And then I asked this question I had been speaking about before: Is this essential, is this very important? 'Jell, and then we probably went on to discuss a few other items. This was not the very end of the discussion, but it was *the last of* the najor items, I think the very last one, the tariff reduction. I'm not sure.

(Zempelin Tr., pp. 16(17-1601).

442. On examination by the staff attorney regarding the question of Puront supplying raw materials at the June .!,11r1 meeting, Zempelin testified:

> 0: Po you recall in the June ';'th meetings with nu Pont representatives whether any representative of Du Pont made a statement to you or any other representative of AKZO that they would not consider licensing any of their =Le. patents unless Ana' purchased its raw materials from DuPont?
>
> A: that is not exactly my recollection, sir. fly recollection of this meeting -- and I an very sure because it was a very important point -- is that this package had been presented, the package that I was talking before; and that the buying of ray material was one of the points.
>
> And immediately a discussion came up, what do you mean, what are the prices? And we said from our side, well, this Is very difficult if we don't have a price basis, and Considering that our ra•.f material plant is already more or less under construction. And this stimulate'! me personally, I remember, to ask a question: ?ow, is this a substantial point or an essential point of bur package? And I said yes.
>
> That is about the conversation.

(Zempelin, £r., pp. 1514-55).

441. sir. Henry testified that Puront did not present "conditions" at the June !*th neetirr, 1'ut rather sought to discuss any terms or package of terms that fairly compensated nu7ont . . ." p. n2). He also confirmed that rr. nlair's sur,gestion with respect to Atzo's purchase of ra' materials was not a "car!!tion," but a point offered for possible inclusion in a package jointly acceptalslc to the parties. (Id. p. 22.-21;-nlaLr, 13^-1 1; Heckert, 7r. pp. 2"--8C).

444. With respect to discussions relating to pricing at the June lfT3 Akzo - DuPont meeting, Atzo's Broekneyer testified:

> Q: What discussions, if any, were there of pricing of aramid fiber at that meeting?
>
> A: (DIRECTLY) I don't recollect. I think Er. Henry -- that is probably where I heard the term for the first time -- made a reference to value-in-use pricing. Any maybe I have 'made a reference to the fact that I did not see that we would disturb U.S. price levels. That is to the best of my recollection.
>
> Q: Do your recollect anything further about price discussions at that time?
>
> A: (Dirncmy) ro, because price discussions as such were not the main topic of that meeting. In fact, they were not a topic as far as I recollect at all.
>
> * * * * **
>
> A: (DrrnorLy) Vo, I don't remember that. Again, r would like to mention that pricing in that meeting was of no consequence, and It was not the occasion and the tine to discuss prices at all.

(Broekneyer, Tr. pp. Y)51-1052, 3055).

445. f.:Ith respect to future estimates of aramid fiber discussed at the June 7, 1112 meeting Akzo's Sroekneyer testified:

> A: (DI7ECTLY) nr. Henry stated that we had overestimated the market. 1r. henry also made a small presentation shoving that the entry of a second supplier, in his mind, would not have a beneficial influence on the groqth of the market. And he referred then to, as far as I remember correctly, Japanese circumstances.
>
> Q: Did you agree with Hr. Eenry that you head overestimated the market?
>
> A: (T'inEcTLY) our estimates were certainly higher than the figures Hr. Venry presented.

(Eroekmeyer, pp. 1D54-1n55).

446. On the June 1, 1112 Akzo DuPont meeting; Dupont wrote on June 14 1113:

- Akzo changed estimate of le.712 worldwide demand from 21:21 lbs. to 202111 lbs. and increased growth projection to n iortai lbs. by 1990 vs. previous statement indicating demand at 56221 lbs. in the 1 ^{1}33-10 period.

- tie expressed quite a different view with 1132 shipments 5P% of Akzo's estimates, and demand thereafter being affected accordingly.

- This wide gap in market views generated considerable discussion on application and growth projections. Akzo's forecast is in existing markets, heavily influenced by their perception of a 2nd supplier impact with rapid growth after 1^{1}34. They also feel that hybrids (aramid/rayon, etc; will have a strong growth impact.

- our view of current capacity satisfying demand thru this decade was considered too conservative versus Akzo's forecast.

- Simply put, Akzo's position is very optimistic and not based on experience or realistic value-in-use analysis. This discussion, at least, presented a somewhat contrary view to their projection.

DargainingTption

- tath the market discussion as background, additional bargaining points were presented by PuPont after confirming that Akzo's offer was not satisfactory.

- The following points were described individually to determine acceptance of the concept rather than debating specific numbers. Our position was clear tat these items should be viewed as a package - all important:

  I. License Curope only as proposed by Akzo, but questioned how Akzo would control secondary or downstream finished articles re: export to non-licensed countries where DuPont patents exist.

  7. Upfront License payment substantially higher than Akzo's i'n:rt proposal.

  ' 3. DuPont would aupply both primary intermediates under supply contract.

  4. Support for current duty exemption - 77.

5. A separate royalty for rubber and special products.

(. License agreenent would give DuPont freedom to operate under existing Akzo aranid patent (i.e. $NnP/DaCl_2$ solvent). Akzo was encouraged to include other offers they deem appropriate — not restricted to fibers.

This package, while difficult from Alzzo's viewpoint, places a more realistic value to Du?ont for any Kevlar license. After much discussion (including the point that the package would be diffetent if Akzo alters their market entry timing), 1r. Loudon stated that this package would he studied and a response ;Sven asap. Both parties agreed that we should quickly establish if further discussions are worthwhile rather than waste tine on fruitless concepts.

(7X-673).

447. Du Pont's Henry testified:

> In early 1983, Du Pont received a proposal from AKZO to license DuPont's aramid fiber technology, including the Blades process patent. Du Pont initiated studies to determine what a reasonable price for a license would be. We sought to quantify the negative financial impact on DuPont if Akzo entered the U.S. aramid fiber market. AKZO's initial licensing proposal was for Europe only, so the initial studies concentrated on the impact on the European market. We concluded that licensing AKZO to sell aramid fiber in Europe would result in a sales volume so small relative to AKZO's plant capacity that it was unlikely that AKZO would be content with only a share of the European market. This was confirmed by AKZO's request for worldwide licenses.

(CX-36, p. 65).

448. In a DuPont memo titled "TACTICAL PLAN AKZO MARKET ENTRY-NO LICENSE" dated June 20, 1983, DuPont wroter

> <u>Objective</u>
>
> Minimize AKZO's impact on "Kevlar" earnings by preventing delaying - limiting AKZO's market entry.
>
> <u>Litigation</u>
>
> - Agressively pursue active litigation.
>   - U.K. - Press infringement suit and obtain an interlocutory injunction as quickly as possible.
>   - France - Direct litigation so that an injunction to prevent AKZO sales is in place prior to AKZO commercial plant start-up.
>   - Germany - Press for validity ruling as quickly as possible while concurrently pursuing infringement suit and injunctive relief.
> - Initiate additional litigation against AKZO.
>
>   Belgium - Initiate infrinlement suit, evidence now in hand.
>
>   Italy - AKZO active, need evidence to initiate suit.
>
> Decide on the best approach to protect the U.S. market and take appropriate action.

Initiate infringement suit now.

Risk

-- Counter suit on use of NMP Cad
-- Patent ruled invalid and U.S. market full open

Benefit

-- Reduces time required for injunction
-- Demonstrates our confidence and will to fight

Wait for AKZO to become more active in the U.S. market then initiate infringement suit

Risk

-- Increase time required to get injunction
-- Passive, position could encourage AKZO

Benefit

-- Patent remains in effect until challenged.

Government Interface

- Before any public change in our posture and position opposite AKZO, make contact with the Dutch Minister of Economic Affairs, NOM, the U.S. State Department and U.S. Ambassador to Hollar.

  - Cover our recent negotiations.
  - Explain our inability to find grounds for accommodation.
  - Stimulate consideration of other opportunities with more certain job and financial prospects.
  - Restate the free world reliance on the patent system to stimulate research.
  - Conclude with our determination to protect our patent rights.

Marketplace Posture

Take a proactive position with end-users thought to he using AKZO product and respond clearly to our custoner inquires.

Provide sales f Irce with a corporate position.

--Feel AKZO Froluct infringes
--DuPont can meet the market needs
--Want to work cooperatively
--Will protect our patent rights through the courts
--Already involvel in litigation in U.K., France, Germany

Public Position - Media

- Following appropriate contacts with AKZO and the various governmental agencies, have corporate management articulate our position in general terms.

  - DuPont makes heavy investment in R&D.
  - R&D investment made with the expected benefits provided by the patent system.
  - "Kevlar" is an example of high technology development in this atmosphere.
  - If R&D investment is to continue, companies like DuPont must be able to rely on the patent system.

Public Position - Media (Con't)

In response to press inquiry and in other interviews, if appropriate, DuPont spokeman should make the following points:

- AKZO requested discussion regarding an aramid license.
- t:e met with AKZO but no agreement could be reached.
- No further discussions are anticipated.
- Our position is unchanged, our patents are strong and we will defend them.
- Wherever we feel our patents are being infringed, we will take action to stop the infringement.

(RX -646).

449. In a memo dated August 4,1983, DuPont's Henry wrote:

> As briefly discussed this week, I suggest we get a firm date set with Akzo for their response to our 6/9 meeting. We need to establish if there is any basis for further discussions so we can proceed in a more definite direction. I suspect they are delaying to get their total project as committed as possible before reaching a final position with DuPont. As of last week construction activity is still minimal with only support services visible (road, fence, construction huts, and a few pilings). Construction workers were on vacation.
>
> In the face of husy schedules and this very important issue, other call to Loudon to estabish a time seems very appropriate. Perhaps we could get a date the week of 9/4; I know you have some vacation plans late August as do l,and our first Torair/"Kevlar" joint venture meeting is the week of 9/12 which I will attend.

(RX -671).

450. Du Pont's position at the June 1983 meeting with Akzo officials in the Netherlands as stated by Akzo in a August 16,1983 letter to Du Pont was to include the following conditions for any Du Pont lease to Enka for aramids:

> 1) We would have to pay "substantially more money", without mentioning'any exact amount.
>
> 2) Enka would give Du Pont a license under its solvent patent (no payment mentioned).
>
> 3) Enka would have to buy the raw materials PPD and TDC from DuPont as long as it has the capacity to supply them.
>
> 4) Enka would have to cooperate in keeping EC import duties for aramides low.
>
> 5) Any license would be Limited to the EC countries and Switzerland.

As to these points Akzo's position was as follows:

> 1) & 2) The $20,000,000 payment we offered previously seems quite generous to us. We remain willing to pay that amount and.are also willing to license our solvent patent at a payment to be negotiated and off set against the $20,000,000.
> 3) We are building our own PPD and TDC plants and cannot agree to this condition.
> 4) This point requires clarification.
> 5) This goes far beyond my earlier offer of compromise, under which we would receive a license which would be limited to Europe for the first few years, provided that all other points were satisfactorily resolved. In the present context, after careful consideration we believe it is essential that Enka be free to sell in other areas, incluidng the United States. Since Enka, (considering its modest capacity and its primary interest in Europe) obviously cannot threaten DuPont's dominant position in the United States for the foreseeable future, or indeed at any time, we do not believe that this would disadavantage DuPont. It may, in fact, expand the market to the benefit of both our companies.
>
> Also expected to be in commercial production at the end of 1985. I ani sure that you understand that it is important to us that our situation is clarified long before then. Accordingly, we would be happy to continue our negotiations within the parameters outlined above as soon as possible.

(CX-33).

451. By letters dated September 19, 1983 Du Pont's Mr. Jefferson wrote to Akzo's Loudon:

> My associates and I have reviewed your August 16, 1983 letter. We interpret that the values which Akzo and we place on DuPont's European aramid patents differ so much, that it is unlikely that we can reach a licensing agreement acceptable to both parties.
>
> Your original offer of 20 million dollars has not changed. Rather, it has diminished by an offset expected from a cross-license of patents which do not impact our ability to operate. Further, your interest now extends beyond Europe during the lifetime of our patents.
>
> Ry contrast, we calculate a large penalty to DuPont in sharing with a licensee a limited, specialty market during the remaining years of patent coverage.
>
> ;r. Henry has shared with you the fact that the market is currently half the size of your apparent planning basis. It seems clear that the completion of your facility would create ,structural industry overcapacity for many years.
>
> we simply cannot responsibly legitimatize that overcapacity through a license for a consideration which is so dramatically less than your impact on our own investment.
>
> This is particularly true in Light of our extensive and strengthening patent structure which we will continue to defend vigorously.
>
> Akzo's inability to address in a meaningful way the points which Mr. Blair discussed with you in June suggests that the gap between us may he too large to bridge. Unless Akzo constructs an offer which deals adequately with each of our essential points, I do not see how we can proceed further in our discussions.

(RX-682).

Kwolek Dutch Applications

452. In 1971 during the prosecution of DuPont's Kwolek United States patent application Serial No. 827,345 which matured into U.S. Patent 3,671,542 (RX-164) an affidavit under Rule 132 dated June 11, 1971 of Paul W. Morgan (the first Morgan affidavit) was submitted describing three experiments and stating the following conclusions (RX-1397 at 4):

> That based upon the above experiments, other similar experiments and his experience in ttre fiber art,he has concluded that:
>
> (1) the anisotropic dopes as claimed in the above-identified application provide substantially improved as-extruded fibers compared to otherwise similar isotropic dopes under essentially the same extrusion conditions, and
>
> (2) this substantial improvement is quite surprising and is not simply attributable to the polymer concentration of the dope."

In this first Morgan affidavit, Dr. Morgan averred that a series of -experiments were performed under his direct supervision to illustrate the as-extruded fiber properties of fibers produced from .an anisotropic dope as claimed in the Kwolek application and from related isotropic dopes. Dr. Morgan further averred that three separate dopes were prepared by adding PPD-T having an inherent viscosity of 3.98 to 300 grams of 99.9% concentrated sulfuric acid in order to form dopes of 4%, 7% nd 10% of polymer by weight. 'Dr. Morgan averred that the 4% and 7% dopes were isotropic and that the 10% dopes was anisotropic; and that each of the dopes were anisotropic. Dr. Mogran averred that each of the dopes was wet spun under identical conditions;

and averred that certain fiber properties were obtained for each dope.

453. Kwolek U.S. Patent No. 3,671,542 issued in June 2, 1972. (RX-164).

454. In 1969, DuPont filed in the Netherlands two Kwolek patent applications that were counterparts to Kwolek U.S. patent application Serial No. 735,410 filed June 12, 1968 and which later became the U.S. '542 patent. The Kwolek Dutch counterparts are Serial No. 69,09889 (RX-2106) and Serial No. 69,08984 (RX-2107), which contained different claims (CX-1125). (visseren Direct, RX-6A p. 2). Both the 69.08984 and 69.08989 applications were filed and were prosecuted by Dr. J.B.J. Kijberg of the firm of Nederland Octorooibureau located in The Hague, the Netherlands. The 69.08984 application was prosecuted before the Dutch Patent Office to the point of final rejection, whereupon DuPont requested prosecution of the 69.08989 application. (llisseren Direct, RX-6A, p. 3).

455. .Subsequent to the issuance of Kwolek U.S. Patent 3,671,542, and durinn the pendency of Dutch applications Serial Nos. 69.08984 and 69.08981, DuPont filed an application in the United States Patent and Trademark Office to reissue U.S. Patent 3,671,542. In the Reissue Oath dated October 3, 1973 (RX-1398), ”s. Kwolek averred that she was aware of information relevant to patentability not previously considered by the U.S. Patent and Trademark Office that might cause the Examiner to deem the original patent wholly or partly inoperative or invalid. More particularly,Ms. Kwolek averred that during the prosecution of U.S. application Serial No. 827,345. (underlying U.S. Patent 3,671,542), certain incomplete data were supplied' to the U.S. Patent and 7rademark Office in support of the claims.

Specifically, Ms. Kwolek averred with respect to the Morgan affidavit that she was "advised by counsel that reliance on the three experimentk described might be deemed to have been error", that

> (a) The three experiments were part of a large group of experiments performed by Dr. Cellura at the same time; the remainder were not described in the affidavit. Although many bf them do not appear to have been reliable, I am advised by counsel that the Examiner might deem that they should have been brought to his attention.
>
> (b) The entire group of experiments is of dubious value and does not adequately show the superiority of fibers spun from anisotropic dopes, because the extrusion conditions probably affected the character of some of the dopes being spun, and their'resulting fiber properties, biasing the results in favor of the isotropic dopes ... The attempt to spin under essentially'the same conditions, and the conditions chosen, were such as to favor isotropic dopes, in.that they required operating at the lower range of anisotropy, where less than optimum properties are obtained." (PX-1398, p. 3).

456. The Kwolek reissue oath reaffirmed the correctness of the conclusions, of the 1971 Morgan affidavit (RX-1398, p. 3):

> "The conclusions reached in Dr. Morgan's affidavit .... were then and are now believed to be true and correct."

457. In support of the Kwolek Reissue, DuPont filed affidavits, of among others, Dr. Cellura and Dr. Morgan. The Cellura affidavit (RX-1404), which was executed October 3, 1978, outlines in some detail the experiments that Dr. Cellura performed at the request of Dr. Morgan in an attempt to demonstrate the alleged unexpected improvement in properties of fibers spun from anisotropic dopes over those spun from isotropic dopes under the same spinning conditions. According to the Cellura affidavit, Dr. Cellura performed a first set of experiments with dopes made of varying. concentrations of 2.5 inherent viscosity PPD-T in 100.8% concentrated sulfuric acid.

However, the first set of experiments were "not satisfactory," and Dr. cellura was asked to perform a second set. The Cellura affidavit lists some 88 difference data points that his experiments generated and attempts to explain how he eliminated most of the data points and how he chose the 16 data points from which Dr. Morgan selected the three data points used in the previously described first Morgan affidavit (RX-1397) **filed** in U.S. application Serial No. 827,325. The conclusion of the Cellura affidavit was that "I believe then (when the first Morgan affidavit was filed), and I believe now," the experiments did not represent a fair showing of the superiority of fibers spun from anisotropic dopes over fibers spun from isotropic dopes; that "the tests actually favored isotropic dopes,, because the conditions required operating at the lower range of anisotropicity where fiber properties are not optimum." The ".organ affidavit (the "second Morgan affidavit") (RX-1399), which was also executed Cctober 3, 1978, describes generally how the three data points set forth in the first Morgan affidavit (RX-1397) were selected and states Dr. Morgan's belief that the facts set forth in the Kwolek Reissue Oath (RX-1398) and the **Cellura** affidavit (RX-1404) are true.

458. The 1978 !organ affidavit submitted in the Kwolek reissue patent application also reaffirmed the premise that anisotropic dopes can be used **to produce an** as-spun fiber of properties superior to those fibers produced from isotropic dopes and went on the show that: "In fact, the superiority of fibers as spun from anisotropic does has become well recognized in the **art**." (RX-1399, pp. 5-7).

459. United States the Patent and Trademark Office examined the Kwolek reissue **patent** application and in October 1979 found the original '542

patent claims patentable for the following reasons (CX-1124, p. 2):

> "The references and affidavits submitted with the instant reissue application by applicant have been considered, and claims 1 and 2 are still deemed neither anticipated nor obvious over the prior art. Although the additional experiment records submitted by means of the above-mentioned affidavits do not all support the conclusions drawn in the affidavits submitted by Dr. Bair and Dr. Morgan during the prosecution of application S.N. 827,345 (which matured into patent N. 3,671,542), it is seen that the overwhelming weight of evidence shows substantial improvement in such as-spun properties as tensile strength for fibers spun from anisotropic dope as compared with fibers spun from isotropic dope. It seems evident that the internal structure of the material (whether anisotropic or not) is not solely dependent on the concentration of the polymer in the spinning dope, but is also influenced by such factors as the nature of the solvent and the viscosity of the aromatic polyamide. The hulk of the evidence submitted clearly shows that it is essential that the spinning dopes be anistropic regardless of any other parameters, in order to in sure the improvements in initial modulus, orientation, etc., and means to determine the degree of anisotropy of the spinning dope are disclosed herein, as on pages 12-15 of the specification. It is therefore seen that the prior art available at thestime of the effective date of application S.N. 827,345 does not anticipate the herein claimed subject matter, nor does it make said subject matter obvious to one of ordinary skill in the art."

460. On June 1980 the Kwolek reissue patent application issued as Reissue Patent No. 30,352 (CX-846). This reissue patent contained the same claims as issued in the original Kwolek U.S. Patent No. 3,671,542. (CX-852-31, RX-164).

461. The record establishes no misconduct by Du Pont in the prosecution of United States Reissue Patent No. 30,352. (CX-846).

462. On June 28, 1177, DuPont asked the Dutch Patent Offide to postpone proceedings on the 6908984 application until a final action was taken

on 6908989. (CX-1128). At the time 6908989 was in an opposition filed by Akto and another. (CX-1128).

463. On December 18, 1979, during the pendency of the Kwolek Reissue application, the Board of Appeals of the Dutch Patent Office issued an Office Action (RX-359) which requested intra alia that DuPont sponsor independent tests to be obtained by an independent Dutch expect, TWO, at Da Pont's expense in order to establish the alleged unexpected superiority of fibers made from anisotropic dopes as opposed to those made from isotropic does. On January 11, 1980, Dr. Stephens (DuPont's inside counsel) and Dr. Klijberg (nuPont's Dutch counsel) had a telephone conversation in which Dr. Stephens indicated that DuPont already had some data corresponding to some of the requested tests. On January 21, 1980,'Dr. Stephens transmitted to Dr. Klijberg at letter (RX-360) and attachments for Dr. Klijberg's use in responding to the Office Action of December 18, 1979. The attachments included:

1. The first affidavit of Paul W. Morgan (RX-1397);
2. Pages 2-6 (RX-1403) of the Cellura affidavit filed in the prosecution of the Kwolek reissue (RX-1404);
3. A graph prepared by Dr. Stephens (part of RX-1403).

Stephens Dep., RX-4300, pp. 292-312).

464. Dr. Stephens' letter of January 21, 1980 (RX-360), specifically refers to the "conclusion" of the first Morgan affidavit. Dr. Klijberg used Dr. Stephens' letter dated January 21, 1980, and its attachments, in the preparation of a response to the Dutch Office Action dated December 18, 1979. (RX-359) Dr. Klijberg's response filed February 19, 1980 included the first, Morgan affidavit, pages 2-6 of the cellura affidavit and the Stephens graph. (RX-4000, pp. 382-391).

465. In the response filed February 18, 1980, in the Dutch Patent Office, Du Pont indicated that the already available test data in the first Morgan 1971 affidavit and pages 2-6 of the 1978 Cellura affidavit were being filed in the hope of avoiding the expense of the TNO tests, but specifically expressed Du Pont's willingness to have TNO run tests if the Dutch Patent Office still considered them necessary (CX-1123, Exhibit 2, p. 4).:

> "Should the above information in the opinion of your Department still not be sufficient to inform your Department sufficiently for taking a founded decision, Applicants are willing to support tests by TNO along the lines suggested provided that said experiments will be performed by experts being experienced in this very particular area."

466. Dr. Stephens admitted that he had unrestricted access to the files of the Kwolek U.S. Reissue proceeding, and acknowledged that he was aware of the Kwolek Reissue proceeding at the time he prepared his letter dated January 21,1980. (Stephens Dep., RX-4000, p. 289).

467. Dr. Stephens testified he did not remember whether he saw the second Morgan affidavit (RX-1399; Stephens Dep., RX-4000, p. 291), although among the enclosures sent to Klijberg on January 21, 1980 were annexes to the second Morgan affidavits, i.e., the Sokolova et al., Vysokomol, Soed., and Black articles. Dr. Stephens testified he did not remember seeing the Kwolek oath. (Stephens Dep., RX-4000, p. 302). He did indicate that he was aware of the complete reissue affidavit (RX-1404) of Robert P. Cellura, and, accordingly, was aware of the material in that affidavit which referred to the Kwolek oath and the second Morgan affidavit (RX-1399), i.e., the fact that the Kwolek oath referred to "errors" and Cellura's statement that the tests he performed did not represent a fair showing of the superiority of anisotropic dopes. (Stephens Dep., RX-4000, pp. 303-304).

468. In response to DuPont's February 18, 1980 letter to the Dutch Patent Office, Akzo in an inter partes opposition attached the incompleteness of DuPont's submission of just pages 2-6 of the Cellura affidavit, and later in a letter dated October 14, 1980 Akzo submitted to the Dutch Patent Office (a) the complete-Cellura affidavit (b) the Kwolek Reissue Oath and (c) the 1978 Morgan affidavit. (CX-1123, Exhibit 3, Appendix II and exhibit 4, pp. 4-6). The complete Cellura affidavit had been on file and available to the public in the U.S. Patent Office in DuPont's Kwolek Reissue Patent No. 30,352 since its filing on October 12, 1978. (RX-2036).

469. In its October 14, 1980 submission to the Dutch Patent Office Akzo also argued that the independent expert tests (TNO) were no longer necessary because DuPont's test data in the Cellura affidavit conformed with Akzo's own tests. Akzo asked the Dutch Patent Office to reject DuPont's claims not on grounds of fraud but on lack of patenability. (CX-1128, at Exhibit 4, pp. 8, 10).

470. The Dutch Patent Office then rejected the patent claims as not being "unobvious" and DuPont lid not obtain a Dutch patent on application 6908989. (CX-1123, Exhibit 5, p. 15).

471. The prosecution of DuPont's second Kwolek application 6908984 was then resumed and that Dutch patent application was also rejected by the Dutch Patent Office application department (CX-1129) and Board of Appeals (CX-1130). In its final decision, the Board of Appeals approved DuPont's filing of two applicatinns with different claims. The Board said in translation, "that ApplIc3nts are free to file two or more patent applications. for reasons broaching to them." (CX-1130, p. 4).

Blades West German Counterpart and other Foreign Patents

472. In connection with DuPont's prosecution of German patent application P 22 19 703, which corresponds to the combination of Blades U.S. Patents 3,767,756 and 3,869,429, the German Bundespatentgericht questioned whether the claim parameter of lateral crystillite order (LCO) could be measured merely by reference the disclosure of the specification of the application. Akzo, in an opposition proceeding, had alleged in its Appeal of Allowance of the Blades German application, that DuPont "grossly violateled1 tits) obligation to uncover the truth" with respect to tests that a French scientific institute made to determine a value known as •LCOTM, which is part of the Blades patent claim in Germany. (CX-1131, pp. 21-26).

473. The French institute had determined the LCO values in the second Table III (RX-2104) of its report in accordance with "conditions stipulated in the French (Blades) patent." (RX-2104).

474. In Du Pont's Reply to the Appeal, Du Pont explained that the French institute had made the required measurements correctly, but the institute had inadvertently had overlooked two instructions in the Blades German application with regard to calculating the required values. The French institute following communications with DuPont then ran the test and calculated values following the instructions in the patent. (CX-1132, pp. 12-15; RX-2104; RX-2105).

475. Notwithstanding Akzo's charges, the German Supreme Court in its decision on appeal held that Akzo's challenges to the LCO measurement did not show a lack of substantiation in the decision below (CX-1133, p. 7-8), and the Court allowed the German Blades application to issue. (CX- 1133, p. 12).

476. In col. 1, line 65 of Blades '756 as well as in the foreign counterparts of that patent, there is a reference to a prior art German application, viz, German Offen. 1,810,426 (pertinent portions at RX-2108). That application was one of several Kwolek applications filed in Germany during the years 1968 and 1969. One of the applications, viz., German Offenlegungsschrift 1,929,694 (RX-2109) filed June 11, 1969 -- which is not referred to in the Blades '756 patent and its foreign cograte -- contains the same illustrative example as occurs in Kwolek U.S. Patent 3,671,542 as Example 23, part B, which discloses completely the subject matter of the Blades dope claim as it occurred in the original U.S. patent application and which still occurs in many of the foreign cognates of the Blades '756 patent, including those in the United Kingdom, Italy and Israel. (Vissersen Direct, RX-6A at 7).

477. DuPont's U.S. patent attorney,Sol Schwartz, who prosecuted the Blades '756 patent, in his response to the Examiner dated February 15, 1973 during the prosecution of the Blades application which eventuated as the '756 patent, stated (File Wrapper of U.S. Serial No. 268,052, RX-2045, P. 2. Amendment of February 15, 1973):

> The patent to Kwolek discloses a variety of isotropic and anisotropic spin dopes of polyamides in any of a variety of liquid media. Among the media disclosed in Kwolek are amides and areas containing specified inorganic salts, concentrated sulfuric acid, hydrofluoric acid and certain sulfonic acids. In the outstanding Office Action, the Examiner states that Examples 1, 2, 23-47, 76 and 80 of Kwolek discloses the spin • dope that is used in the instance process. This is not correct. Of the 29 examples to which the Examiner refers, only one spin dope meets the requirements of the present claims, namely, Example 23,part B. Some of the examples of the group selected by the Examiner disclose spin dopes which employ hydrogen fluoride (Examples 40-47) or amides (Examples 76, and 80) as solvents as distinguished from the required concentrated sulfuric acids. Others in said.group show spin dopes with polymer concentrations or inherent viscosities or a combination of such parameteii which is far below that required in the instant claims. Kwolek does not disclose

> extrusion of any spin dope through a layer of inert fluid and into a coagulating bath. Clearly, the patent to r_wolek does not suggest that certain of the spin dopes give fibers of markedly higher as-spun tenacity when prepared in the manner presently claimed than when the same spin dopes are spun as described in Kwolek.

478. Du Pont's attorney with responsibility for handling Du Pont foreign of the '756 patent applications was not aware that Kwolek Example 23B meets the requirement of any Blades claims. Du Pont's attorney Stephens testified at his deposition in October 1984,

> .... Dr. Stephens, did there come a time when you knew that Example 23B of Kwolek met the requirements of any of the Blades claims?
>
> "A. I don't think it meets the requirements of the Blades claim." (RK-47, p. 126, 11. 18-22).

<u>Du Pont and Dutch Government</u>

479. Du Pont conducts business in The Netherlands through a Dutch subsidiary, Du Pont Nederland. (Clay, RX-501, p. 5).

436. Du Pont Nederland owns and operates a major chemical complex at Dordrecht, The Netherlands, which is among fu Pont's largest investments in Europe. (tlatkins, TA-54n, p. 14). The Dordrecht works is "central to Du Pont's position in Europe, Middle East and Africa." (Id.)

4n1. The Dordrecht works have been in operation for approximately 25 years. (Id. at 25). In the early 1980's, Du Pont embarked on a million investment program to expand the Dordrecht facilities, and was accordingly greatly concerned that nothing occur which would harm its excellent relations with the Dutch Government. pp. 10-12, 14-1(5, 25-26, 143-45; Jefferson, •X-513, pp. 77-78; Blair, RX-528, p. 55; Henry, CX-391, p. 25).

412. Du Pont's Dordrecht investment program has proceeded ¯exactly on schedule." (Watkins, RX-540, p. 13). Additional expansion plans were announced in March 1984 and are now underway. (Henry, CX-391, p. 25).

483. Because of its longstanding, strategic investments in The Netherlands, Du Pont executives have communicated frequently with the Dutch Government and its Ministry of Economic Affairs "over a long period of time" ragarding matters of concern to the parties. (Clay, RX-501, p. 33).

414. In the late 1970's, Du Pont learned that Akzo had opened communications with the Dutch Ministry of Economic Affairs for the purpose of persuading the Government of The Netherlands to invest in, subsidize or provide other financial support to-Akzo's contemplated aramid fiber venture. (Rx-1309, p. 8000339; RX-1312, p. 8100003-04).

485. On January 23, 1979 Du Pont representatives met with a Dutch government delegation from the Ministry of Economic Affairs in the Hague. Du Pont made a presentation about "Nevlar" and explained Du Pont's patent position and the properties of 'Akzo's Arenka fiber as they relate to Du Pont's patent position. Du Pont with respect to cash commitments stated:

Cash Commitments

> Since our first distribution of samples from semi-works in 1971 the cumulative research, engineering and marketing costs, and capitl outlays well in excess of $3"0121. We are not profitable and losses.will continue for several years. The total cash draw down including operative losses and capital expenditures by 1,2 will be in excess of $60011•1.
>
> This level of resource allocation for a fibers business totaling 20H tons reflects both the high capital cost of aramid technology and the expensive and long development programs leading to profitable operations. The cash commitment to "Kevlar¯ represents the largest resource allocation to a new product in Du Pont experience. It should be apparent that we approach the "Revlar" business with a long-range view. This long-term view is based on:

- A worldwide market approach
- Economies of scale consistent with a low volume market.
- A strong patent position and determination to defend that position.

(RX-1312, p. 3100013).

486. It was represented by Du Pont that at the January 23, 1979 meeting the Dutch Government *made* the point that it cannot take sides in a patent dispute between private companies, but that it did not want to embarrass the government by providing support to an enterprise which would lose in a patent dispute and be subject to injunctions. (RX-1312,p. 8100004).

487. According to a Du Pont memorandum concerning the meeting between Du Pont and Dutch government officials on January 23,1979, the following occured:

(a) a discussion that Du.Pont's "present capacity" would be adequate to supply the "specialty, high technology applications through the'mid-1980's (RX-1312,p. 8100009) and the additional projected demand for lower-value uses that were thenliilli=(id. at 1100010).

(b) Pu Pont's attorney Hoes described the Dutch patent proceedings then pending, and stated that "we expect [one of several pending patent cases) to be granted in about one year." (Id. at 81(10013).

(c) Mr. Hoes also described tests performed by Du Pont showing that Arenka fiber samples contained Min. (Id. at 1100017-13). (Samples, of Arenlia fiber had been obtained and tested both in 1977 and 1971. (CX-544, CX-545). Two weeks before the meeting with the Putch Government, Hr. Hoes had received a memorandum summarizing the tests, which stated that the presence of phosphorus indicated use of 121PA. (CX-545, p. 3).

(d) 21r. Hoes said that Pu Pont's existing Dutch patent would • cover aromatic polyamides,.whether made with Il:17.^{1}A or UMP, to which it *was* thought that Akzo might change. (PX-1312, *p.* nionn11).

488. **Textile Fibers management reported to Du Pont's Executive Committee in flay I'M:**

> **Separate from this project, we are making an alternate study to determine if we should install sone "Eevlar" capacity in Europe, where we forecast about one third** *of* **our shipments. AE20 has made the point to some of our customers and to government authorities that a strategic material such as this should not be dependent on a foreign supply. The lack of Kevlar production capability in the common market area could result in mandatory licensing of "Eevlar" there. In a second meeting with the Putch Government, they expressed a positive interest in the possibility to our installing capacity at Dordrecht.**
>
> **Therefore, we are studying cases that would install about 15•1/1 lbs. of the** *added* **capacity of this project at either Dordrecht or Maydowm in Northern Ireland. All dry polymer would be produced at Spruance for both here and Europe.**
>
> **The added project costs would be in the range of to install solution prep, one spinning machine and associated facilities at Europe.**
>
> **This Spruance expansion project would be credited** $15MM **with the deletion of one of the two spinning machines.**
>
> **This would result in an increase of project expenditures in** *the* **range, :71th manufacturing costs only slightly increased.**
>
> **Investment and cost advantages favor Maydown. "Kevlar" capacity at** Ilaydotrn **would help relieve the possible Orlon facility shutdown situation. flarketing implications that result from these two locations are under study.**
>
> **If we conclude that we should proceed with a European plan, we will initiate project action in early** insi **to Install one spinning machine in Europe for start-up about one year after the start-up of the first spinning machine at Spruance.**

(RX-636, pp. 0016n3-1604).

4S9. A Du Pont memo originating from its headquarters in Geneva, Switzerland commented on a meeting on "revlar" with Dutch Ministry of Economic. affairs on August 5, 19CO. It was said that the purpose of the meeting was to

inform the Dutch government that Du Pont is planning to build a "Kevlar" spinning plant in Europe and to determine level of interest and support that could be expected from the Dutch authorities. A point in the summary of the memo was that "[t)aken together with unclear patent situation, this meeting points strongly against a 'Kevlar' plant in Holland" (RX—1322). Present at the meeting for Du Pont were J. Donker T)uyvis, A. Itoozendaal, H. Schriber and J. Rufino (RX-1362).

490. Walter B. Watkins, a Vice President of Du Pont testified in deposition that from the end of 1979 through 1982 he was Chairman of Du Pont International S.A. (DISA) headquartered in Geneva with responsibilty for Du Pont operations in Europe, Middle East and Africa. He further testified that no "services consideration" to his knowledge was given during the period of time he was Chairman of DISA to the installation of spinning capacity nor was there any consideration given to the manufacture of PPD, the intermediate for "Kevlar". (Watkins Dep., pp. 23-29).

491. A Du Pont memo of February 21, 1980 originating from Geneva Switzerland in connection with "Investment incentives — Dordrecht" stated that W.B. Watkins suggested that a high level meeting be held with Dutch government officials to stress Pu Pont's desire to invest in the Netherlands and that this investment would be at Dordrecht with "Kevlar" production by 86/87. (R.X-1325).

492. Du Pont's Henry testified at the hearing that Du Pont plans to construct "Kevlar" spinning and finishing facilities in Maydown, northern Ireland; that approval of this plan by Pu Pont's Executive Committee is expected by mid-1985 and that the facilities are expected to because operational sometime in 1^{1}37. henry testified that once operational, the

Haydown facilities will have the capacity to produce between million pounds of "Kevlar" *and* its rate of production will be expandable to million pounds. (Henry, CX-391, p. 8; Henry Tr•., pp. 1315, 1322).

493. Akzo Loudon's letter to the Dutch flinistry of Economic Affairs dated October 31, 1930 stated:

> In connection with our phone call of last week I hereby confirm our request to suspend handling of the Arenka project for a certain time period.
>
> A clear deterioration in the course of affairs in a number of sectors of the synthetic fiber industry began to show themselves in the second quarter of this year. In light of this development it is necessary that we further consider the consequences of this for our group before taking a final decision to pass on to the realization of the Arenka project.
>
> We will keep you informed of further developments and expect to get back to you before the end of this year.

(CX-564).

494. A Du Pont August 14, 1981 "Kevlar" aramid update memo stated that:

> Our most active potential in-kind competitor has been AKZO. In mid-193n they announced plans to construct plants for the manufacing polymer and fibers nearly identical to "Kevlar". However, in early 1931, the project was delayed indefinitely due to lack of funds as a result of losses sustained by Akzo's fibers business and unsuccessful *attempts* to obtain government grants. We *have* reviewed their application for government permits to build these plants. AKZO's process is conceptually similar to ours, but there are some differences in technology. For example, they planned to use batch polymerization and also a solution preparation system for each spinning machine. We believe these differences would result in manufacturing costs significantly higher than that of "Kevlar".

(RX-603, p. 000194).

495. Du Pont continued to have periodic contacts with the Dutch Government during the period 1932-84, and used the occasion of those contacts to express its concerns that Government support of Akzo's aramid venture would involve the Dutch Government in patent infringements and adversely affect its relations with Du Pont.

496. On March 4, 1932, three Du Pont executives (Mr. Watkins of Du Pont International, Ur. Cardinal of the Textile Fibers Department in Wilmington, and Hr. Donker Duyvis of Du Pont Nederland) met with Mr. Leliveld (Director General for Industry of the Dutch Ministry of Economic Affairs) and two of his colleagues. (RX-1313). According to a !larch 9, 1982. Du Pont memo, the purpose of the visit was to discuss two key subjects: the near term expansion programs and the "Eevlar" situation. When Du Ppont's Watkins raised the question how can flu Pont avoid a decision will be taken in favor of the "Arenka" project, a Government official answered. "1. Accept the 'collision', 2. Start talks with Akzo (a.o. on licensing). 3. guild on our plant in Europe" (DX-1318). A Du Pont February 24, 1932 memo stated an objective of the visit to the Dutch Government was to deter funding of Akzo's "Aranka" plant by the Dutch government by presenting facts on Du Pont's persent postion and future expectations in the market for aramid and by quietly communicating Du Pont's determination to defend our patent position. (EX-692)-

497. At the March 4, 1982 meeting with Dutch government officials Du Pont's Mr. Watkins used the expression "collision course". lie explained the expression as follows:

> Well, I guess I generated that expression. We had a long and mutually-beneficial history of Du Pont's presence in Holland, mutually beneficial with the Dutch Government. We have been at Dordrecht now for something around 25 years.

I mentioned to you earlier the importance, which I am sure as a businessman you would appreciate, the importance of harmonious relationships with the government" of the country in which you are located. We are so very dependent on any country for grants and permits, and'simply permission to continue to operate. And we value this very, very highly.

The reports which we received had indicated that Akzo was considering the Construction of a plant to produce Aramid fiber in Holland, and the reports which we had *received* through trade intelligence indicated'that they had not been able to obtain a private investor to the extent it was *needed,* and that serious consideration was being given by the Dutch Government to supporting financially this private enterprise.

We found ourselvesi therefore, faced with the uncomfortable position of having a relationshp, a proper relationship between a private enterprise and a Government being shifted, such that we would now, as a private enterprise, be competing with a company Which was not just a private enterprise, but was private enterprise plus the Government, that we looked to for our permits and our grants and our continuing life flow, if you will.

And we envisioned that as our dispute with Akzo and their stockholder, Dutch Government', became more intense, as we defended our patents, that we would find ourselves now on a collision course between.our allegiance as a private entrepreneur with the Government and a relationship of the Government as *a* stoCkhorder'and owner, a substantial, maybe even majority owner, in a business with which we had conflict.

And we viewed this as, indeed, a collision course. We were gravely concerned that as that confrontation intensified, we would find the Government then who was torn between its loyalty to use as an entrepeneur and private citizen and its allegiance as a stockholder to our competitor.

It was not your objective in using the term "collision course" to attempt. to persuade the Dutch Government not to support the Akzo Aranid fiber project?

A. No, it wasn't. I just described to you as best I know how what our definition of "collision course" was.

(tlatkins,

493. In April 1982, two staff members of the Putch **Ministry of** Economic Affairs **visited Du** Pont in Wilmington. Mr. Corbin, marketing nanager in Du Pont's Textile Fibers Department shared with the Dutch Du Pont's actual forecasts for "Itevlar" prices and sales through the end of the decade. (Corbin Dep., RX-502; pp. 146-47). Du Pont's Dryvis from *Geneva* Switzerland who accompanied that Dutch government officials concluded from the meeting that the Dutch government is definitely not enthusiastic about spending government money "Arenka" and that "Arenka should better not come yet" (RX-1313, RX-1315).

499. Akzo communicated to NOM ((Uoordelijke Ontiwik, Eelinginaatschappj Northern Development Company)) its renewed interest in the **aramid** project "around the middle of 1932." (Wiseman, CX-652, p. 35). After a meeting among Akzo, the Ministry of Economic Affairs and NOR on July 14, 1932, NON sent Akzo a telex on July 15, 1982, setting forth all the principal terms of Enka-NON partnership. -(CX-572; Willman, Tr. p. 2574).

500. The Ministry of Economic Affairs "insisted on having (Akzo's] answer on Friday, 16 July," the next day. (CX-93). On July 20, 1932, the Dutch Minister-of Economic Affairs issued a public statement announcing the agreement and the commitment of the Government and NOM to support and participate in construction of Akzo's aramid fiber plants in The Netherlands. (CX-250).

501. In July 1982, the Dutch Minister of Economic Affairs (Mr. Terlouw) reached a decision to provide half of the capital required by AE20 to build an 11MM annual pound (expandable to 221114) aramid fiber plant and a matching ingredients plant. This-teas said.to create 400 workplaces, about equally split between ingredients and fiber production. Total investment is

about . The Northern development Co. (a regional agency funded principally by the federal government) is a 50% equity partner of AKZO in this venture. Startup was originally reported to be 1935 but some recent reports suggested possible sliding into 1986. Construction is reportedly in the very early stages. (RX-702).

502.' A letter dated December 3,1982 by Du Pont's Watkins to Minister van Ardenne stated in part:

> Over the years, Mr. J. Donker Duyvis, Managing Director of Du Pont (Nederland), and I have worked with Mr. Leliveld and his staff to encourage the growth of Du Pont investments in manufacturing facilities in Holland. We have very much appreciated this working relationship and the help Mr. Leliveld and his staff have provided in facilitating our investments. We feel these joint efforts have proven to be of mutual benefit to the economy and people of Holland and to Du Pont.
>
> There is one recent development, however, that remains of concern to us; and with the change in administration in The Netherlands, we thought it important to restate our position in the matter so there would be no future misunderstanding. The concern involves the decision last July by national and local government in Holfnd to support the AK20 "Arenka" fiber project for the north-of Holland through WIR and IpR premiums, loan facilities and NOM's participation in the share capital of the "Arenka" joint venture.
>
> The purpose of this letter is two-fold. First, we find it hard to understand the basis for the granting of these supports and NOM's equity participation. In essence,the "Arenka" project would appear not only to involve infringement of our patents in numerous countries throughout the world, but also to be economically unattractive since there does not appear to be sufficient demand for this high performance fiber product during the 1980's to sustain our recently expanded plant and the one contemplated by AKZO.
>
> Secondly, we want to call your attention to our firm position and to the possible consequences that may occur as a result of actions we will be forced to take in the advanOement of our. position.

> With respect to the patent conflict, we believe AKZO's "Arenda" fiber infringes our basic patents on iCevlar™. There is no dispute that Du Pont was the first to develop this type of aramid fibers in the mid-1960's. We have basic and improvement patents issued in 32 countries, including all major markets with the exception of Holland. We have already taken legal action for patent infringement against AK20 in the U.K., Prance, and Germany.
>
> In addition, our world-wide patent protection for 'levier" aramid fiber was further strengthened recently by the decision of the German Federal Patent Court to issue one of our key patents covering Kevlar product. We believe this decision is particularly significant because of the court that rendered the decision, the commercial importance of Germany and the fact that the decision was taken in the face of vigorous opposition from AKZO. The German patent examining procedure is recognized as one of the most thorough in the world.
>
> Although "Kevlar" aramid fibers are a key advance in the state of the art for high performance fibers, we believe the market growth has some critical limitations. We recently trebled our production facilities to have the capability of producing million pounds per year, expandable to over million pounds per year. Our forecast is that this additional capacity will satisfy the entire world's need for such aramid fibers through the 1980's. We further have experienced keen competktion from alternate high performance fibers (steel wire, fiberglass, and carbon fiber) already in commercial production by many producers throughout the world. They act as a limiting factor on the growth of the aramid fiber market.
>
> In the invention and development of aramid fibers, the Du Pont Company has already invested over 500 million dollars. Accordingly, we must and will take all legal and commercial steps deemed necessary to protect our investment and property rights. We realize that the defense of our property rights may bring economic harm to the participants in the "Arenka" project.
>
> We are concerned that this activity will affect our relationship with your government because while wp are filing lawsuits around the world to enjoin the sale of "Arenka" fiber we at the same time desire to work closely with your Ministry in encouraging Du Pont investments in Holland. Although we feel uncomfortable with this potential future conflict, we have no alternative but to *defend* our position to the fullest extent.

(RX -625).

503. A Du Pont memo dated January 31, 1983 stated:

> The Dutch election in November 1932 resulted in a new Minister (Mr. van Ardenne), to whom we have addressed a request for reconsideration. In our past discussions with Ministry officials,they have expressed their discomfort with being caught in the middle and have urged Du Pont to find an accommodation with AKZO. We have repeatedly indicated that we had no interest in licensing our patents.

(RX -702).

504. On March 4, 1933, Akzo and NOM entered into the definitive agreements establishing the Arami partnership. (RX-1809, 1310). The agreements embodied, although in somewhat greater detail, the provisions of the agreement in principle of June 1932 (CX-572). Arami's Board of Directors also approved the construction contracts for the Arami plants on March 4, 1933. (Zempelin, CX-657, pp. 35-37). Physical construction activities promptly began in April or May 1933.(Uisman, Tr. , p. 2586).

505. A letter dated September 28, 1933 by Du Pont's W. Robert Clay, Watkin't successor as PISA Ghaltman in Geveva Switzerland (EX-501, p. 2) to Minister van Ardenne stated in part:

> We met with Mr. Leliveld on March 2, 1983 as you suggested and ourlined the growing *evidence* that the Dutch decision to proceed was based on premises which time was demonstrating to be inconsistent with the facts. Emphasis was placed on the inequity of the government participating in the violation of our property rights.
>
> Since we last corresponded, two facts have emerged which seriously undermine the premise upon which the Dutch aramid venture is based.
>
> 1. Market Size I, Crowth Rate
>
> lased on statement of Akzo management, it appears that they have estimated the 1912 market size to be twice

the actual. Further, in order for the market to reach Akzo's estimate for 1990, the growth rate between now and then must average 302 per year for eight years. . This is unlikely and leads us to conclude that.Akzo and the Dutch government have based venture decision on a misconception *sof* market size and growth rates.

Based on the trend of actual growth rates over the last eight years, with which we have direct experience, the projected market in 1990 will result in an industry operating rate in the range of 50 to 672, *if* the Dutch facility were to he built. At these operating rates, heavy losses of money, and workplace instability would be a certainty.

Ile are all well aware of the enormous losses of the European fiber industry where structual overcapacity resulted from poor investment decisions based on exaggerated forecast market size and growth rates. *All* parties should seek to avoid creating a similar situation in the case of aramids.

2. Patent Validity

Akzo have consistently maintained that Du Pont's aramid inventions were anticipated by the prior art and, therefore, patents were not a significant issue. Over the last several years, Du Pont has repeatedly reviewed our patent estate for your staff and cautioned that our patent estate was strong and improving.

The Cernan patent office and Supreme Court have now joined Japan, the United States and 30 other countries in disagreeing with the Akzo premise. Germany and Japan are widely recognized as having very strenuous opposition procedures. Du Pont basic patents have now issued in both countries despite vigorous opposition.

Steadily legal opinion is being supplanted by binding decisions. We have not yet lost an opposition proceeding outside the Netherlands. Even if we should lose an occasional *case* in the future, we still have basic patent protection in 33 countries.

Infringement suits are underway in the U.K., France and Cernany. Ue will continue to file suit where infringement is found.

> Since receiving your January 18X93 letter we have sought an avenue of relief with your staff and worked diligently to provide Akzo management with the specific elements which any reasonable offer must address. Akzo's offer of August 16, 1983 is less acceptable than we understood their offer to be on February 7, 1983. We have made no progress and there does not seem to be any prospect for progress.
>
> Du Pont finds it extremely disturbing that, while we are making large investments and establishing high quality workplaces in Holland in high technology businesses, we face competition that is ignoring our property rights and attempting to deny us the rewards of our innovation in aramid fibers. The involvement of the Dutch government, or its agencies, in this situation makes it all the more disturbing.

> This matter has been reviewed with Corporate management, and they strongly support my decision to write to you and convey our urgent sense of concern, and to respectually request that we meet at your earliest convenience to discuss this issue with you.

(RX -649).

506. A memo dated Oct. 20, 1933

507. A meeting was held between the Dutch Government and Du Pont on January 5,1984. A Du Pont memo to the file on the meeting stated in part.

> R.J. Blair thanked the Minister for taking time for this meeting and continued with a statement of Du Pont's intense concern. He emphasized Du Pont's desire to maintain a good relationship with the Dutch Government. In Du Pont's opinion, however, the issue at hand is not merely a dispute between two companies. The Dutch Government is directly involved because they provided the funds for 502 of the share capital of the new venture.
>
> There are two basic issues:
>
> . MArket size and growth
> . Patent validity
>
> . <u>Market size and growth</u>
>
> Du Pont believes that Akzo's expectation of 302 compounded growth is unrealistic. The development of end-uses takes 3-5 years. This experience was initially also not anticipated by Du Pont. The 1982 figures show that Akzo's estimates were much higher than actual. If this trend continues Du Pont expects that the manufacturing facilities of both companies will operate at about 402 capacity by 1986 which leads inevitably to extensive losses for both Akzo and Du Pont. These losses will be . covered by the Dutch joint venture will the Dutch Government inject more funds into the venture if such losses are incurred?
>
> . <u>Patent validity</u>
>
> Du Pont believes that our patent situation, with the exception of the Netherlands, is strengthening. Outside The Netherlands we have not lost a patent case incourt. With an investment of over 500 million dollars Du Pont has

> no other alternative but to strongly act in defence of this large investment. Infringement suits have been brought already in several European countries. The defence of patent will put Du Pont in conflict with the Dutch Government. This is a concept to Du Pont.
>
> Responses of Minister Van Ardenne
>
> Du Pont should have no concern that relations with the Dutch Government will deteriorate.
>
> The position of the Dutch Government is that Akzo has no joint venture with the Dutch Government but with the VON (Northern Development Company). The NOM acts independently even though the capital is provided by the Government. Once the contract with the NOM is signed the Government can withdraw from it.

(EX-1122).

503. One of NOM's objectives is to reap a profit from its involvement in the Arami project. (Wisman, Tr. p. 2599).

509. The Dutch government owns all of the stock of NOM. (Wittman, tr. p. 2584).

510. The Dutch government has guaranteed loans to Arami. (Wisman, Tr. p. 2583).

511. A meeting was held among Akzo, Du Pont, NO!! and Government personnel at the offices of the Ministry in the Hague on March 30, 1984. (Henry, CX-391,p. 24).

512. Mr. Leliveld opened the March 30, 1984 meeting with the statement that he was hopeful that the two companies, both important to The Netherlands, would be able to work out their differences. (Henry, CX-391, p. 24). Du Pont repeated its concerns about the importance'of good relations with the Dutch Government; the risk that such relations would be harmed by differences between Du Pont and th Arami partnership; and the unfairness of the Government's entering into a partnership that would violate Du Pont's patents. (Id. at 25).

513. Ministry Textiles Director Dr. Schoots, who attended, prepared a detailed April 3, 1984 memorandum of the March 30, 1984 meeting for the Minister himself. (CX-653). The memorandum was later "leaked" to MOM. (Wiseman, Tr. p. 2589; Cx 652 pp. 16-18). The memorandum purported to be a "direct point-by-point summary" of the meeting. The memorandum does not reflect any "threats" by Du Pont to reconsider investments or take other action; any urging that Akzo delay entry; or any prediction that there would be effects on U.S.-Dutch relations. (CX-653; Wisman, Tr. pp. 2590-91). The memorandum does report that both Akzo and Du Pont respresentatives agreed that "at this moment in time -- through to around 1990 -- there is certain overcapacity" in thi market for aramids. (CX-653). The memorandum reflects tha the ministry was well informed on the issues and devoted to a policy under which "the Ministry of Economic Affairs is allowed to stimulate the development of aramid applications without getting involved in a direct confrontation." (Id.).

514. Hendrik Wisman, the President of MOM a Board member of Arami and an attendee at the March 30 1984 meeting, stated that in "the course of the meeting Du Pont's representatives brought up the fact that Du Pont had investments in Holland . . . and that Du Pont might reconsider further investment plans with respect to Holland as a result of the Arami's project" (Uiseman, RX-9 p. 5).

515. Mr. Wisman testified that Dr. J. Schootz was "a lower level employee" of the Dutch Ministry. (Wittman, Tr. p. 2593).

516. Mr. Wisman testified upon cross-examination, that the Schootz April 3, 1954 memorandum was not a full account of the meeting since the

"meeting was set for a discussion *between* Akzo-Enka on the one side and Du Pont on the other side, and the government, the Ministry of Economic Affairs, was not taking part in that discussion" (Wisman Tr. p. 2593); that Mr. Blair, was using the opportunity [of the meeting] to try and discuss with the government representatives Du Pont-Dutch relations"; that these discussions were not reported on because Mr. Schoots is not supposed to give opinion or facts about discussions that a meeting was not set for" Oilman, Tr. p. 2594).

517. The 15-year term formal partnership and other agreements between MOM and Enka had been concluded more than.a year before the March 30, 1984 meeting (Zempelin, Tr. p. 1573). Construction of the plants had been underway since April or May of 1933. (Wisman, Tr. p. 2586).

518. On cross-examination, Mr. Uisman changed his written testimony. Instead of attributing to Du Pont representatives a statement that U.S.-Dutch relations "would" be affected by the Arami partnership, he acknowledged that the testimony-should read "could" be affected.. (Wisman, Tr. 2567-70; CX-652 p. 48). He could not remember any details of what was said on this subject at the meeting. (Visman, CX-652.pp. 46-43).

nu Pont's Sale of "Revlar"

519. Dean MacAvoy, Akzo's economist, has stated that in pricing Revlar Du Pont has demonstrated "a total lack of pricing restraint" and has set Kevlar's prices at levels which are "much too high". (RX-14 p. 30).

520. Dean MacAvoy's conclusions in this respect are derived from a table, Table 3, which appears at page 31 of his Pebuttal Statement, RX 14, That table purports to show that in the eight-year period 1976-83 inclusive

the prices of "Revlar" have risen by more than 1072, whereas the prices of various other products aluminum, rayon, polypropylene, steel, etc.). have risen by significantly lower percentage ranging from 29.5% to 72.2%.

521. Dean iIacAvoy's testified that Table 3 was intended to convey the impression that in general the prices of the various categories or end-uses of tevler have risen by more than 100%. (MacAvoy, CX-654 p. 73).

522. Dean 21acAVoy also testified that Table 3 is based on the average prices for all categories of tevlar in a given year and the results would be affected by the nix of products sold in any given year. (MacAvoy, CX-654 pp. 79-80).

523. Dean MacAvoy further testifed that a table prepared as he prepared Table 3 might show a 1002 price increase on an average basis even though not a single product included in the data base had had a price increase in that amount. For example, if such a table were prepared on the basis of just two products, neither one of which had risen in price by more than 40%, the mix of products and prices'could nonetheless produce a result suggesting that both products had risen by innz. (MacAvoy, CX-654 pp. 77, 80-33).

524. Dean MacAvoy's Table 3 does not establish that there is any category of "Kevlar" for which the price has risen by the percentage suggested in Table 3.

525. Uhen Dean MacAvoy reviewed the price changes for "Mevlar" over the most recent five-year period covered by his Table 3 he stated that he would not characterize" those price changes as exhibiting "a lack of pricing restraint". (CX-654 pp. n4-n5).

Value-in-Use Pricing

526. Du Pont prices Kevlar aramid fiber differently in separate end use markets (called "Market segment pricing") and employs "value-in-use" concepts in identifying the markets in which it will offer "Kevlar" and the prices it will seek to charge for the fiber. (Henry, CX-36 at 49).

527. Du Pont's Henry testified:

> We have found that 'value-in-use" analysis is quite helpful In addrssing a number of the problems involved in developing markets for "tevlar" and aramid fiber. "Value-in-use" is the phrase we use in seeking to ascertain how much our product is worth to the customer when measured against the best functional alternative. We use value-in-use analysis to guide us to end use markets in which "Nevlar' is most likely to be both a technical and economic success, to demonstrate to customers the advantages of "tevlar," and to aid in pricing "Revise.
>
> We ascertain the value of "Revlar" for a particular use by figuring out the cost of-the alternative material and adjusting upwards or downwards for added advatages or costs that would result from t'he use of "tevlar". For example, we would adjust the value upwards if "Revlar" were more durable than the incumbent and downwards if the use of "Kevlar" would increase our customer's manufacturing costs. By applying this type of analysis to the large number of potential uses for "Kevlar," we can eliminate uses which might be technically successful but which would not command an adequate price, and focus on those uses for which we might be able to sell "tevlar" at a profit.

(Henry, CX-36, pp. 39-40).

528. If a Du Pont customer applies "Kevlae to a use other than the one identified at the time the fiber was purchased from Du Pont or resells the 'Kevlar" for such a different use, Du Pont expects that the price it received for the."Keviar" will be adjusted with Du Pont either receiving or paying• as appropriate, the difference between the original price and the higher or lower price that would have been charged if the actual use and been identified at the outset of the transaction, (Henry, CX-rl pp. 26-27).

529. Du Pont's "value-in-use" system relies upon restricting customer use and controlling customer resale of "Kevlar" (Henry, Tr. 1359; Harris, Dep., RX-532 pp 20, 27-29; Cole Dep., RX-529 pp. 21-22; Morgan Dep., RX-520 p. 73)

530. In order to maintain its value-in-use pricing system Du Pont rquires that its customers apply "Kevlar" to the specific end use for which it has been priced. If customers use the "Kevlar" for a different end use, they must pay Du Pont the higher price. Vice President Charles L. Henry testified that Du Pont's "position with the customer" is "that the product must stay in the use that it was intended for, and that if it were substituted, that he would have to pay the higher price for that end use." (Henry, Dep., RX-511 p. 174; Henry Tr. pp. 1357-1359; Henry Rebuttal, CX-391 p. 26-27; Cole Dep., RX-529 pp. 21-22; Cates, Kevlar Aramid Fiber Sales Agreement, RX-1509 at P00589-P000590.

531. Du Pont's Heckert testified that if Du Pont did not attempt to keep reasonable track of its customers "use of Revise, it would risk disadvantaging Du Pont's customers in their ability to compete. (Hechkert Tr. pp. 270 271).

532. According to Ni Pont the perceived value-in-use for "Kevlar 49" for fabric for power boats was less in the United States than in Europe and accordingly Du Pont reduced the U.S. Price in order to promote volume in the United States. (Cordin, RX-502 p. 76; James, RX-512 p. 42). Du Pont required that, if U.S. weavers sold fabric for power boats to Europe, Du Pont was to be reimbursed for the difference between the U.S. and European "Kevlar" price. (Corbin, RX-502 at 69; Rawlins, RX-523 at 72; James, RX-512 p. 47). "Kevlar" sold for use in fabric for power boats accounts for a small percentage of total Kevlar sales. (RX-1530 p. 9900002, "marine").

533. Goodyear Rubber Co. has purchased "Kevlar" for both tire and mechanical rubber good end uses (Wilson, Dep., RX-541 p. 163; hill Dep. (I), RX-535 p. 53). Goodyear currently conducts its "Kevlar" tire business through its Kelly Springfield unit (Wilson, Dep., RX-541 pp. 59, 65-66).

534. Gates Rubber Co. has purchased "Kevlar" only for mechanical rubber good end'Uses (Wilson, Dep., RX-541 at 163; 2Ielke Dep., RX-546 p. 3; Cole Dep., RX-529 p. 63).

535. Du Pont has sold and continues to sell "Kevlar" for use in mechanical rubber good end uses at a significantly higher price than "Revise for use in tire end uses. The list price of "Kevlar" for mechanical rubber goods has ranged froM $8.10 to $9.20 per pound while the price for tires has ranged from $4.25 to $6.50 per pound over the past five years, (Alternate Strategy Focus Forecast, RX-4007 pp. 4101094-4101095; Du Pont, Nov. 23, 1982, Memorandum, RX-950).

536. Customers in the rubber industry have frequently asked Du Pont whether Type 950 "Kevlar" priced for tire applications could be substituted for the higher price Type !'56 "revise used in mechanical rubber good applications; Larry Cole, Marketing Manager for the rubber industry market from 1973 through 1982, testified that "[Lit very well might work" but asserts "it wasn't designed for the use." (Cole, Dep., RX-529 p. 63).

537. Du Pont has sold and continues to sell "Kevlar" for use In mechanical rubber good end uses at a significantly higher price than "Kevlar" for use in tire end uses. The list price of "Kevlar" for mechanical rubber goods has ranged from $8.10 to $9.20 per pound while the price for tires has ranged from $4.25 to $6.50 per pound over the past five years. (Alternate Strategy Focus Forecast, PX-4007 pp. 4101094-4101095; Du Pont, Nov. 25, 1982, Memorandum, RX-950).

533. Customers in the rubber industry have frequently asked ru Pont whether Type 950 "Kevlar" priced for tire applications could be substituted for the higher priced Type 956 "Eevlar" used in mechanical rubber good appliations; Larry Cole, Marketing Manager for the rubber industry market from 1978 through 1982, testified that lilt very well might work" but asserts." it wasn't designed for the use." (Cole Dep., RX 529, pp. 73-79).

539. Du Pont's expert economic witness, Prof. Hausman, testified:

> A Well, economists typically have three types of price discrimination, and this goes back to the famous English economist Pigou at Cambridge, England. And he identified three types of price discrimination, and value-in-use pricing most closely accords with what he called third degree price discrimination.
>
> row, when I was graduate student -- and I imagine graduate students now always study the famous book of Mrs. Joan Robinson which was published in the 1930s, and she analyzes third degree price discrimination, and I think that is where I really became most familiar with the term.
>
> And I might say that although third degree price discrimination has both cost and benefits to the consumer, Mrs. Robinson in her book came to the conclusion that it probably was beneficial overall to society to permit third degree price discrimination or here, value-in-use pricing. (Hausman Tr. p. 1034).

540. Akzo's Twaron price list, w-Europe for 1985/1986 is said to be

End-use	7ype	Hfl/kg	1984 comparison Nevlar, incl. 2 duty
Tires	r 1000/ D 1001		45,30
Mechanical Rubber Goods	D 1▶n/D 1001		66,50
Ropes/Optical Fibre Cables	D 1000/0 1020		75,75
	D 1055		102,45
Friction materials etc.	D 1000		97,90
	D 1031		02,50
	D 1070		62,95

	D 1080	52,30
	D 1090	39,45(+)
Advanced composites	D 1050	
	D 1055/ D 1056	102,45
Industrial fabrics	D 1000	97,90
	D 1040	

(RX 1306, p E 700970).

541. "Kevlar" is not a single product. Du Pont's price lists. contained in CX 43 illustrate the many combinations of denier, finish and modulus that are sold. Du Pont has developed a broad variety of "Kevlar" products with a variation in prices to meet the needs of different end uses of the fiber. (Henry, CX-36 at 9). For example, the price is for a 1500 denier regular modulus fiber while the price is for a 195 denier high modulus "Kevlar 49" fiber. (CX-43). In addition, both the fine denier and the high modulus add to the cost of manufacturing 195 Denier "Kevlar 49". The time required to produce a pound of 195 denier yarn is 71/2 times longer than the time required to produce a pound of 1500 denier yarn. (Henry, CX-36 PP• 52-53).

542. Du Pont's price lists for individual "Kevlar" products in CX-43 show that as of December. 31, 1983, "Kevlar" yarn was offered in 30 combinations of modulus, finish and denier, that both wet and dry pulp are sold, that there is high and low modulus staple, and that the staple is available with eight different cut lengths of fiber.

543. There are occasions when the sane denier and type of "Kevlar" may be sold at different prices for different uses, for the most part the different end uses require different products -- products that are distinguished by such factors as denier, modulus and finish. (CITER 8.20(b)).

544. By selling "Kevlar" aramid fiber at different prices for different end-uses. Pu Pont is able to maximize the uses to which "Kevlar"

can be put and accordingly enlarge the volume of "Kevlar" that is sold. Du Pont cannot sell "Kevlar" only at $5 per pound if it looks to recover its capital investment. If, however, Du Pont were to sell "Kevlar" only at a substantially higher price, it could never obtain the high volume business it has in the tire market, so that it could not achieve the economics of *scale* and other cost reductions that come from producing greater quantities of "Kevlar". (Henry, CX-36 p. 49; Hausman, CX-180 pp. 16-22).

545. Du Pont has priced "Kevlar" at less than the amount that would produce the greatest short-term profits. Thus, the price of "tevlar" cable used in offshore drilling applications is $8.00 per pound, *even* though the value of Kevlar in this end use is $16.00 per pound. (Henry, CX-36 *p.* 44).

546.

547. A customer deposed by Akzo testified:

(Zelka Dep. RX 546, p. 134).

548. Gates Rubber Co. must "certify, in writing, at *the* end of each Contract Year its disposition of 'Kevlar'", pursuant to its "Fevlar" Aranid

Fiber Sales Agreennt with Du Pont (RX 1509 at P000590). Included in this contract provision is the explanation:

> "Kevlar' is priced for specific applications. For example, Type-956 'Kevlar' and all other types of 'Kevlar' sold hereunder are priced for use in mechancial rubber goods reinforcements unless DUPOUT otherwise notifies GATES. Any 'Kevlar' used for nonspecified use or sold by GATES to a third party will be priced to GATES at the list price for the application to which GATES or the third party will be priced to GATEES at the list price for the application to which GATES or the third party puts the 'Kevlar.' If necessary, retroactive price adjustments shall be made on this basis, and a credit or debit invoice issued to GATES accordingly.

(RX 1509 pp P000539-P000590).

549. A Du Pont memo dated Dec. 21, 1981 to Du Pont's Corbin from the field stated in part:

> is the largest domestic hose distributor, and has a very aggessive, growth oriented business philosophy which does not include "Kevlar" aramid in a major way. Presently, "Eevlar" reinforced 10088 hoses which consumed nearly all of the 1'981 est. pounds, are in imminent danger of being converted to polyester because of cost. Furthermore, management are seeking to develop steel reinforced hoses in preference to "Eevlar" because of cost.
>
> We want to encourgage a more aggressive "Kevlar" development program by partially funding the development costs of new hoses during 1932.
>
> We propose a development allowance of <u>$1.15/lb.</u> beginning with Jan., '82 shipments and to be re-evaluated in Dec., '82 for extension, if warranted.
>
> Please give us your approval of this proposal so we can meet with the customer in early January and obtain agreement to retain Kevlar in 100RS hoses until higher VII' products such as 100R9, loonio, and rubber hydraulic hose replacements can be developed.

. . (RX7947).

550. did in fact engage in new hose development (RX-955, p. 4600059).

551. Du Pont's Cole testified that an Armstrong passenger tire which uses Kevlar employs the so-called "Tredlock" design -- a deSign which is entirely different from the "cut belt" design of the other manufacturers, and which results in a tire that does not compete directly for the same customers as Goodyear, etc. (Cole, CX-494 pp. 93-96; Henry, RX-534 pp. 4041, 150-51; CX-503 p. 156).

552. A , instituted in 1932 to Armstrong wash to help Armstrong develop its own process for manufacturing "Kevlar" containing cord for "Tredlock" tires after it had initially manufactured that tire using "Kevlar"-containing cord obtained from outside manufacturers. (Henry,,CX-36, pp. 24-25; Henry, RX-534 p. 43; RX-946 p. 4600042; Cole, CX-494 pp. 93-96).

553. Clark-Schwebel Fiber Class Corp. is a "sizeable" du Pont custoner (tX 520, Moran Pep. pp. 375-77). Du Pont's llugh James Ralph Cilby met with Clark-Schwebel's marketing manager Dieter Vacther in February 1984. During that dinner meeting Cilby told patcher that:

(Wachter, Dep., RX-545 p. 61). Cilby told Wachter that Du Pont planned on pursuing in Belgium, where Clark-Schwebel has a weaving operation (Cilby Dep., RX-531 p. 107). In a follow-up letter, "Cilby wrote" that Clark-Schwebel could become embroiled in the suit.

> "To clarify the points I was naking on the the Du Pont position in protecting our patents, I can summarize as

> follows. We are committed to defending our rights on Kevlar aramid fibers. How your company or any purchaser of a competitive aramid might or might not be involved is something that will depend on circumstances. This is a decision you will have to make for yourself. It your Legal people would like to talk to our lawyers about this, I would suggest they call Don A. Hoes, 302/774-6974 or James A. Forstner (Jim) at 302/774-8610. Thanks a lot" (RX 1530).

Similar advice was given to Gates (RX 15n1; Takvorlan Dep., RX 532 pp. 151-153).

554. Du Pont has told Natick Tabs that a "question exists" as to whether Arenka's fiber infringes Du Pont's patent and the Du Pont would take appropriate action to defend its patents. (RX 813 p 2103095).

555. A Oct. 1903 Du Pont memo to its sales personnel stated:

DC'S Arr parrs - AX20 LITIGATION

DO'S

- Continue to carry on your business activity in a normal manner.
- Seek informatin from customers on Akzo market activity and docuemnt in trip repdrts.
    - What customers have been visted?
    - Who made the Akzo call?
    - Get copies of brochures or other product description.
    - Determine Akzo product availability, when, how such?
    - What priced? Special incentives?
    - What end uses are targeted by Akzo?
    - Has customer processed Akzo product?
    - How do Akzo products perform?
    - Report trade shows, technical seminars, other activity.

Respond when asked about litigation. Deal possitively with the issue.

- there are a number of legal preceedings around Du Pont's aranid patents.

- Du Pont has sued Akzo in Francs, Germany, Ut for marketing an aramid fiber which. Du Pont feels infringes it patents.

- Akzo has sued Du Pont in the U.S. seeking to overturn Du Pont's patents and alleging antitrust and unfair compeition violations.

- Du Pont is confident of its position; expects to prevail.

o When asked about action Du Pont will take against a U.S., *firm* buying Akzo aramid, the following response can be given.

- Purchase of Akzo fiber is a decision the customer must , make for himself.

- Du Pont believes the current Akzo product infringes its patents and has often stated, it will *defend* those patents.

DOVT'S

o Don't offer a personal opinion on what the Du Pont Company might or night not do regarding use of Akzo fiber.

o Don't make any statement that could be construed as a threat against Akzo or the customer.

o Don't speculate or discuss the implications for a customer if he chooses to buy competitive fiber.

o Don't discuss what actions Du Pont will or will not take to defend its patent rights.

(nx-1170).

555. Pu Pont does not dispute that the "Kevlar" sold for tire and MG uses may be interchangeable; the Kevlar is priced differently because its value in use is different.

(CX-534, pp. 139-140; C)-533).

Du Pont's Polymerization Solvent

557. A May 2, 1980 Du Pont "Kevlar" Aramid Fiber Presentation to Du Pont's Executive Committee stated in part:

> Follwing start-up in '72, part 1 of this expansion project at Spruance was authorized in '74 and halted in '75 due to the finding that the polymerization solvent hexamethylphosphoramide or MITA was an exprimental carcinogen. Part 2 transferred the prototype spinning machine to the market development facility which was expanded to 14MM lbs./yr. using HMPA. This enabled us to expand the market and buy time to develop the alternate solvent 11-methylpyrrolidone [N^11^{5}1. We accomplished these two and proceeded last year with expansion when part 3 was authorized for CCE, long Delivery equipment, and preliminary construction. This increased total authorized to $60MH for this poject plus $25:11'1 part 1 for the associated Petrochemicals Project.

(RX 636 p 0001599)

558. In 1974 Du Pont had a capacity of roughly six million pounds for "Keylar". In 1974 there yap a proposal to move in stages, from six million pounds to million pounds "Kevlar" production capacity. (Heckert, Tr. pp. 86-87).

559. Du Pont's Heckert agreed that Du Pont spent many millions of dollars to avoid contact with HNPA by its employees and spent slot of money In studying the problem and in switching from HIIPA to VHP. (Heckert, Tr. p. 113).

560. Du Pont's decision to halt the use of IIMPA because it was believed to be carcenogenic was made on or about October 3, 1975 (C1-546, Response to Interrogatory No. 93(d)(e)).

561. Du Pont's Mitchell at about September 1^75 participated in a . session at Du Pont with respect to how to dessiminate the finding regarding ETA. Fitzerald made a number of outside contacts. He believed he called

Akzo. Letters were sent to other people that Du Pont felt were not immediately involved but might possibly be involved. (llithchell, Dep., Tr. pp. 48-49).

562. An Akzo report stated that in early 1975 the news reached Akzo from the U.S. that long-term inhbition experiments in rats had shown that "HMPT" could cause tumors and that at the end of September 1975 the details of Du Pont's experiments became available to Akzo. (CX-611, PE 444970).

563. In early October 1975, work began at "Kevlar" Research at Du Pont to select an alternative solvent to HHPA for the polymerization of PPD-T. Du Pont's Fitzgerald, who is a research manager with the Textile Fibers Department of Du Pont testified that in early January 1976, Dr. Katz reported that he had obtained PPD-T with a high inherent viscosity (that is, high molecular weight) using NMP and lithium chloride. Weekly Summary of January 9, 1976, p. 1. (CX-420); that later in January, he reported success with DMAc and lithium chloride. Weekly Summary of January 23, 1976, p. 3 (CX-421); that at the'beginning of February 1976, he learned that Drs. Miler and ratz had also produced high viscosity PPD-T in the Du Pont laboratory by combining NMP with calcium chloride rather than lithium chloride, as the salt;

Fitzgerald Ct-414 pp. 1, 2, 4, 5).

56t. Thomas E. MIthcell who was a technial director of Du Pont's Textile Fibers department agreed that Du Pont's Textile Fibers department continued to have interest in an altenative solVent for UMPA in the manufacture of "Kevlar" aramid fiber as of nay 1976. (Mitchell, Dep., CX-519, p. 135).

565. On June 1, 1976 Du Pont filed a patent application coverning its NEP/calculm chloride solvent system with the United States Patent and Trademark Office. (RX-1184; CX-1122 B p. 11, Du Pont abandoned the application in June 1977 (RX-1185; RX-4031).

566. Du Pont's Fitzgerald testified that after selecting as the alternative solvent system Du Pont would use in is scale-up work. Du Pont had several problems to resolve before it was in a position to commit production facilities to that solvent system. The two most important tasks in the scale-up process were: first, to establish that Du Pont could use the solvent system to produce high viscosity ppD-57 polymer in a continuous polymerization process, rather than in separate discrete batches such as were *made* in the laboratory; second, to produce a PPD-T polymer with this solvent system from which Du Pont could spin a yarn that would be identical it the yarn we had been makeing (and selling) from PPD-T polymerized with UMPA. (Fitzergald, CX-414, pp. 74.1).

567. Du Pont was still using UMPA in 1978. Thus Du Pot's Heckert testified that by 1978, Du Pont's capcacity to manufacture "Kevlar" reached the approval level of 15 million pounds per year, using UMPA as the polymerization solvent. (Ueckert, CX-1, p. 19).

568.

On the basis of opinions from counsel, the Textile Fibers Department recommended that DU Pont ignore the Enka patent as invalid. On behalf of the Executive Committee along with Du Pont's Barnes, Du Pont's Heckert approved this recommendation in !larch 1982. (Heckert, CX-1, p. 22; CX-20).

569. A Du Pont memo by C. P. Honeywell dated January 14, 1983, stated in part:

> The first sample of "Arenka" was obtained in early 1975. In the following three years, eight samples of the product, both as-spun and heat-treated, were determined to be essentially equivalent to "Kevlar". All of these samples contained traces of phosphorus, suggesting Akzo was using hexamethylphosphoramide (Min) as a polymerization solvent despite their claims in 1975 to use of an alternate solvent presumably' N-methylpyrrolidone (211T)/calcium chloride (CaC12). (Akzo discussed their technolgy for VA21/CAC12 solvent system in 1976).

A covering Du Pont memo by Honeywell dated January 17, 1983 stated "O'Dell would like to establish if and'When AEZO shifted from HNPA to IBIP/CaC1$_2$ polymeriztion solvent. (RX-1334).

570. In deposition Uoneywell testified that the information in his Jan. 14, 1983 memo had been gathered over a period of a number of years and integrated together to try to put together the picture of what "we bad thought" was the history of the Arenka Venture. (Honeywell, RX-509, p. 98).

571. In November, 1975, Dr. Jos Stara, an employee of Du Pont International, S.A. ("PISA") in charge of toxicology matters, was told by his counterpart at Akzo, 'Ir. 7:ees van der Lee, that (1) Akzo "had discontinued. use of IIMPA,".(2) Akzo had an alternative for =PA "on the shelf", and (3) "D4 Pont also knows this because there had been a techology exchange on this in

the past." Dr. Stan immediately telexed this information to Du Pont in Wilmington. (Du Pont Nov. 14, 1975, Sum telex to Long, RX 1046; &tam Dep., RX-526 pp. 26-29, 34, 65-67; Mitchell Dep., RX-519 p. 70; Du Pont, Mitchell handwritten notes, RX-1199).

572. Akzo's Mr. van der Lee had called Du Font's Dr. Stan earlier, on October 10,1975, requesting information on the toxicity of IIMPA (Stan Dep., RX-526 pp. 21, 24-26, 52-64; Du Pont Oct. 10, 1975, Stem handwritten notes of conversation with van der Lee, RX-1053; Du Pont Oct. 10, 1975, Stan telex to Long, RX-1049). During this October 10, 1975 conversation, hr. van der Lee told Dr. Stem that "[Akzol fiber people had been in contact with Du Pont fiber people on the exchange of KEVLAR technology" in what Dr. Stan believes was "this area of spinning of an Aramid fiber in which HBPT [HMPT is synonymous with HUPA] was a solvent" (Stan Dep., RX-526 pp. 24-26, 52-64; RX-1053; RX-1049). Dr. Stem assumed that Mr. van der Lee attributed Du Pont's knowledge of the technology exchange to Dr. Frans van Berkel, a senior Enka official who dealth with Uitchell on a regular basis (Stan Dep., RX-526 pp. 24-26, 63-64; RX-1053). In accordance with his usual practice, Dr. Stem telexed this information to Du Pont in Wilmington that same day (Oct. 10, 1975) along with Mr. van der Lee's request for information (Stan Dep., RX-526 pp. 52-65; EX-1049).

573. On December 16, 1975, Du Pont's Dr. Mitchell's assistant, Dr. C.O. King, requested that Dr. Stem "inquire of Mr. van der Lee of Akzo regarding their alternative for IRMA and any past technology exchange involving such information" (Du Pont Dec. 16, 1975, King letter to Belck,-RX-1043; Du Pont Jan. 7, 1976, Belck note to Stan, RX-1055, Siam Dep.., RX-526 pp. 32, 70-72; Mitchell Dep., EX-519 p. 72). Du Pont "sought a source who is

supposed to know what or what is supposed to know what or what is supposed to have happened here. There were contacts between other departments and Akzo or Enka. For example, in the area of polymer intermediates, [Du Pont) wanted to find out what kind of contact had been made." (Mitchell Dep., RX-519 p. 62; Heckert Tr. p. 124). Dr. Stam made the requested telephone call to Mr. van der Lee on January 9, 1976. (RX-11481 Stam, Dep., RX-526 pp. 29, 73-76; RX-1199).

574. In the Jan. 9, 1976 call Mr. van der Lee "repeated that he was sure that there had been a technology exchange with Du Pont on this matter" (RX-1148; Stan Dep., RX-526 pp. 29, 73-76). However he also said that he could not give any more details because "actually it was not his area" (Stan, Dep., RX-526, p. 36). Me advised Dr. Stam that Du Pont "should contact other people in Akzo on this" (RX-1148; RX-1199). Dr. Stan telexed this information to Dr. King (RX-1148; Stem Dep., RX-526 pp. 37, 39-40, 73-76). Dr. Stem believed hr. van der Lee when he said that Akzo had made available some information on this alternative' polymerization solvent to Du Pont for he has "the highest esteem for Mr. van der Lee" (Stem Dep., RX-526 pp. 34-35).

575. Du Pont's Ming in a February 20, 1978 report stated that "[wle ave not been able to identify any transfer of information from a member of the Akzo group to Du Pont in which information on an Akzo solvent nay have been involved". (RX-1149).

575. On Eay 13, 1976, King reported to the members of the Patent Board that he had been "unable to identify knowledge within Du Pont of Akzo's substitute for HMPA," and that 13u Pont had therefore approched Akzo directly. (RX-1152).

577. In March of 1976, after discussing the matter with "Eevlar" development people, Dr. Mitchell approached Akzo for further information on Akzo's alternate solent system (Mitchell Dep., RX-519 at 110-113, 117-118). He was told that Akzo's alternate system "offered better economics" and Mitchell was "intereted in better economics" (Mitchell Dep., RX-519 at 143; Du Pont, Mitchell handwritten notes, lx-1199 at TC37449).

578. Dr. Mitchell met Dr. Frans van Berkel of Enka in Detroit on March 24, 1976. With respect to that meeting Akzo's van Berkel in a memo dated April 28, 1976 stated in part:

> During the meeting you and I had in Detroit on March 24, 1976 you explained the difficulties you apparently have with the toxicity of the UMPT in your aromatic polyamide polymerization solvent system. You raised the question whether Enka Clanzstoff would be willing to license Du Pont under their (future) patent and know-how. You may recall that I suggested that an eventual license from our side could and should, be the first step of an association of some kind.
>
> After having discussed subject matter with my colleagues I now inform you that we are willing to license you under our know-how, provided that you-would be willing to grant us a license of similar value in the aromatic polyamide field.
>
> Please let me know whether you would agree in priniciple to this approach so that we nay start working things out.

(DX-1151).

579. A van Berkel memo dated April 15, 1976 to the Enka Board of Directors stated that Du Pont's Mitchell had learned from earlier discussions that Akzo has a solvent which does not contain HMPT and for this reason Mitchell asked if Enka would be prepared to sell the know-how of this system to Du Pont. Berkel referred to patent applications filed by Enka on a polymeritation process. The first disclosure of the applications was said to occur in Germany and the Netherlands on August 21, 1976. Hence Berkel concluded by the end of August, Du Pont would know exactly what is involved.

To the board he suggested three alternatives, one of which was to send Du Pont a copy of the U.S. patent application which van Berkel favored. (0X-605).

530. As shown by an Akzo memo dated April 23, 1976 the Enka Board of Directors empowered Berkel to give Du Pont a written answer to the effect that Enka Glanzstoff is prepared for discussions only under the condition that they will cover the entire complex. Thus, not only regarding the question of the solvents, but regarding the patent question of aramids as a whole. (CX-532).

581. According to Dr. Mitchell his dealings with Dr. van Berkel on Akzo's NHP/$CaC1_2$ solvent system proceeded as follows:

> "1 do remember at some point and time having suggested a non-research -- I mean a non-disclosure, non-use agreement under which they would make such a disclosure to us. Shortly after that, this copy of the patent application showed up with a note on it saying that this is the area so that we know what we are talking abour or something like that." (Mitchell Dep., RX-519 at 115).

The note from Dr. van Berkel says:- "Thought you would like to see this so that we know what we talk about - F" (RX-1200; Mitchell Dep., nx-519 p. 196). "Evidently the application was sent in an envelop without a cover letter and addressed to Mitchell marked 'Priveate and Confidential'" (floes Direct, I'7-427; Hoes Tr. p. 343G).

582. Dr. Mitchell testified that he cannot recall the date on which he.recelved the patent application from Dr. van Berkel, "Eolnly that it would be after 4/28/76" (Mitchell Pep., RX-519 p. 194).

583. On June 1976, Mitchell met with van Berkel and others in Arnhem and discussed the possible discloiure and licensing to Du Pont of Akzo's solvent. (CX-607; CX-626)., At that meeting, Mitchell told van Berkel

that Du Pont "would be interested in receiving a disclosure of their solvent know-how under an appropriate non-disclosure and non-use agreement ....," (CX-626) so that Du Pont "could evalutate that technology to see if it was something that [Du Pont] wanted to deal with." (Mitchell, 0X-483 pp. 129, 140).

584. At the June 9, 1976 meeting, Mitchell emphasized that a prompt disclosure was necessary if Du Pont was to consider using Akzo's solvent, because Du Pont was "well along in [its] program to develop an alternative solvent and . . . as time goes by it would become increasingly difficult . . . to consider another possibility . . . ." (CX-626; Mitchell, CX-483 pp. 130, 145).

585. As of the time of this meeting, Mitchell testified:

> Q As of June 9, did you have any understanding as to whether or not their process included NMP?
>
> A No.
>
> Q Or calcium chloride?
>
> A No.
>
> Q Or a combination of the two?
>
> A ro. I very much suspected at that point in time that it does not include any of those, because I have told van Berkel when I asked if they had an alternate system that we were developing in that system DIIAC and IMP with metal halides and I said if you have something different than this, if you would like to talk about it, we would like to talk about it. I am not interested in talking about those systems, because we are already up to our ears in those systems. I do not need to know anything in that area. I already know something in that area, but if they have got something different, I would like to know about it.

(CX-483, pp. 142-143).

586. Dr. Van Berkel retired from Enka in or about February"1977 (Mitchell Dep., RX-519 p. 234; EX-1154). Dr. Mitchell reopened negotiations

with Akzo on January 24, 1977, through a telex to Dr. Stohr, Dr. van Berkel's replacement at Akzo, which stated:

> "As you may know, we have been developing alternates to hexamethylphosphoramide for use in Kevlar aramid production. Your company had one some work with a potential alternate, • V-methylpyrolidone/CaC12 mixtures, and had indicated willingness to license this technology to use. After some preliminary laboratory work, I told Dr. van Berkel verbally that the advantages we saw were sufficient to warrant our continued interest. This situation has changed and we would now like to consider a license unde any patents you have, or have applied for, on this solvent system. We are not interested in know-how but we would ask that you consider including the results of any testing you have done to establish the biological activity of this system. Would you please let me know the terms you would ask for such a license as soon as you conveniently can?"

(RX-1153).

XIV. THE DOMESTIC INDUSTRY

5C7. Du Pont manufactures "Nevlar" at its Spruance facility near Richmond, Virgina. The principal ingredients used in making "Kevlar", PPD and TCL, are manufactured at Du Pont plants in Louisiana and New Jersey. There are no other manufacturing facilities in the United States utilized in the production of aramid fiber. (Heckert, CX-1, pp. 19-23).

503. When "Kevlar" was first offered, potential customers were not familiar with the product and ready markets did not exist. Du Pont has had to create markets for "Kevlar", and continues to do so. Du Pont personnel have identified potential end uses for which "kevlar" offers value, developed the technical expertise required to utilize "Revlar" for those end uses, and ' educated manufacturers and consumers involved in the end use markets to persuade them to use "Kevlar". (Henry, CX-36 p. 11).

589. For each end use application, Du Pont has had to market "Xevlar" to a number of potential customers. For most uses, several levels of the manufacturing chain stand between 'levier" as a raw material and the final product suitable for Du Pont to market the product to its direct customers, who may be weavers, spinners, or manufacturers of tires, ropes, or friction products. It alio has to establish the merits of "Kevlar" to the satisfaction of its indirect customers, who must *decide* whether to utilize products of the direct customers. With each link in the manufacturing chain, Du Pont must support product and market development, provide technical assistance, and help develop techniques for using Kevlar. (Eenry, CX-36, pp. 11-17; CX-44).

590. Du Pont's marketing efforts over the last dozen years have developed some twenty major end uses falling into three general categories: (1) tires, (2) mechanical rubber goods (including hoses and belts), and (3) special products, which covers non-rubber goods such as armor (hard and soft), ropes and cables, asbestos replacement, aerospace and aircraft, and marine. Within these end-uses, there are today nearly 500 different applications of nevlar. (Henry, CX-36 pp. 32-39; CX-392).

591. In the period 1972-1984, Du Pont's worldwide sales of "Revise amounted to about million (CX-57). About million pounds of "Kevlar" were sold worldwide during this period, of which about million pounds were sold in the United States (CX-56):

(in millions of pounds)

	World wide	U.S.
1972		
1973		
1974		
1975		
1976		

1977
1978
1979
1980
1981
1982
1983
1984

592. 'Except for the recession of 1981-32, sales of "Kevlar" have grown steadily worldwide and in the United States since 1972. (CX-56). Between 19C2 and 1984 sales of "Kevlar" for mechanical rubber goods nearly doubled in the United States and sales for special products more than trebled. This included a tripling of sales of "Kevlar" for ballistic apparel, a doubling of sales for ropes and cables, and over a four fold increase in sales of Kevlar for friction products. (0X-58, 59, 60, 61).

XV. EFFICIENT AND ECCNOVIC CM:RATION

Investment in Research and Development:.

593. Du Pont has nade the following expenditures on research and development, and in particular for product and process development, for "Kevlar" (CM-25,; CX-1C3):

Year	R&D	P& PD
pre-1972		
1972		
1973		
1974		
1975		
1976		
1977		
1978		
1979		

1980
1981
1932
1983
1984

---

* includes million in R&D for PPD.
Measured in 1983 dollars, Du Pont's R D expenditures have amounted to million. (Hanemann, 0X-130, p. 24).

Investment in Advertising, Promotion and Development of Consumer Goodwill:

594. Du Pont has spent the following amounts (in millions of dollars) on marketing, advertising and publicity, and end-use research to develop the market for aramid fiber (CX-55):

Year	Marketing	Advertising & Publicity	End-Use Research	Total
1975				
1976				
1977				
1973				
1979				
1930				
1981				
1932				
1933				
1984				

---

* Excludes Du Pont institutional advertising featuring Mevlar in the amount of million.
** Excludes Du Pont institutional advertising featuring levlar in the amount of

595. Du Pont engages in a variety of market development and advertising activities that are designed to create markets by educating customers about Revlar, assisting in the creation of products that use "Kevlar", and promoting products that contain Revlar. (flenry, CX-36, PP. 11-30, 33; Heckert, CX-1, pp. 252().

596. Du Pont has had to create markets for "Kevlar". Du Pont's market development activities include identification of potential emd uses for "Kevlar", development of the technology necessary to use "Kevlar" for these applications, and education of manufacturers and consumers in the end-use markets as to the uses of "Kevlar". (Henry, CX-36, pp. 11-17, 83-84).

597. Market development tasks included demonstrations of Kevlar-containing products at trade shows and support for projects that engage the interest of the technical community and eduate them about "Kevlar". Du Pont's Kevlar marketing personnel participated in 31 trade shows in 1983 and 24 shows in 1934. (Henry, CX-36, pp. 13, 83, CX-775; CX-76).

593. Apart from its research and development group, which works on improvements in "Kevlar" fiber and "Kevlar" processing, Du Pont maintains an end use research group of over 20 engineers and scientists and support staff, which works on new applications for Kevlar.

(Henry, CX-35, p. 84)..

599. Du Pont has a *sales* force of 30 product representatives stationed *in* Wilmington, Delaware, Akron, Ohio; and Los Angeles, California. (Henry, CX-36, pp. 33-04).

60n. Du Pont also has 17 technical representatives who identify the appropriate type, denier, and form of "Kevlar" for a particular application and the intermediate "Kevlar" product (fabric, spun yarn, prepreg) for that application and suggest modificatino in processing techniques and equipment. (Henry, CX-36, pp. 15-116, 34).

601. As part of its technical assistance to users of "tevlar", Du Pont has developed a family of tools designed specifically to machine Kevlar. These tools are based on novel geometry and tungiten carbide faces and are now available from independent tool manufactureres. Du Pont worked with Cinicinnati Milicron to adopt a water jet system to cut "tevlar" and with Bendix, GTE Sylvania, and Laser Applications to develop a laser system to cut tevlar composites. (Henry, CX-36, pp. 16-17).

602. When "tevlar" was first offered, potential customers were not familiar with the product and ready markets did not exist. Du Pont has had to create markets for "tevlar", and continues to do so. Du Pont personnel have identified potential end uses for which "Kevlar" offers value, developed the technical expertise required to utilize "Kevlar" for those end uses, and educated manufacturers and consumers involved in the end use markets to persuade them to use "tevlar". (Henry, CX-36 p. 11). Other potential end *uses* have been developed by customers. (Henry, CX-36 pp. 16-26; O'Brien Dep., DX-538 pp. 34, 125, 146-47 or by Ara° Eupje 11X-10, pp. 20-26).

603. Du Pont's marketing efforts over the last dozen years have developed some twenty major end-uses falling into three general categories: (1) tires, (2), mechanical rubber goods (including hoses and belts), and (3) special products, which covers non-rubber goods such as armor (hard and soft), ropes and cables, asbestos replacement, aerospace and aircraft, and marine. Within these end-uses, there are today nearly 500 different applications of Kevlar. (Henry, Cg--36 pp. 32-39; OX 392).

Uodern Production Equipment and Facilities

604. Du Pont began production of "Keviar" in November 1971 at HDF-1 (market Development Facility) in Spruance, Virginia. NDF-1 cost $4.1 million to build and had a nameplate capacity of 300,000 pounds per year. .(Heckert, CX-1, p. 12, CX-8, CX-9).

605. An *expanded* facility, MDF-2, went on line in 1974 at a cost of $17.4 million. HDF-2 had a nameplate capacity of 6 million pounds. (Heckert, CX-1, p. 12; CX-10; CX-11).

606. Du Pont expanded'the capacity of IIDF-2 to 9 million pounds per year in 1976, and in 1978 to 15 million pounds per year. (Heckert, CX-1, P. lr; CX-14).

607. Constuction of the commercial facility pounds annually *was* approved in Nay 1979. This facility began production in later 1982; its present effective capacity is approximately million pounds a year. (Heckert, CX-1, pp. 19-22; CX-15; CX-647; CX-647A).

603. Expansion of the Kevlar production facility to commercial scale required expansion of the ingredients facilities. A plant to produce PPD was built at Pontchartrain in La Place, Louisiana in 1982 at a cost of million. (Heckert, CX-1, pp. 20-21; CX-16; CX-17). A new facility to produce TC1 was completed in 1981 at the Chambers Works in Deepwater, *New Jersey at a* cost of million. (Heckert, CX-1, pp. 20-21; CX-18).

609. Both *the* Pontchartrain and Chambers works facilities have capacity to produce ingredients' required for million pounds of "Kevlar" per year. (Henry, CX-36, p. 73).

610. "Kevlar" is manufactured at a state-of-the-art manufacturing facility in Spruance, Virginia that uses advanced materials and processes for handling the highly corrosive ingredients necessary to manufacture "Kevlar". (Heckert, CX-1, p. 23).

611. The manufacture of "Kevlar" requires a significant. capital investment. Many of the chemicals that are used in the process, such as sulphuric acid, are extremely corrosive. The facilities accordingly require expensive materials, such as high quality stainless steel and tantalum. (Heckert, CX-1, p. 11).

612. Sophisticated computers control many aspects of the production process at Spruance,.and the entire process is highly automated. (Heckert, CX-1, p. 23; CPX-1).

613. Both ingredients plants -- in Louisiana and New Jersey -- incorporate the latest technological advances and the efficient processes for manufacturing PPD and TC1. (Heckert, CX-1, at 23-24). These plants are highly automated with centralized computer monitoring to control the manufacturing process. (Henry, CX-36, p. 77).

614. Du Pont's investment in physical facilities to produce "Revlar" at Spruance, the required ingredients PPd and TC1 and Louisiana and new Jersey, and the working capital necessary to operate these facilities are shown in the following table in millions of dollars (CX-24):

	Permanent Facilities	Committed Constuction Funds	Uorking Capital	Total
Spruance Facilities				
=1 Facilities				
PPD Facilities				

Improvement Programs:

615. Du Pont has made a series of improvements in its "Kevlar" production process. When RDF-1 opened in 1972, its spinning machines had a theoretical capacity to spin 1500 denier "tevlar" fiber at pounds per hour per spinning position; machines installed in MDF-2 in 1973 had a capacity of about pounds per hour per position, the third generation of machines, installed at HDF-2 in 1976, had a capacity of approximately pounds per hour per position. (Henry, CX-36, p. 76).

616. The productivity of Du Pont's polymerization unit has also been improved. The production rate at EDF-2 in 1973 was pounds per hours, with 13 operators required per shift. In 1973, the production rate was pounds per hour, with the same number of operators. The polymerization unit in the Spruance commercial facility has an averagy.production rate of pounds per hour and requires only 7 operators per shift. (Henry, CX-36, P. 77).

617. Du Pont operates its Spruace, Pontchartrain, and Chambers Works plants using four shifts around the clock, seven days a week, 365 days per year, in order to get the most out of its capital investment. (Heckert, CX-1, p. 25).

618. In 1932, Du Pont instituted a cost reduction program. Programs to improve spinning continuite and to recover waste yarn for reprocessing into tevlar pulp have yielded over $10 million in savings since 1932. These two programs, together with programs to recover waste by rewashing polymer and by converting solution waste, are expected to yield about $33 millionin cost savings from 19C5 to 19C9. (Menry, CM-36. p. 73).

Employee Benefit Programs:

619. Du Pont employs in the Itevlar" business highly skilled workers, many of whom hold advanced educational degrees. (Heckert, CX-1, at 24).

620. Du Pont provides generaous salaries and benefits to such employees and creates opportunites for stock ownership. Unde a savings plan, Du Pont matches $0.50 of every dollar a worker saves up to sixpercent of his or her salary; at least one-half of the Company's contribution is invested in Du Pont stock with investment options available for the remainder. Employees nay withdraw stock and funds from their savings accounts annually and, after vesting (in five years), may withdraw the total. Du Pont also funds a stock trust fund for employees pursuant to the Tax Reform Act Stock Ownership Plan. (I:enry, CX-36, pp. 01-32; CX-73; CX-21).

621. Each plant involved in Xevlar manufacturing -- Spruance, Pontchaitrain, Chambers Works = has a workplace safety program. (Heckert, CX-1, p. 24).

622. Du Pont provides its employees with a variety of health, dental, disability, life Insurance, and pension benefits. (Eenry, CX-36, PP. 31-n2; CX-73).

623. Du Pont's safety record at the Spruance plant is twenty times better than national average for the chemical industry. As of the end of 1134, the Spruance plant had goone about 3 years -- more than 19 million man-hours -- without a lost workday due to injury. (Heckert, CX-I, p. 24).

624. The Spruance plant hs qualified for and *received* every award offered by the Rational Safety Council and the Virginia Safety Council. (Heckert, CX-1, p. 242).

Quality Control

625. Du Pont controls the quality of "Kevlar" according to strict standards. The ingredients, PFD and TC1, must meet strict specifications. The polymerization process has computer feedback control to regulate feed rates, power, teiperatue, and concentration. Temperature, pressures and speed are also monitored carefully for the solution of the polymer and the spinning of the polymer into fiber. Du Pont analyzes the final "Kevlar" fiber produced to ensure that it meets all specifications and follows a system that enables it to trace each bobbin of fiber back to its production cycle should any question arise during a customer's use of Kevlar. (Henry, CX-36, pp. 82-83).

Profitability

626. As of the close of 1984, Du Pont's "Kevlar" business has not operated at a profit. (Heckert[4], CX-1, p. 29; Henry, CX-36, pp. 71-72; hausman, CX-180, pp. 24-25; Heckert, Tr. 177).

627. Up through 1984, Du Pont has not earned any return on its million investment in Kevlar plant and equipment facilities or the additoinal million in research and development and marketing investment. (Hausman, CX-180, p. 24; CX-1C3).

628. Du Pont experienced its first positive cash flow from the "Kevlar" business in the fourth quarter of 1983. (Henry, CX-36, p. 71).

629. In 1934, "Levlar" sustained a loss, but generated its first full-year poiltive cash flow. (Heckert, C2-1, p. 29).

630. Du Pont's cumulative loss on its "Kevlar" business through 1984 is almost million. (Heckert, CX-1 p. 29).

631. Du Pont estimates that it willhave positive net operating earings for 1935 (Heckert, CX-1, p. 29).

632. Du Pont has found that it requires a number of years to achieve profits on successful high technology ventures. Ueoprene produced its first profit for Du Pont 15 years after it was invented. "Tedlar". polyfluorocarbon film did not earn a profit until 24 years after its discovery and 10 years after commercial production began. "Delrin" acetal resin first turned a profit 13 years after discovery and 5 years after sales began. "Kapton" polyimide film was not produced commerically unitl eight years after discovery. (Heckert, CX-1 pp. 29-30). Du Pont also invested over $120 million in the 1960s in "Homex" which did not generate a profit until nine years after market development began. (Henry, CX-391 pp. 33). *As* extended introducyory period is usually required to develop a profitable market for Innovative products that, licke "Eevlar", require potential customers and users to learn about an entirely new type of material. (Thomas, CX-133 pp. 11-19, 23-26).

WI. II:JTS?

Substantial Injury

633. Du Pont opened its first Market Development Facility ("rnF-1-) designed to proddce nevlar, in 1971 and in 1982 opened its first commercial nevlar facility. (CX-16, p. 71).

634. Du Pont's present actual production capacity is more than million pounds per year. (CX-1, p. 22).

635. The following table represents 1)u Pont's U.S. Revlar sales for Vrn—In14:

	MLLES	WAS
ivnn		
l.cri		
1132		
19C3		
1914		

(CX-16; CX-57).

636. Revlar Is entering a growth phase of development characterized by a sharp increase in sales, the emergence of a wide variety of specific end-use applications and the entrance of competition. (Thomas, CX-In, pp. 16-1n; CX-5/1-55, CX-5r'-6(1).

637. Because substantial tine and knowledge are needed by both the innovator and its customers before end *uses are* developed and purchases will he made, aramid fiber is a "high learning" innovation. (Thomas, C) -1.13, pp. 1, 3-16; Hausman, CX—nr, pp. '21, 77; see also, Heckert, CX-1, pp. 2572•; NacAvoy, CX-654 pp. 15' -).

631. Approximately of all sales of nevlar occur in the H.S. (Henry, CX-16, p. 63).

639. Du Pont's marketing efforts over the last dozen years have developed some twenty major end-uses falling into three general categories: (1) tires, (2) mechanical rubber goods (including hoses and belts); and (3> special products, which covers non-rubber goods such as armor (hard and soft, ropes and cables, asbestos replacement, aerospace and aircraft, and narine. Within these end-uses, there are today nearly 50n different applications of nevlar. (Henry, CX-36, pp. 17, 32-r; CX-5P; CX-59; CM-62; CX-392).

640. Du 7ont engages in a variety of market development and advertising activities that are designed to create markets by educating customers about nevlar, assisting in the creation of products that use nevlar, and promoting products that contain revlar. (Henry, CX-36 pp. 11-30, 33; Heckert, CX-1 pp. 25-29).

641. ru Pont's market development activities include identification of potential end uses for revlar[4], development of the technology necessary to use Revlar for these applications, and education of manufacturers and consumers in the end-use markets as to the uses of nevlar. (Henry, C:: 36 pp. 11-17, 12-14).

642. The manufacturing chain for nevlar-containing products requires that Du Pont engage in market development activities at each link in the chain: the weavers ani spinners *rho create fabric out of nevlar, other finishers, cutters, or "prepreggers" who work on the fabric, the manufacturers who use the fabric to produce a product, and the ultimate consumer who purchases.the 7evlar-containin3 product. (Henry, C7-:5. pp. 11-14; CX-44).

642. !lost of Ole eavers, spinners, and other manufacturers who purchase revlar require that the 7evlar."qunlify% that Is meet their

specifications, which is usually a time-consuming and costly process. Any modification in the properties or process of making revlar ordinarily require requalification. (Henry, CX-36, p. 12).

644. Market development tasks include demonstrations of nevlar-containing products at trade shows and support for projects.that engage the interest of the technical community and educate then about tevlar. (Henry, CX-36, pp. 13, 33; CX-75; CX-76).

645. The market development activities in which Pu Pont has engaged include ballistic apparel (bullet-resistant vests and military helmets), passenger tires, and aircraft composites, in which nevlar is combined with other materials in making certain parts of airplanes. Work in each of these end-uses took at least five and usually closer to ten years before commercial sales were achieved. (Henry, CX-36, pp. 17-3n).

546. Pu Pont has spent the following amounts (in millions of dollars) on marketing, advertising and publicity, and end-use research to develop the market for aramid f'iher (CX-55)"

Year	Marketing	Advertising & Publicity	End Use Research	Total
1975				
1176				
1177				
1178				
1171				
1130				
1131				
1!%12				
Iln3				
1134				

---

* Records not maintained for these years.

** Excludes Pu Pont institutional advertising featuring revlar in the.amount of million.

** Excludes Du Pont institutional advertising featuring nevlar in theAbonnt of

647. In 1°77, Akzo established an aramid fiber pilot plant to produce aranid fibers for testing and sampling purposes. The design capacity of this facility is approximately 100 metric tons. (Zenpelin, RX-7, pp. 4-5; Van de Ven, CX-89, pp. 9-10).

648. Akzo's pilot plant currently produces approximately 50 metric tons of aramid fiber per year which are distributed in Uestern Europe, the United States and other countries in sample quantities prinarily'to enable potential customers to test the technical properties of the product. (Zenpelin, RX-7, pp. 4-5).

449. On narch4, 1903, Enka and the NON, entered into an agreement to establish a joint venture to manufacture and sell aranid fiber. (RX-1809).

650. As of !larch 4, 1933, Bomaride B.V., a subsidiary of NOM, and Enka Aramide E.V., a subsidiary of Enka B.V., entered into an agreement establishing a partnership under the name Aramide :laatschappij v.o.f. ("Arami") (EZ-1110).

' 651. By and through' Arami, facilities for the production of aramid fibers in commercial quantities are currently under construction in the Northern Netherlands. At Delfzijl, a city located on the North Sea, three raw material plants including a polymerization plant are being built. The polymer will be transported by truck to the spinning facility being built in Ennen. There will be three production lines for the spinning of yarn at the Ennen facilities. (Zenpelin, rX-7 p. 5, Zenpelin Tr. p. 1536).

652. Physical construction activities at the Ennen and Delfzijl sites are currently In progress and it is anticipated that production of • aramid fiberi will commence in ('ctoher 1915. (Uisnan, Tr. p. 2586; .7empelin, Tr. p 1582).

653. Akzo has been selling industrial fibers to the tire industry, the mechanical rubber goods industry, the ropes and cables industry and the industrial fabrics industry for over thirty yearS (Broekmeyer, RX-8 p. 4).

654. Akzo began marketing activities of Twaron in the U.S. sometime after 1982 after the Arani project was approved. (Broekmeyer, Tr. p. 3122).

655. The objective of Akzo's marketing in the United States in the past few years has been to advise the market of its proposed entry, and to learn aabout the market's requirements. (Broekmeyer, Tr. p. 3122).

656. Akzo's goal is to receive the necessary approval of individual customers for all end uses of Twaron. Depending on the end use and the customer, this process of approval may take from a few months up to more than one year. (RX-1806, p. E 700^63).

65'. Akzo's aim is to achieve "tentative'approval of ... pilot plant products, resulting in fast final approval once the Emmen production becomes available." (PX-1106, p. E7C(1^53).

653. Cne of Akzo's objectives in the United States is to gain approval of its product so that it will be ready to supply Twaron in commercial quantities when Akzo begins commercial production a the end of 19r5. This period is being used to enable customers to qualify Akzo's production before Twaron is available in commercial quantities. (Broekmeyer, Tr. p. 3125).

659. In the pending complaint filed in the Western District of rorth Carolina (Civ. Vo. A-C-I3-315), since transferred to Delaware, Enka stated that:

> Enka plans to sell 7nka Aramids in larger quantities in the major industrial countries including the United States,

> and in the meanwhile Enka has been, is and will continue to sample and sell quantities of Enka Aramids made in its semi-works to customers in the United States and elsewhere . for the purpose of encouraging them to become large-scale users of Enka Aramids as soon as larger production quantities become available. (Complaint at paragraph 12).

(Henry, CX-36, pp. 58-57).

660. Starting in 198• Akzo has "stepped up [its] activities in the States" by "systematically widening" its marketing effort. This increased effort included "contact with key companies in almost all important end-use sectors." (Broekmeyer, Tr. p. 3122; MC-1505 p. E433757).

661. Akzo has tried to widely cover the U.S. aramid fiber market. It has visited many companies which could or might use aramid including companies producing tires, mechanical rubber goods, ropes, fishing nets, weavers and prepreggers. (Broekneyer, Tr. p. 3126).

662. In the last quarter of 1903 American Enka Company, an operating company of Respondent Akzona Incorporated, became the sole distributor/importer of the industrial fibers marketed by.Enka in the United States and Canada. In addition to,aranid fibers these industrial fibers sold by Enka in the United States include rayon, polyester, polyamide 6, polymide 6.6 and steel cord. The staff of the Industrial Yarns Products Sales Department of American Anka, which is responsible for the marketing of all of these industrial fibers in the United States and Canada, consisted of people in addition to in 113: marketing representatives; In January 11[14 (n-1^01; Cotton, CX-104 pp. 6-15).

663. The total budget for American Enka's Industrial Yarns Product Sales Department for 19C4 was approximately and is planned for 1'715 at approximately (C: 376, p. 3; CX-377, p. 2; rijland, CX-374, pp. 73-86).

664. Akzo has lists of U.S. prospective customers to when it has shipped samples of its aranid product and attempted to gain approval. (Droekmeyer, Tr. pp. 3127-10).

665. Akzo salesnen are taking orders for Twaron for delivery within a four-week period and not longer term (Shorter, CX-228, pp. 31-32).

666. The following table represents Akzo shipments of aranid fiber to the U.S. for 1100-19C3;

l!Nno	inn	1932	1983
lbs.	lbs.	lbs.	lbs.

(CX-170, pp. 7410125, E410126):

667. Of the pounds of aranid fiber shipped by Akzo in 1933,

. (cx-170 p. E410126).

661. are both aranid fiber customers of Du Pont. (CX-642, pp. 2, 3, 1C-21).

669. As of 7ebruary, Azo had booked lbs. of aranid fiber shipments to tLe r.r. for r'n4. (CX-566, p. 24, answer to interrogatory_ no. 10; CX-170, p.

670. Of Akzo's customers for whom shipments were booked in VIM

(CX-170, p. E 410127; CX-642).

671. In the U.S. tire industry, Akzo has provided Twaron in sample quantities to

It has discussed Twaron

as well, with potential customers. (Broekmeyer, Tr. p. 3132; CX-170, pp. 2, 3; CX-642).

672. Akzo has received approvals for its

from some potential customers; approval has not been *received* for some of its new materials, such as the , because they require a long-term development. (Broekmeyer, Tr. pp. 3132-33).

673. Akzo has shipped Twaron to at least prospective customers in the United States, as shown in the following list of customers derived from the exhibits indicated:

Customer	CX. no.	<u>Page No.</u>

NS: none shown

674. A comparison of the companies identified as having received Twaron samples with Du Pont's 1984 Customer list (CX-642) shows that at least of the companies who received samples of Twaron were not on the Du Pont 1984 "Revise' customer list.

675. Akzo shipped approximately metric tons or lbs. of aramid fiber to the U.S. in 1984. (Droekmeyer, 1'X-0, 4 6; Broekmeyer, Tr. 311-3121).

676. eine metric ton equals 2,20^{1}.6 lbs. (Hausman, Tr. p. 2109).

677. From 1930-1984 Akzo shipped (excluding fiber which the record indicates was "booked" in 1984) approximately lbs. of aramid fiber into the V.S. (rF 64(,- 675).

67r. Expressed as a percentage of Du Pont's U.S. aramid fiber sales from 1'.'3')-1⁹84, Akzo's shipment of aranid fiber for the same period_ (excluding the lbs. of fiber "booked" in 1934 (FF 669) represented between approximately and of aranid fiber sold or distributed in the U.S. from 1981-1984. (lbs. (IT 677)/4:3.1 million lbs. (FF 635); lbs. (Fr 677)/48.1 million lbs. (F• 635).

679. Expressed as a percentage of Du Pont's U.S. aramid fiber sales from 1^no-19s4, Akzo's shipment of aramid fiber, as well as the volume of aramid fiber "booked" by Akzo in 19E4 represented between approximately and of aramid fiber sold or distributed in the U.S. from 1V20-1934. lbs. (Fr 677) + lbs. (Fr 669))/4E.1 million lbs. (FF 635); lbs. + lbs (FT 661))/41.1 million lbs. (FF 2)).

681. (Dunderdale, CX-173 pp. 62-63).

611. An Akzo marketng representative obtained from the plant manager of a Pu Pont customer, , information on the market for aranid fiber, the structure of that market, and the identities of other ru 'Pont customers. (CX-174).

6E2. Akzo's activities in the United States market have provided it with ready access to such market information as the structure and needs of the market and the aramid fiber products required to satisfy those needs. Akzo has thereby gained this information at low cost. (Thomas, CZ-133, pp. 34-35; Thomas, Tr. pp. 1nS°5-1rnn).

682. Du Pont's expert ultness on marketing, Dr. Robert. Thomas, has . estimated that if Akzo capitalizes on 10% of Pu Pont's expenditures on

marketing, the value to Akzo of the market information it has obtained is $6 million. If these costs uere added to Akzo's other costs, its price structure in competing with Du Pont night be different. By saving these costs, Akzo obtains a competitive advantage over Du Pont. (Thonas, CM-133 p. 35; Thomas, Tr. pp. 1913-19).

684. Professor Thomas testified that it is difficult to place an accurate dollar value on the magnitude of "information losses" to Du Pont. (Thomas, CX-133, p. 35).

685. Professor Thomas testified that Akzo's marketing activities have likely lengthened the purchase process of customers who are considering buying Kevlar, postponing the realization of sales of Kevlar and that the presence of two potential suppliers would tend to generate lengthy negotiations. (Thomas, CX-133, pp. 35, 36).

635. Professor Thomas testified that he did not know of any present Du Pont customer who has delayed making a purchasing decision for aramid fiber because of Akzo's sampling activities. (Thomas, Tr. p. 1876).

687. Richard E. Heckert, Vice Chairman of the Board and Chief Operating Officer of Pu Pont testified that he had no specific knowledge of any Du Pont customer which may have derred purchases of Kevlar in anticipation of Akzo's entry into the U.S. (Heckert, Tr. p. 309).

633. nu Pont's Alternate Strategy analysis is, to some extent, intended to aid Du Pont in designing market strategies. (Henry, CX-36, p. 69).

639. As part of Pu Pont's 19'4 Alternate Strategy analysis, Pu Pont determined to ameliorate the impact of Akzo's market entry by expediting previously planned research and development work and increasing Du Pont's t'.S. marketing activities. The resulting additional expenditures of abou020 million will be made in the years 1915 to lorm. (henry, CX-36, p. 6^{9}).

690. Pu Pont would have increased its research and development expenditures and marketing resources whether Akzo entered the U.S. market or not. (Renry, Tr. p. 1031, 1333-40).

691. Thomas F. O'Brien, Jr., Croup Manager of Market Development for Du Pont's Industrial Fibers Division testified that the possibility that nu Pont customers may purchase Twaron rather than nevlar did not enter into his planning and that nobody had expressed concern to him that sales would be lost to Twaron. (O'Brien, m;-51r, pp. 25, 26).

692. Mr. O'Brien testified that he did not consider Twaron to be either an actual competitor or a potential competitor in 1985 to 1990, of nevlar in ropes and cables or gaskets. (O'Brien, RX-533, p. 27).

693. Robert C. Forney, Executive Vice President of Du Pont, testified that to date Akzo's sale of aramid fibers in the U.S. has not injured Du Pont in any way. (rorney, PAC-506, p. 157).

694. robert A. Vilson, Du Pont's Manager for the rubber industry market, testified that to date'the success of the rubber industry marketing group's efforts t7ith 1evlar have not been injured by Akzo's sampling of Goodyear with aramid fibers. (17ilson, RX-541, pp. 176-177).

695. Edward F. Moran, Vice President Corporate Development for Du Pont Canada since July 1, 1 9P4, was Marketing Director of Industrial Fibers Division, Du Pont from December, 19n7 through June, 1934. Mr. Moran testified that he had no knowledge of any adverse consequences upon Du Pont's Mevlar sales as a result of Akzo's sale of Twaron up to the time he began to work for Du Pont Canada. (Moran, Rn-52 9, pp. 145-146).

696. Du Pont experienced its first positive cash flow from the revlar business in tla fourth quarter of 19C3. (lienry, CX-36, p. 71).

697. In 1904, Kevlar generated its first full-year positive cash flow. (Heckert, CX-1, p. 29).

698. Du Pont estimates that Kevlar will generate positive net operating earnings for 1985. (Heckert, CX-1, p. 29; CX-29).

Tendency to Substantially Injure

699. Currently, Akzo has a spinning plant under construction in the Dutch city of Emmen that will initially have a planned production capacity of 5,000 metric tons (or approximately 11 million pounds) of aramid fiber per year. It is not expected to produce at full capacity until the second half of (Zempelin, RX-7, p. 6; Broekmeyer, RX-C, p. 4; Broekmeyer, Tr. pp. 2995-96).

710. By the end of October 1935, Akzo will have all three spinning lines in operation at its Emmen-facility. (Broekmeyer, Tr. p. 3006-07).

701. By means of parameterizing" or increasing efficiency, the Emmen facility will increase its production capacity to 6,000 metric tons or approximately 12.2 million lbs. by (CX-333, p. E 42829C; Zempelin, Tr. pp. 1543-44).

702. The raw materials required to produce aramid fiber will he produced at three plants under construction in the Dutch city of Delfzijl. (Broekmeyer, Tr. 29r7; Zempelin, Tr. 1535-36).

703. The Delfzijl plants when operational will have a production capacity of 5,000 metric tons or approximately 11 million lbs. but could be expanded to a production capacity of 10,000 metric tons or approximately 22

million lbs. with only a minor investment. (Zempelin; RX-7, p. 6; Broekmeyer, nX-3, p. 4; CX-383, p. E428260; Zempelin, Tr. pp. 1547-49; Broekmeyer, Tr. p. 2997).

704. Greater investment would be required by Akzo to bring the Emmen facilities to the 22 million lbs. capacity, since the building itself would have to be'doubled in size. (Broekmeyer, Tr. pp. 3016-17, 3204-05).

705. An expansion of the facilities at Emmen to 22 million lbs. is not expected to be considered until . Expansion could be considered prior to if, for example, there was an increase in market demand. (Zempelin, Tr. pp. 1540-49, 1582-84, 1600-01; Zempelin, RX-7, p. 6; Broekmeyer, Tr. pp. 3203-04).

706. Once a decision is made to expand the capacity of the Emmen facilities, it would take approximately years before such an expansion was completed. (Zempelin, Tr. pp. 1582-84; 1600-01; Broekmeyer, Tr. p. 3204)

707. The raw materials plants at Delfzijl can be expanded to 22 million lbs. much sooner than the Emmen facilities could be expanded to that sane capacity. (Zeppelin, Tr. p. 1583).

703. Strong market demand for Twaron could lead to a decision to expand Emnen's capacity to 10,000 metric tons before . (Zempelin, Tr. PP. 1533, 1583-14, 1600-01; Broekmeyer, Tr. pp. 3013-14, 3237; see van de Ven, CX-89 p. 81).

Akzo's most recent projection of its 1990 sales of Twaron to the Western European market *is* metric tons. Added to its anticipated sales in 1990 of at least metric tons in the United States, Akzo's forecasted sales of Twaron in will exceed its parameterized spinning capacity of 6,000 metric tons. (x-1305; p. E433753; Broekmeyer, RX-S p. 15; Broekmeyer, Tr. pp. 2157-51).

710. Akzo must operate its facilities at a high percentage of capacity to obtain efficient and economical production. (Broekneyer, CX-78 pp. 156-57; NacAvoy, RX-13 p. 19; Mac Avoy, Tr. pp. 2813, 2821).

711. At the Delfzijl plants, where Akzo's investment far exceeds its investment in the Emmen facilities, the substantial majority of fixed costs -- including number of employees -- will be the sane at outputs of 5,0^{00} and 10,000 metric tons per year. (Zeppelin, Tr., p. 1537; CX-313 p. 423300).

712. Mr. Janse, Controller of Aranide testified that on the basis of his "break-even" studies, Akzo must produce and sell at least metric tons of aranid fiber in to cover its costs. *(Janse,* CX-378, pp. 63-64).

713. The following chart summarizes Akzo's present estimates of total market demand excluding an unidentified demand for 1,500-2,500 metric tons for 1984, 1935, 1986 and 1987 as set forth in Arami's Three Year Operational Plan 1185-1987, November, 1984, in thousands of pounds (and metric tons) and Akzo's estimate of U.S. market demand for 1990, as set forth in its T•aron USA Market Update, July,' 1984:

In Thousand Pounds

(In Metric Tons)

	1934	1985	1936	1907	1990
r.lorldwide	22,266 (10,100)	26,676 (12,100)	31,746 (14,400)	39,462 (17,900)	--
United States	16,093 (7,300)	18,739 (8,500)	22,046 (10,000)	26,455 (12,000)	28,659 (13,000)

(RX-1306, p. E700068; CX-370, p. t450170)

714. On the "Focus Case" assumption that Du Pont would put additional resources into new product invention and market development, and Akzo would commence importation and sale in the United Sates in 1986 (Henry, Tr. p. 1037-39), Du Pont's 1984 Alternate Strategy Focus Forecast shows the following estimates of total market size for the years 1984-1999:

In Thousand Pounds

(In Metric Tons)

	1984	19n5	19C6	1887	1981	19Pr	1989
Worldwide							
United States							

(CX-210).

715. On the "2ase Case" assumption that DuPont would merely continue its past business strategies and Akzo would commence importation and sale of aranid fiber in the United States beginning in 1.86 (Henry, Tr. p. 1937), Du Pont forecast that the total demand for aranid fiber in the United States, broken down between major categories of end uses, would be as follows:

Pu Pont's Base Case Forecast of remand for Aranid Fiber in the United States (million pounds)

Year	Tires	ITC	Special Products	Total
1985				
1986				
1937				
1988.				
1939				
1990				

(CX-648A).

716. Charles L. Eenry, Vice President of the Textile 7ibers Department of Du Pont, testified that Du Pont's base case forecast was the most realistic in terms of what Du Pont could expect to accomplish in the market. (Henry, Tr. pp. 1037, 1039, 1041, 1050-52).

717. In Arami's Three Year Operational Plan 1935 - 1937, November, 1934, it is stated that "[r]esponsible quantitative predictions cannot be made because of divergent reports on present markets and their development. (RX-1306, p. E700963).

718. Akzo should be able to produce approximately lbs. of aramid fiber during the fourth quarter of . (Zempelin, Ta-7, p. 6; MC-1306, pp. E700983-84; rx-1806A, pp. 31-32; 3roekmeyer, Tr. pp. 2991-2001).

719. Akzo's most recent statement of its production plans indicates its intention to produce approximately pounds of aramid fiber in and approximately pounds in . (EX-1806, p. E700984).

720. If there were demand, Akzo could produce more than the pounds estimated for . (Zroekmeyer, Tr. pp. 3148-49).

721. In October, 10n4 Akzo made the following estimates of Western European demand for aramid fiber for 1984 - 19n7 (in millions of pounds):

100,•	1935	1986	1037
4.6	5.3	6.0	7.3

(ra-18o6, p. E70096•).

722. Akzo currently plans to sell metric tons (pounds) in Western T.urope in 1975, out of a total demand in Vestern rUrope that it projects at 2400 metric tons (5,291,040 pounds), giving it a market share of just over in 1915. In 1916, Akzo projects its Western European

sales to be metric tons (pounds) out of a total projected market of 2700 metric tons (5,952,420 pounds), giving it a projected market share of over . In 1987, it projects Western European sales of metric tons (pounds), out of a projected market demand of 3300 metric tons (7,275,100 pounds), giving it a market share of more than . (PX-1306, pp. E700963-69; Broekmeyer, Tr. pp. 3110-11).

723. Du Pont estimates that Akzo's market share for aramid fiber in Europe in 1986 will be very small (S-102) since it will be Akzo's first year in business with a commercial facility. (Henry, Tr. p. 1322).

724. Du Pont will market its aramid fiber aggressively in Europe and does not believe Akzo can get 50% of the European market in 1986, therefore, Du Pont believes that Akzo will be very active in the United States in trying to sell Twaron. (Henry, Tr. pp. 1070-1071).

725. Akzo estimates that it will ship to Japan metric tons lbs.) in 1985, metric tons (lbs.) in 1936, and metric tons (lbs.) in 1987. (tx-ism, o. E700969)

726. Akzo has always considered the U.S. market to be an important market. Akzo has been active in the U.S. market for many years, now with aramid and formerly with rayon and other synthetic fibers. (Broekmeyer, Tr. pp. 3117-1:[1])

727. The United States market for aramid fiber is especially important to Akzo. (C1-651, 7 13; Broekmeyer, Tr. pp. 3117-13; Zempelin, Tr. p. 1531).

72g. The many reasons for its interest in the United Sates market were stated by Akzo as follows:

- The U.S. is the world's largest single industrial market

- The U.S. is the world's leading technological market
- The U.S. is an existing aramid market absorbing today . 3/4 of the total demand
- The U.S. aramid market is still in its growth stage
- Many multinational companies are headquartered in the U.S. These UQs technical - and commercial approval of Enka aramid is in many cases necessary or helpful for supplying their affiliated overseas plants.
- All above arguments are valid for our direct exports as well as for our 'indirect' exports.
- Last but not least, we can expect not to be sold out in 1986. Thus, we need shipments to the U.S. to ease that situation.

(nX 1804 at E700551 (emphasis in original)).

729. Akzo believes that the United States market has the biggest potential for future sales of aramid. (Bioekmeyer, CX-78, p. 76).

730. Because of the current strength of the United States dollar against European currencies, sales of aramid fiber by Akzo in the United States *are* more profitable thad such sales in Europe. As a result, Akzo has an incentive to increase its sales in the United States. (Broekmeyer, Tr. **pp,** 3115; 3116; nacAvoy, Tr. p. 2692-q5; MacAvoy, CX-654 p. 42).

731. Akzo recognizes that the technological edge of the markets for aramid fiber is in the United States. This is one of the reasons Akzo attaches particular significance to the United States market for aramid fiber. (2empelin, Tr. p. 1592; Broekmeyer, RX-3 p. 8).

732.

(Cotton, CX104 pp. 32-36).

733. An extended period of market development is required before a customer is willing to try aramid fiber in an end use. (Henry, CX-36, pp. 14-17; Thomas, CX-133, p. 41).

734. The aramid fiber that a customer uses must "qualify," or meet the customer's specification. For a customer that already has purchased Kevlar, the qualification'process for Twaron will cost less than it did for Revlar. (Henry, CX-36, p. 56).,

735. Through the marketing and sampling activities associated with the importation of aramid fiber into the United States, Akzo has advanced that time when it can sell fiber on a commercial scale in the United States. (Thomas, CX-133, pp.' 30, 33-34).

736. Akzo's most recent planning document states that to some extent, its estimated sales to the United States in 1985, 1986, and 1987 "... are based on actual potential customers contacts." (rX-1306, p. E700969).

737.

(Cotton, CX-104, p. 44).

733.

(Cotton, CX-104 p. 00).

739. Akzo has also sought to become

(2roelmeyer, Tr. p. 3126).

740.

(Cotton, CX-104 pp. 139, 175; CX-167 pp. 1, 3; CX-293, p. 4; CX 114; CX-300; CX-304; CX-320; CX-322).

741. In its June 17[1] ":'arl:eting Plan Ak7:o statet: that it 1;111 commit itself *and* demonstrate a long—tern engagement to supply- aramid fiber to the U.S. (7X-14, p. 7.7550).

742. azo[1]s United States sales staff is confident they can sell Akzo's fiber in the United States. (3roebneyer, Tr. p. 3147).

743. in the 7nitel States market, Al:zo 7111 he at a disadvante;e due to the logistics involved in its being an "off—shore" competitor (.:eckerr Tr. p. 215; Thonas, CX-12,3 pp. 37-1"; Thomas Tr. pp. 177•4—?5, 1^rn). ^1 7ont enjoys competitive advantages river ."'.hZo in the United States due to its longstanding business relationshipS, the proximity of supply and its established customer reputation. (Eeckert, Tr. p. n5).

744. •ru Pont acbnowledges as a competitive advantage against in—kind conpetition the fact that 7:'vlar Is the "[Ilncum'hent material in long lead tine businesses" p. 7w[1]3",!').

745. ',:hatever ,[4]1:zo's -share in the world maaet, its share in the "niter'. States mnr::et T7oull proh&hly he considerably less 77ecause of Du Port's competitive advantages with respect tc the rnited States. (::ecbert, Tr. P. 25C).

74r. Anerican 7r.ka Cor,pnny estimate•_' in July, *1^N* that Abzo coild sell retrTc tons lbs.) of "2:Jaron" in the C.S. market in 1^re metric tons lbs.) it 1"7, and metric tons In in". (r:X-:[1]7r, p. :45[7]17r; 7;roe:reys2r, Tr. pp. 1[1]_4[7]-5[1]

747. In a letter 'fated August '4, 1[7]4, from :*te. 1;c1,hard Schulz—rster, 1:arl:etinc :anz!:ler for Aramide, addresse0 to rr. John Cotton of American rnka Conpany,

(Fchulz-Cster. a-115, p. ';

nn. 2, 1)

741. Azo expects to ship the followin quantities of aramfl fiber to the U.S. in 1'n5-1T.'7:

Lhs. (::etric tons)

1985
1986
1987

("X-1^('6, p. 7,7r.'n'76'!; Is.roehmayer, p. 1A; Croelrneyer, Tr. pp. ilt.r▪, 32.05-6).

74". Akco expects to sell approximately metric tons) of aranid fiber in the U.S. for each of years (Iroekmeyer, Tr., pp. 1157-5r3, 32(16; See Sroehneyer, RX-1, pp. 14-15).

11:7to's planned sales of Tuaron in the Vnited States are well eloy the capacity to produce for all years fron 1^^.(through 199(% fr roeneyer, Tr. p. r5n).

7c1. anticipated sales of Tuaron in the U.S. are not conaidered liritations, lut rather targets. (Croebmeyer, Tr. pp. 32C5-r'r').

.1..co's estimated sales of Twaron in the U.S. for the years Irr..7-17 and 1^7r1, as a percentage of the estinated total u.n. arania fiber -arket as presently estivate('. by nzo, are represented in the table below:

1905 1'•

lhs

~~1/1f77~~

lbs./1 6,455,"0 lhs.)

lbs. 21,65!',prn lbs.)

(77 712, 74C, 74!!).

753. Atzo's estimated sales of Twaron in the 7.3. for t!:e years 1' 5 - 17',n, as a percenta3e of the estimated total U.S. aramid filer nartet as estimate! in ro Pont's 1^!',4 alternate Strategy Focus 7orecast, are represented in the table below:

InPn

(77 71h, 74'7, 70).

754. estinated sales of Twaron in the 7.S. for the years 1'!r5-1'2^rs, as a percentacze of the estimated total U.S. aranid fiber market as estimated in N Pont's rase Case Forecast, are represented in the table below:

1 1- 5

1nr7

1n 1^^n

(rr 715, 7!'7', 74 5')).

775. A%zo's estinnted sales of Twaron in the U. for the years 17r5 - 1rT!), ;Is a Percentage of the estinate total U.S. aranid fiber market, are represented inC'e tahle *below:*

· 1 ^^^r 15"r, in rin

(r• 77 7 — 7r4)

ne reT)rosents lost revenues to ru Pont as a re... ult of Ak7o salen of Twaron in the r. 1. for the year!', 1'715-1'17r, amsunil:!, th.at 7.1:7.0'm sales do not affect Cie nveraIe price of 7!evlar, that nzo's sales lo not affect the derland for arctic' **fiber** and assuraims that each pound of

Twaron sole represents a sale cf a pound of 71evlar which ^u Poat Lave va0e:

.ear	Annual ;ales (million pounds)	Avera3e Price (Constant 1^^^ trJ.) =	Lost revenu,2s (million !!
1775			
l!'r•			
1988			
1989			
Total			

*Average of :,!:zo's expccte.: Twaron shiments (17 735).

p. 1!;r'n('3; 17, In),

757. N:zo's Three *rear* Operatin3 Plan **roveml)er, 1?$4,** inlicates that it **expEcts to ship -** ns. (metric tons) to "others" In l^:!(, "ot1ers" !)eirl h.an-27! upon a potential market volume, the size of cannot ^{1}:e accurate•y estirinted. .*;:no e xpects to ship 11)s. (metric tons) to "others" in l'"7. (r::-17m p. $^{-7}$ t"^(7).

75C. nzo's l'^c projection of sales for aromid fibers incluA.es pound;: of ara-1:1 fi'ser not designate(' for any particular country but he soli any :here in tie inc1udin3 the 7nited States, should the demand arise. "!roe'') yer, 7r. p. *1 1;* p. 77N")(°).

759. rnha nnticir:ntes sellin3 - of Twaron in the r.n.. in the

approximately tons out of a total of tons, cr of its 17r salts.

(7.ro!',emeyer, Tr. pp, 21".—!'1, nroehmeyer, p. L!').

76n. rut of the roughly million pounds of 7.evlar sold in the U.S. in 1"4, approximately million pounds were sold in the asbestos replacement narhet segment. (DX-217, p. !.'rr. $^{0}5^{1}$).

761. ru Pont considers the asbestos replacement end use.segrent a "7:ey volume flywheel" which will generate high volume sales and enable Pu ?ont to reduce costs per unit arp.' Increase profits across all market segments. (renry, Tr. pp. 1241-42, 122'-3'').

762. A "fly wheel" is a colloquialism for a product for which high volume sales can reasonably he predicted. (1:enry, T . r. 1233),

7'Y!. !!r. 7enry testified that a successful fly wheel is important to the atarid fiber venture because the investment in aramid fiber is so high that some high volume *base* of business is *needed* to reduce manufacturing costs. (renry, Tr. p. 123A).

7A. In inrr, Pu 'clt bores to sell approximately million pounds of 7avlar tc customers in the ab•estos market segment. (nx-4(xo7, p. 410YT3P).

76'. In lr"!6, Akzo expects to sell pounds of Tx/arom for which would account for approximately cf Du Pont's expecte'' sales in thin end use in 1"'3. ‣ E^{7}n1P25; a-217, p.

7n. It is :717. :!enry^{1}s view that the demane for aramid fiber as an asbestos replacement is less than the comhined capacity in 1^•6 of Abzo and Pu 'ont to manufacture arnnid fibers for the asbestos replacement market segment. (;:eery, Tr. p. 127'1).

7c7. In 1"4, 2xpccts to sell lbs. of Twaron for end uses, representiug approximately of its expected 1^n6 r.s. sales and

approximately of ^u Pont's forcasted sales in the r.r:. in 1 (, .
p. 77r'1027; CN-217, p. ^:70Cn52).

Pu Pont's Capacity to :feet remand

76P. Since r77, ^u ront has projected that by 1n7-1C Pu Pont's nameplate **capacity of** **million** pounds per year will be insufficient to satisfy the demands of the worldwide market for aranid fibers. *nee* "Alternate Strateties r:ey Prerises", April 5, rr2, nX-63'1, p. mc1I5.1 ("capacity shortfall exists beyound 1"7"); p. OC1160 ("Pu Pont's rnA plant capacity will he insufficient unless two or more competitors are in place"); Corbin, Y'X-^2, p. 253 (Pu Pont's vle•7 has been that "tha 10 needs . . . had always been in excess of our initial capacity of million pounds" and that a!.sent Pu Pont el:pansion, additional capacity would have to cone from **other** sources).

7''. Du Pont's Spurante plant has experienced technical **problems** related to **the** **Actual,** present capacity is million pounds per year (I!echert Tr. pp. 111-77, *24!'-:"n;* CN-1, p. I!enry Tr. p. 1(2^; nenry, p. 7:!)•

77^. nu -out's effective spinning **capacity for** the commercial production of 7evlar has I **een as follows:**

'ear	=inn Pounts
1'771	
P.774	
n77	
"7r;	
1777	
1 non	
1"77	

1980
1981
1982
1983
1984

(rx-1534, CX-647; CX-647 A)

771. On April 1, 11`, Pu Pont will increase spinning, speeds from yards per minute and the number of ends per spin module from brinr,in3 effective annual capacity to million pounds. Pu Pont intends to further increase effective capacity to million pounds wit!lin the next two years and to million pounds by 11'17. (17enry, CX-31¹1, p. 24).

772. .ru Pont forcasts worldwide sales of Kevlar for the years 1¹11–lnle, as follows (in millions of lbs.):

inns	1986	1987	1 t71 rlrt	1989	1990

(nom.-P;Ir, p. 11'N'r'12; p. "nn '25).

772. The Spruance facility :Yas desi3ned to allow expansion of production from million pounds. 7¹,e facility already has adequate polyrerizatioa solvent recovery and inredients capacity to produce million pounds c: 7:evlar annually. (Eenry, p. 73; Ileckert, C2-1, pp. 22-23).

77t. fpace in the fpruance plant. has 7'een allocated for additional polymerization an" spinninz equipment. Vie addition of two spinnin3 machines of the current type and one polymerization unit would increase capacity to million pounds; that equipment can he installed pith a lead time of appro%imately two years. 1:enry, 77).

".0 "Pr fl Pont plans to construct a spinning plant for arxiid in :*ayown, rorthern Ireland. C'peration is expected to 1'egin in 1.7 with a nameplate capacity of million pounds. **nu** Pont Intends to e%parw the nameplate capacity to nillion pounds per year in the second quarter of 1'1% (::enry, CX—rl, pp. n-A).

7 7r. Construction of the :laydoun plant :las not yet !een but nil Font has applied for 3overnment grants to assist in funding. (:'enry, Tr. pp. tnn--n1).

777. nu Pont has entered into a joint venture to oanufncture and market nevlar, which joint venture includes a proposal to Fund a spinning plant in Japan as 'soon **as** Japanese sales of ':evlar reach nillion pounds per year. It is expected that construction of a Japanese plant will hegin in . C:enry, Tr. p. 1r("!; p. 7,1P3C4, g d).

:.esters: ¯nro7e, tl!e 711r;'1-price policy anr! the frequent price increasen of Po Pont earlier than originally foreseen. (r7::-1"r, p. 77r"7rs).

77n. In :!estern 171trop, 11'7n (!".cie.1 to

nn•1

Intends to (CU-11Th p. 7-'n^m7 ; flroehneyer, Tr., pp. 12'.-1"".

¯in its June 1"' rr Plan, in its rovenT.er rperatinf 711n 1^qc-l^",.'rd it testimony fron officials, Al zo 1 as e-tpressed Cle intention n.

7.1rr"7r; ¯enpelin, Tr., 15"- ^P; nroekneyer, Tr., pp. 11", "11 1-111, 1175-117'; r. ¯7"r '.").

Alzc's stater reasons for 'ihv it intents to are: l; ^u Pont !'as r lorinant position in the U.S. -larl-Pt, ant' Ahzo ir rtlat!velv nnall --,nr%et ,hare (2enpelin, Tr., pp. 11"-l'i' , aro /) :1-zo '.,o°_L.ves that Pu Pont, .r th ^f percent or more of rarLet,

(.7eipelin, '2r. pp. 77^¯-17""; nrre'mk_yer, pp. 7 1 14, 17r2-717.17, :1773-7274;

^ccea7'c ¯ 71.in T'PA stites tl•at "ne nr:r1:et •/ould 77elco-e an- sc,con'' supplier for reasons 1!'e price control, quality control, ar!r!ition•l tchn!.cal assistance, specialty necs, and .:ton-gap supplies." r::-"' ', 7Alr" 7").

..... 7:rael:eyer tetifie•that a c: toner can reasona7ly expect a 1(3-Jar trice as a **resillt** of a second supplier be in, In the nar!:et. (Broekreyer, p. lt").

711:. AT:70 S !raft operr,tional plan for 1^"4-2^Th eater' 7over:Ser lnrl, states:

p. 11^7/.).

rei. Al....0 officials e.(2resseo iltention to

if

Al.;:o fines that 7sti Pont

(nrclel:neyer, Tr., pp. *71f,f¹-11r•4;* x-^, p. 7).

,V:Lo Ilan not yet leterrIne:: ../hether

'roe'-leyer, Tr., pp. 3141-n 64).

^7.

as peen by an At= official refer to an in3tar;:e Tilere

In particular, a ctIstoner comperic!;

In relation to a conpetitor tl'nt

p. 7; :roe! never, Or., Tv.). 'v,1-117!).

f0..b ^. AccorYir- to a July 7 "0%1 A 30 plannirr locurent,

p. /6"1"; 1::celnever, 7r., p.

4 141

Al.r.o unal le to

(nroekneyer, Tr p. 77").

7". In riurope,

p. r7^' 7(').

iThco r:!ccnnizes t

p. 75 1 7747).

7".. In C:!E nirutes descriljn1 Al:zo's 1 27 :'aster :':arketing Plan,

z0's price policy stated that Al:zn

!1:roc177.•A7(r, 7,1". ' 1-^-11n!o.

ullitiel tilan price ,' re also considered inportant by custoners. (7.roekneyer, Tr., p7d. 27 1 2-7717, 7 21 7; (77,:-1, pp. 25-7 ,

pp. 1--1)•

. . c1 :tbbrs for 4 f_ ier expect L :at Clete !All 7'e a ;rice-rucinr: effct A':.zo's entry into C'e r.c. narl:et. (!enr7, Tr., pp. 1'17-1 71'; nrperleyer, Tr., pp. 71r.7, 717^- 74,71, 71.7-'177;

1 17-1 1^; "lis, p. r:X-1^7, p. 7L 7 1Le 2; p. 71 1!.771;

=-77 4; p. i"', 177 v; 7:'-' 1 71, F. A71n ').

After a *3007* e 'lot' the 7nitel States aid '.!estern 7urcrenn aro lie fiber mat1:ets, a consultian firm, NJ!. Little, reported to ALzo in nay VTA that: "Zveryhody Is ''siting for a second supplier and suhsequent price competition".

7^5. ru Pont expects to respond to corpetition from nzo's ertry into the raiket by reducing prices to maintain mari et

CX-1.11, pp. 7-4n, C7.-1", pp. 5-C, 1P; :!ausman, Tr., pp. ""-^^^1)

7^7. Accordinr. to Professor rausran, a price decrease qill affect a71 of ^u 7ont's sales of ':evlay. (rausran, p. 17).

71% none aramid custoMers

(TX-(04; den

::crton, pp., 7';-'1; C::•771).

"^. In t%e r.n. 0 mre have ''ear! certain

a

;nroeh:r.eyer, Tr., pp. " 72-1172).

compnmicr:

repartel tack vor7.1 purchase ararid from

"::-1^^1 p. 7!:^^"7; C7-7".1, n. _1^1 1110.

testified that havin3 no commercial leverage ri.spect to pricinl uns a .qsalvantage of relyinc a sln3le source of sun71v. !C•-77!, p. 17).

7ont's nose Case forecasts ?roject followinr: avenige prices Ter ponnd for r.evlar in the 1^n6—l"^ period depending en vhether cr not A!:zo is excluded from the mar!:et:

nAr- rA77. rcrrcAcTr

rrcjectel lvera^e i'riccs for "7eviar"

U.!7.

Pollars)

			1 " "		1		1[illegible]		1[illegible]	
	.',7:::o out r:rt.	,',1-;:o in :71:-t.	A!:::o out 711-t.	4■1:zr. in mkt.	Akzo cut rl:t.	,Thzo in 711::.	.',1--zo out ,11.t.	1,1:zo in rkt.	:.hzo out 1711.t.	;,!:.-:,) !.n mkt.
7t 11-! er od										
^neci.11 "rodccts										
A11 rr!vluctr										

%%?.,n i t Of rulr':et: 4r'15, p. 5.("nn:"; .11::7o in marl:et: Trz, Arr7)

AAA 'u rtse "7nr, fcr,:casts nroject t' .at 7u Pcnt's prices fcr revinr fner 1,111 lre lcpressed !iy the follocing alounts znd percentngee per pounc! if enters t')e V.% rlare :

nP,77 cAn:
r.s.
Frojectee 'Op:essinr of ?Price or
riber

	gimme per—:1^" cent	1m., r cr—:1^7 4 ce.it	n nnn nar—:1"." cent	AAA per—:1"7 * cent	1 ner—:1"1 C131
Tires	1.1:	?.1:	[illegible]	4.?:	5.
^uV'er Mods	n	1?.?:	?.?:	?.?:	AA.
rncci-"1 ^ro''uct::		11.?:	11.4:	11.?:	12.6:
2$11 ^rcy'uct,-	m e •	1^ 1,	I f% ":	1? n:	114 7

(Trcparee 71v ccnparisons Ar7; ':ar%et" 7rices •/Ith "Ar7f. our of natket" pricer., p.

-ont'I 7nctls forecants project averaF,e price per pound for ':evInr in 0•e 1^^-4-1^^^ period !cpeneiri : on .et!ler or not Azo is excluded fror the mae:et:

7(= cArr ¯er77,v777
Projected Aver.lre 7rices for "7evlar ¯

Pollars)

	1nnr		Inn+				ln^n		*1^ nr*	
	/V:7C ot!t r7:t.	Al:nc in	out	Akzo in	,Thno 71'C.	in r.	Al:no out	in	.V.7zo out	in
7:res										
Coodn										
npecial Ilroucts										
.111 Products										
(A'zo out of maCeet: .1'.1-.zo.n-mnrkett	C:!. 217 at ',..!^rrilf;									

rrr, **"u runt's rccus** 71se **forecasts project that** NI **nont's prices for 7.evlar fner** t7 **]1** **.iepressed** 1›)y **the follouln3 amounts and percentages Per pound if Akzo enters the**

rrcrr

r7.

rrojected 7**enressior. of Frices of**

–evinr !.ranid riher

			ly`r"	1 n ··ft	1"""
	per—:1^^" cent	per—:1"" $ **cent**	per—:1"7 **cent**	t **per—:1"r1 $ cent**	per—:1^^7 t **cent**
Tires	:	2.1:	1.2:	4.1:	4.0:
:!echanical ruYer Cootis	5.r :			[illegible]	10.0:
Ipecial Products		1:		5.2:	3.8:
All Products		2:		5.3:	4.1:

(rreparec! %y **comparisons** of Ic ¯7arl:et" **pith** "Arnr out of market" **pries, C:-21** 7, p. *"rrr7A;* "::-/."**r?,** ˙r. 4 ▾▾ 1 "4.4)

"'tr. 7rofes:l7r riu,rmon used *(!ptn* in t!'e rocus ferecnat in **computinz** Ca-lazes to ^u root, 'Int **rcconnize: that** the Lest viet7 of ***ae*** nramil nne!et nitIht snr¯ew!,..re in 1'et•leer *the* 7;nse and locus forecasts. (Vausman, 7r., pp. 1111—'114).

^^7. Professor ::ausman based his injury calculations on the Focus forecast, hecause to the extent that the Focus forecast embodies all the neasures that Ni ?out has adopted to counter Akzo's entry in the 717C and the it could seen to me that this would lead to a conservative bias in favor of Akzo in calculating ny injury.estinates." (7ausnan, 1^67-1^61).

nr% The estimates of price declines resulting fron the entry of A!:zo into the 7.S. 7arket-that are used by Professor Fausnan for his injury calculations are based. on price forecasts contained in Pu Pont's Focus Case forecasts. (Eausnan, p. 14; CX-(71, pp. '^70no15-^7n0P1r).

^C^. As part of Ni Pont's annual business planning cycle, the Ine.ustrisl rners nivision. of ru Pont's Textile Fiber Pepartnent prepares **forecasts** of prices an•! volume ty)at compare *the* expected results of proposed e.inges in husiaess strateg'ies to the results that would he **expected** if preexirtirv' 3trPtegies 'Yer.! continued vithout change. (Xerry, Tr. pp. 1r171, 11^t; rayntex pp. IP, r!1-1?, 1n^;

f"lts.. The price declines resulting fron Akzo's entry into the U.1. -arl;et that ar,': containcd ir. 7u **Pont's** lase Case and '7ocus Case forecasts "**cre 1-aser on P,** "ont mar!!etin2, representatives' assesszent of what the price impact of entry 'Iould he. (naynter, 7::-721, pp. r7-7'; enry, C7-1(;, pp. r.7-''."; ::eery, Tr., pp. 1057-1('fl, lnr1; 7ausnan, Tr., pp. 7717-371).

'IL The 'u ''**ont forecasting rodel** is the researched output of a process which involves ^11 **Pont's** er.,plovces qho are responsible for the sales **of Vevlar, and** 7 u•ront nanaement analysts. (raunan, Tr. pp. 3714-•71().

Acccrdinr; to Peary, in estimatin7 Cle price eecline caused !'y the entry of Alczo, wilan n.lrl:etin,^ experts became auare that Ahzo had contacte:1 a Du "opt customer, "our people tried to take into account that customer's reaction to 7•.mron, the price at chic' we 1:elieyed 7uaron uaf; 1,ein3 offered, and the price incentive that Thzo must offer in en C1 end use nne:at to sell Tuaron. Ile than tried to .striate t7¨e effect of A.7¨zo'r entry on th price at u'dch "u Pont would '-ave to sell "evlar tc remain ccrpetitive." C'enry, pp.

Al'. "rofessor ::ausmaa testified that he discussed with :*r. "aynter the assumptions that were included in 'u "ont's forecasts, and conclude'' that tLe assumptions were hose' on good economic grounOs. (1:.'Lsrnn, 7r. p. 712).

772 Pu Pont stiles representatives '*o contributed to the forec.Irts ¯ere riven no :eelines cn t1 e linitntion of C'e amount of Twaron rave avail:11'1e for sale in the rniteC "totes. (.Paynter, ^r, ▌.

A15. r. "-yot,:r testified C.at helieved there were sone rarlet!ns se::Tents fo- -arletinr: representatives !le not have any specific '¨no:'10!1-e intent ions. ;Tnynter, p. ^1).

Ascor':a"' tc an A%no Jun: lAA4 monthly report, Al¨zo has 'seen acce:Ae! as futtre se-cent producer of ara-Ad, an the concern of customers lc ' pertains to future A1:7:o lvnlYty and nrice policy. (C7-?3.5, p. rhnl"r1).

"1'. 'tas offered to all or solstant:_ally all custcners ''ave reinesteJ an

7':zo resp(nse to interroflotory nvm!:er 1^3, pp. !.4-7".

·L· :anr7 testifier', that Ole marketinA representatives uenll have ,Ist•! T•7nron pric:c at co7:rercial quantities in their competitive prApe arnlype.s. (7!eary, 7r., p. lr-1("r.7).

7o :t 7 ruvPes develclment allcr,ance to ::ev1;11 11::.1rs for nn initlal period of ti7v! to allow tfi= requirert investments to intenrote 7evlar into their product-.• (C2:-^{7} "r, p. 1"; (1""2 peried); Cr.-11f: (l'7? period); CX-217 (1"77 period)..

r2r. The growing strer:',01 of the iollnr a;Ininst the rutch !;uil.!er in recent years translates into 3 7,reater natgin cf profit for 11:zn's .'niter! Suites sales tl'an..uos anticipates then Akzo's aranid project -:as conccived and estallishe4. (Zroekneyer, pp. ';:l-r-^{1}!). an apprecir;ting eollar, nzo could reduce Cle price and cone out with tfie sane revenue. (:21 oefiloyer, 7e., p. 211(;; !lacAvoy, a-^{1};14, p. 42).

'71. Trefessor 7aunron an 2roefineyer expected the eollar to depreciate !.etJeen nrw and 1nr.r. (7::-.^{1} ""; (77.:-"7", p. 74^75:11; nroekneyer, Tr., pp. 71'7-71 ^{14}).

7'enn !:ocAvoy !velieves'tfiot in the Pnited state s, denand for the Al:nc prod.uct ranT:c of 1 etween 5e'^,n^r an(' one pounds at constant or current :)rics. '(ac.%voy, 7r., p. 77'1).

Tenn !.7acAvc7 reli ves ti•nt .1:zo can nate substantially nore '.ones/ lry its sales in the $tntes to a .pillion poun'!s or less nnd selling at 7u 7ort prices. C::ac..voy, Tr., p. 77"5).

"74. ac.',vol. testified it is 1-etter for Akzo to 'seep its roles in t!!e rr–,^rsn. to one r'111.1 on pound range Oan to push sales hi!ler, and thert:'y di rapt the price structure exintinf; in the "nitee ::tates. (raUvoy, Tr., p. "7"7; P -

"15. 'e' ac'voy t st!riet he uoul!' expect n zo to sect: narlet s:laTe in the 7nit.'! "rat:fs cf "no ':ire th:In)ercent of tltal rae:et supply hecause that uc..11ci 21.1w7 the nareL ?rice in Cie rnited ntatec to rEnain constant." ('lac.'nxr, p. 17^{1}).

"1(7ean conter•s tbat X:zo's entry into the r.S. rarl:et could' henefit ^11 7ont by stimulating demand Increaser in the short run (1^n';—Pr7), and new aramid *uses* in the long run. (1,acAvoy, 7X-13, p. 1').

n27. mean racAvoy believes that /kzo's entry into the V.7. ara7Ad narket will expand the narket *Secause:*

(1) A second swIrce of supply would expand the narhet because customers are provided *a* greater assurance of supply reliability. (77:-1A, pp. 17-1!7, paragraphs *7-5)*

(2) :ikzo's presense will spur nu Pont to increase enenditures for maf:erin!: and ^!:n for new uses (r::-14, p. pararaph

(3) ;I:zo '7.11 contrillute technical innovations that will create new use for aramid fiber (''T.-14, pp. 1A-17, paragraph 1)

(10 Any price decline will stthulate an increase in the quantity of *aranid sales* such that nu limit could not he Injured by a price decline, 'used on !!acAvey's estimated price elasticity of from ! to 15. p. 12)

"ean !!acAvoy states that while *the* liklihood of the dynamic erfectr (shifts in the •!enanc! carve) are great, it is possible that they •ill not occur, or will occur slowly: If Clis **IF** the case, the injury analynic would rcly on th.i rtimulus to t':e quantity denanded caused by 1(er rraC,voy, 77-11, p. "Y.

An n 7cononic expert t; for 7lotb complainant nv..1 respondents acnowLedge that Al7zo's entry into the L.S. aramid fiber market will result in nn increase in overall len•nd for arami.: fibers. ! :lausman, p. 7X—cfn, pp. 1'7237^, rr7^ Eaosnan, pp. '! 7

mean :7acAvoy states that the increase in 7u Pont's corketing and ntr expenditures during the period 1f.'17, to in•!" due to anticipated competition from Akzo will expand demand by approximately 25 percent. (nacAvoy, 71X-14, p. 16).

131. Professor Eausnan believes that tLe market expansion effect of nzo's entry into the u.r. market reaches a maximum of 2.^ percent ir 1^^^. (1Iausman, t7:711, p. 71).

132. 7u Pont !'elieves that its increased expeneitures on marketinl and rex will produce new 7evlar products and will increase the volume of ::evlar sales. (flenry, Tr., pp. 1n77-1nr,

n.7:1. Professor Iausr.an believes that "Du Pont will suffer no• injury. fron Alzo"s entry by virtue of lost sales volume, only if the market expands sufficiently so that nu Pont suffers no reduction in revlar sales." Professor 1:aus7aan does ,not believe that any market expansion resulting from Azo's entry into the -.n. market will offset '12 Port's loss of marLet share to Ahzo. (•ansran, p. 11).

:yen for currently developed end uses, there is a long lead tine betwe'm the tine a customer decic'es to test aramid and its use by that customer in connercinl wantities. !::acAvey, ":--f'54, pp. 152-1'; Thomas, p.

nnrket expansion fron a sccon'! supplier

nroekne:er testified that prospective customers are more likley to purchast Tworon if they are nlri.ady fPniliar with ararid filer through their use of 7evlar. (Eroekneyer, 7r., r. 235n).

716. Customers who have already received and approved samples of 7'11ron frrn Akzo -Jill serve as .hzc's custoner (1s,roemeyer, Ir. pp.

nzo believes that of all the customers it has provided shipments to,

response to Int. No. !!()).

Sr. Du Pont's PrI• sales reccris shou that nu Pont has skippee aranid **fiber to**

(f7X-547, pp. 17, r, and *126).*

Nr. Droekneyer testified that the market "increase ly reason of a sccone supply could be of only a fey.' percent." (Croekreyer, Tr., p. 3"t2).

nr. l',roe•neyer **testifieA** that Akzo's market estinates are based on the assumption of a two supplier situation. (Droelaneyer, Tr., p. 7167)..

141.

!nun,³erdale, p.1.5; ('ills, C::-124, Sinclaii, C.7-175, pp. :'.n-71; 7ielke, p. IC).

ft?. Accoreing to a 1^^7 internal nu Pont renorandum, "certain people at Coodyear were concernee ahout ':evlar being single-sourced ¯¯almost leadinl you to believe **that** sourcing coul! he as much a concern as tire

p. 7rnnr7).

:!arket eNpansion from innovation

"An. ?n increase in **the** quantity of nevlar purchased, resulting from **increased** nu **T'ont ompenliturils for narl:eting or for 74n, is represented** l)y a shift of **tlie'delan0 curve** outward, nthich is independent of the price elasticity. (nausran, Tr. pp. ?".74-3"7").

P44. An outwar shift of the demand curve constitutes an *increase* in the quantity sold at the sa:le price. (1:ausman, Tr., pp. 3r5-37)77).

r45. bean :alcAvoy 17elieves that the lord lend tine involved in developing some new aranid end uses will !;cgin to stimulate demand for nrami(used in those end uses 1"!7, 17"7, or 1 7 77. (lacAvoy, C!.-05!-, pr. 117„).

• some industries, it takes a nuaher of years to adopt **aranid fibers** for use. (CX-7r, pp. 17-11; CN-177, pp. 11-14; C::-.11n, pp. :1-32; p. (TN:37; nacAvoy, C::"7'4, pr. 15n, 1 7 5, 221).

'47. The time required for cnstoners to approve Twnron for use in C•nir mnnufacturing operations can range from a few nontl•s to more than one year. (7::-1"r"., p. *r'n-^4 1)*•

ny September 1 7 76, Ahzo will have spent approximately on marlet Oevelopment and product **researe'** since **leno.** From 1705-S7 A7:7.0 plans to spen': million or research and ,!evelopnent, marketInn and mana;e-cat. 7x-11'Y-, pp. 4, t1;.

7u ?ont spent nn average of mill!on per year for ncrheting, ad•ertisin:1, and n r:7 7 fron 1 71 7 to 17'4. (7X-57)..

1 5r. 711 That a 1^nA .7,1tercentive Strategy Focus Case f;)recast (Focus 7trnte3y), nssunes that 'u Pont !'ill allocate ndelitiounl resources into lee! proe:Wct invention and rne:et development, and estimated r4llion for tis purpose in the years 17"5 to 1”0. (renry,

n51. The Teens 7trate",y is heial enployed by 7u Pent around the !orld to ameliorate the **impact** of :',Lzo's entry. ru Pont has **put in place** the resources to purse::: this **strnterly.** **(:!enry, Tr. pp. 1** 7 0,7, 1174; 1:au:;nan, T.r. pp. 7r1r-7¯71).

7t rort forecasted 7:ev'_ar shipments a7.e pricer with .',kzo both in the nar':et are out of the market, assuring the rocus case stratenies were followed. (CX-177, SY.-^.17).

The rocus strateg' was adopter' hy 'u rf..nt management an% carried forJard into nu Font's nunber one 1^^S marl:etinz forecast. C:'enr•, Tr. pp. 1115-1114).

ru Pont developed a l!'!"4 Alternative Strategy 7.n. nast? Case T.S. forecast (nase Case, assuned that ru Font would continue the strategies it had been follu•ng ritb 7evlar, including net: product developnent, and aggressively purAninn the market and cost reductions. C:enry, Tr., pp. 1r3(-1n37).

•55. ru ?oat forecasted "evlar shiprents and prices with Akzo bot!: in the marhet and out of the market, assuming the 3ase case strategies were followed. (F.::-1;

^5r1. ru roar's .rorecasters in performing their forecast analysis assured ¯t at ,%1:20 ² s 7ajor narheling thrust would he in the United States. The forecasters.:ere instructed to consider all those parareters that would affect the measured impact of a second source coning into the U.S.: the value of the pro‹ ⁷uct, the !ifficulty of letting another product in, the apparent interert of a custe ¯,cr in a second source, arr.! whether or rot they. could see nny price elstfcity of the Ivs!.ness. (renry, Tr, pp. 1^57-1r51).

f57. rean ::nciwcy estinated that the nartet expansion fror ru roat's additional rartetin7, and ir•r eNperlitures, caused hv Akzo's entry into the narket, wil: le 7.r percent in 1^^r, 5.7 percent in ¹ ^17, and 12.5 percent in lrM p.

'757. 'nean !:acAvoy's estimates of market expansion were based on comparing ru Pont's total domestic aranid sales forecasts with Akzo out of the market (fl -1535, p. 21r-^45:!) No. 1 l!" !n Forecast, a nu Pont n/^1 forecast, with Focus case estimates for Akzo in the mae:et (C-21r, p. r(^{1}0026, a Du Pont In/r4 forecast).

•5% lased on a comparison of Du Pont's Focus market estimates which were made in r,epteoller P77/' for Akzo out of the market (CX-217, p. FT,mnpc1) and 117.0 in the market (CX-7.1,, p. T','nnn7r'), market expansion reaches a maximum of 2.^ percent in 1"n. (Lausman, cx-rn, p. 3(').

•6P. Both the NacAvoy comparisons and the Du Pont Focus case comparisons also include any market expansion resulting from lower price. (Compare for eariple, priceS in CX-nr) and CX-n7).

1. '"espondents rely on a comparison of nu Pont's pre tax earnirr,s in the nose case forecast with Akno out of the market (^::-015, pp. 17.(!nrnl-^7nP^r5) and the rodms case forecast uith Akzo in the market

!7::-.-1n7) to 0'0w that T$^{?}$ti ront's uorld wide pre-tax earnings will increase by an average of 17.5 percent over the period. (rm-4e2(,).

'f)2. To support this comparison, nacAvoy testified that the Dose case strateies and forecasts reflect n "no-competitor" situation, and the locus caf;e strategies and forecasts reflect the existence of a competitor (Akzo) in the marl:et. ('lacAvoy, Tr. pp. 2S7r-2^{4}71).

'(P. Accordin3 to nt. :terry, if Akzo is restricted from the U.S. market, ru Pont will not abandon its Focus strategies, but will pursue them under a different tine table or at decreases expenditures. (::eery, Tr. pp. 1:^{1}3n-131, 17r17; Lausmon, Tr., pp.. 7r21-772).

'!r. nenry doesn't view the results set forth in the Focus forecast, which are based on many strategies being employed during a very compressed time period, as presenting the most realistic view of market growth. (lienry, Tr., pp. 10^{1}r, 124r).

nrJc. :Ir. Henry testified that the-results set forth in the ::nse Case forecasts with ITC protection, with respect to volume, price, and earnings, present the most realistir *view* of the aramid market lletween 12t6-1rr, without Akzo in the U.S. market. (Henry, Tr., p.

^{1}.66. Ur. *Uenry* believes that the base case forecasts T7ith Ak=o out of the marl:et are more realistic because "the premises are more realistic in terms of the kinds of things we're counting on in that five—year period. I:e're counting on a lot of product development and a lot of things happening, but we're not counting on the kinds of things we've got *in* the focus case." (Henry, Tr., p. 1%1).

".r/ (a). !!enry testified that a comparison of the Case Case and Focus case forecasts would he in error l'ecause the underlying assumptions stratelies in the two cases are different. (Henry, Tr., p. lrr^).

r67. ::enry's injury estimates compared ^u Pont's Case case pre—tax carninls formIrts with an:'. without A'zr.o entry into the United 7.tates. *These* estimates are shown in the tailulation below:

	1.4	V17		1^{n} $_{7I}$ ^{n}	1^^n	Total
		TiWThillionn of 1'^{1}.4 dollars)				
7re tax **rxirnings:**						
!!ith Al=		"(' .1	1.4	1.1.1		^{1} 2r .?
att,out Akzo-- 1r,.^			4 %! '	" f	n1 . ^1	143.4
I.oss of earrin,o	- ,1 n	'1.1	ti.m	4M.	n7.7	.loo'?

p. rs5rNnr!r^. ; PP. r^{7-}")

!!r. 7enry testified tat"cramming" of the P&P and marketing, effort into a• shorter tine period because of Akzo's expected entry into the aramid market would make Pu Pont's costs for the effort greater than they otherwise would have been. (;:eery, Tr. pp. 13^^-10(1).

!!6'21. Professor Eausman testified that the additional expenditures to counter Akzo entry would he injurious to Pu Pont to the extent that these expenditures uere inefficiently accelerated by Du Pont hecause of thc entry of i1:zo, and not lead to an econonic return to Du 'Pont. (Hausman, 7r. p. 2125, C::-4r ", p. 1^).

'rofessor 1:ausman believes that while 7u Pont nay spend more on r&- in the short run because of the entry of Akzo into the aramid market, in the long run, total rtin expenditures by Du Pont will be less because Du Pont must share the economic returns of innovation with Akzo. (Eausman, CX-4"", p. 17).

^71. Accorr'ing to :!r.- Director of 7esearch and 7[1]evelopment and Technical cervices cf the Indurtrial Tires Product Croup of Znka, Akzo's technical narketinl and application ievelopnent includes current end use applications, as well as the develonent cf new applications of aramid filers. (:!upje, p. 1).

"?[1]. _;ceordinl to A7:::o's efforts in the area of new aramid aranil applications include:

(7upie, pp. 20-1q.

A.7.1. ^ean nacAvay's testinony uas arSigucus concernir4; whether 71e **believed *ikze's* new use development for aramid fiber would result in a substantial increase in aranid demon'' during** lm!-Iirn. **(Compare CX—')5 4 , p. V?, lines 11-24 with C: 65 1 , p. 154, lines 14-1n).**

p74. **Broekneyer believes that Akzo's development of nrami:2 usage will result in market expansion of 5 to ln percent a year.** (Droelneyer, 7r., pp. 3062-3Cf,3).

r75. ':r. 3roekneyer testified that to the extent Al:zo expects any volune fro' the **new end uses, ti.ey would be reflected in the U.S. market size and** Akzo export shipment volumes A!:zo has predicted in its Tr7 forecast for ^nc_In^7. (¯X_1"n; **nroesmeyer, Tr., p. ?MO.**

Arn11

17(. Accorlir•; to !:r.-

(Yupje,

p

¯r. :*lpjc 0.at

rcpje, p. O.

Adhesion activatel cramids

^71. Are'ids '!ere •originally used exactly like steel or fil'erglass in the belts of rlein' tires. Like radii/ tires nude from steel_ or fi'lerolnss Setts, ralial tires **made from nevlar belts c▸ere sul%ject to belt erle separation. (::enry, C.7—:r,** pp. **?2-21).**

ru Pont 't./.15 a: are recemher of that the belt edge separation problem could impe:ie the Adoption of aranid fibers in the passenger tire marhet. (r.K-733, 2rT!'?16).

ncn. :Mile the development of an adhesion activated revlar product had been a technical o"'jective at ru Pont as early as 1^77 .or 1^7", the use of Pu Pont rese:Irch and technical capabilities elsewhere *slot!ed* 'own the development of this product. 0^{1,7}",rien, p.

1.'11. In Tecember of 12 a presentation was niven ty er:zo to a number of American companies in the tire industry. Among the topics discussed. was the statue cf development of adhesion activated aramids. ((=-n76; p. EAlr145; r:.-^n, pp. 41r21C4-41e2r5).

A copy of the "1T72 Znha Presentation to the Tire Industry" (rx-^21) was given co nobert Lindler in 1!'r2, who was at that time was a T•u Pont marketing representative, by a n.r. Coodrich employee. (Lindler, pp. 1, 15L-155).

"?. Lin(!ler sent a copy of t"•is document to the strategist responsible for the tire inlustry, so that he could see what the competition uns offering. (71-517, pp. 155).

r!4. rn I:unter of nu r'ont sent a nenorandun to C.L. nenry, eiscussinr, conp.Aitive tactics to meet Ahzo's entry into the narket. Anonn the tactics •was an accelerated "introduction of new leap frog products such as adhesive activates' finishes--oLsolete [sick their products before they introduce them." ('::-777).

n115. Akzo's

::upje, p. 13).

!? 1f,.. I:upje testified that

tofollow. (:alpje, ca.-446, pp. 115-126).

n'37. The (!evelopnent of

according to nr. Vupje. (CX-44A, p. '124).

rmr. Both nr. Nenry and Nr. r'3rien testified that Pe Pont's adhesion activated 1:evlar has now been field tested and will be available in connerical quantities this year (11T5). fO'Brien,. nx-5.1n, pp. !In-"-9; Eenry Tr., P. rirl).

Asbestos subsitution

r!^.^. **Pu Pont sells** Pr= impregnated yarn for pump pacl:ing. Akzo **is**

(nupje, ^X-1l, p. 2r ; (.7::-.44% pp. 145 ′147; Eenry, Tr. *pp.* 327^4-3?3^3 lenry, C7Z-1^1, p,. ^{1}J-15).

^{n}9C. re ?ont produces and aranid staple fiber for end uses such as clutch facings. According to nr. Nenrv, user reports conflict as to whether or cot one staple in superior to the

rupje, p. 25; flenry, p. 1^7).

.aape

nrl. Vndirectionnl tape of untwisted 7evlar in prm!uced commercially by ru ront.

i:!upje, p. ?6; Hupje, CY.-446, pp. 1714-1r; renry, Cn-:^{1}71, p. 10.

Aramid hybrids

lu Pont's aramid hyhirds with steel, nylon, and polyester have reached the marketplace. (1:enry, Ca: 3^l, pp. 13-14)•

Soft helmets and ˉantiballistic vests

r^7. In lor7, Pu ront male its first significant volume sales of **:evlar for** vests and :Ielmets **for** the r.S. Mmy. Pu Pont sold million pounds of 7:evlar for military apparel in rn!, **million pounds in 1!`!7f!,** and expects to sell a total of million pounds in 1^7` through According to !:r. Eenry, development of this market took ten years. (Henry, CX-16, p. 2^).

Concrete reinforcenert

,

^r.4. noel ^{7}**U Pont** *zn(!* ,IL.zo **are conducting** nn **for** aramid use in **concrete reinforcement. (i:upjc** 7::-10, pp. 52-31;; 1:enry, C—Sq, p. 17).

'!indow profil2s

"Pe .▮,ramil produced by Pu Pont is now used in uindov frames.

(Eepr7, **p.** 1:Upje,

p·

:larket stimulation unrou: a price '!ecline

P96. The demand elasticity is a single nunler used to summarize the sensitivity of the quantity deranded at a particular price to a snnll chanZe in that price. All other factors in the market are assumed .to he held constant. The demand elasticity is calculated as the percentage channe in quantity lividee by the percentane charge in price, for small percentarx change3 in price. (7,N-671, p. 1C; Eausnan, Tr. p. 2('15).

7cononic experts for both complainants and respondents *use* elasticity estimates in their calculations of the effect on the ru Pont of the entry of Ahzointo the •.s. aranid narl:et. (Kausnan, cx-13n, p. 35; ::acAvoy, 727.-14, p. 12).

Some 7u Pont executives and internal Du ront documents itv!icate the belief that a reduction in aranid prices in the United States iotld law! to increases to the volume of *sales.* (C::-144, p. MOC14; RX-766, p. 2^N^r."; p. 2"7777;'CN-l'l, pp. 21eln?4^-211r342; Nenry, Tr. pP• 17'-7-17-4; p. p. 7aynter, p. 144).

Professor :Ausman, the economic expert for complainant, testifie•! that at a certain !•sh elasticity level, ru Pont would benefit fl̄o• a price .!ecline. At elasticity values ranginc up to 2.', EdUSMan't S cnlculaticas f:::(r!ee Clat 7u Pont would be injured by the entry of Akzo. (::Pusnan, Tr., pp. 207 17 -2^7r-, P

!NCT. Professor Nausman testified that for *a* short run elasticity (1 or 2 years in the future), nr' elasticity of 2.5 is vastly ahcve anything :e has ever seen in the econometrics or economic literature (Eausmaa,.Tr.,

^^1. Penn ThcAvoy, the economic expert witness for respondents, estimated the price elasticity for aranid to rare *between* and 15, meaning that if the price of ararid fell by aranid sales volume would increase ':y fro- to 1_..,. (¯ncAvoy, p. 17).

Penn nac.\voy asserts Hat the elasticity estimates of 5•to 15 are extraordinarily high. (TT,-14, p. 12; ::acAvoy, Tr., p. 27!").

Ar!2. Dean nacAvoy's elasticity estimates constitute the long—tern response (the response over a 2 or 2 year period of sales to changes in price; in the introductory period, the elasticity would he lower. •(::acAvoy, Tr., pp. 2721-2 2, 2..1 r)).

^f" The elasticity is lower in the short run, accordin3 to Pean :!acAvoy, 1-ecnuse it takes tine to adjust the equipment, sign contracts, establish lines of delivery, and experiment with the fiber to masse sure it has the required consistent quality. (::acAvoy, Tr., p. 2721)

non. !!roehmeyer testified that the result of a price decrease would ..7:c to initially lower profits, and the benefits of increased quantities

iron the lower price would occur at a later stage. Pr. Broekneyer could not say Alen the increased benefits would occur. (Droe:meyer, Tr., p. 717").

Are. conometrics I7s a subject in economics which applies statistical techniques to ceononic data to estimate or derive certain under1yin7 econonic parameters, such as demand elasticity." C.lausmar, Tr., p. 2Tr).

.T7. Pr. Jerry nausran is a Professor of 7cononics at the :•assachusetts Intstitute of TecFnology, specializing in econometrics and applies' microeconoics. ::ausnar, has been an associate editor of *rconoaetrica* and the ramr! *Journal* of r.concnics, and was the recipient of the Trisch nelal in 14'22 for the hest applied papr pulllished in *Ecenonetrica* over the previous five years. (=-1rn, p. 1).

econorletrically-estinated elasticities of both Pears nacAvoy and Professor Lansman relied on ten or eleven observations,. generally over the period 1"74-ln3.,(ausnan, p. 7; C::¯n⁷29 pp- '"7rOrrr-17rPr04; !:acAvoy, Tr. pp. r71-7.r77).

90'2. The econometric elasticity estirates made by the expert economic witnesses relied on "small sample size " (Lausnan, p. ⁷) or on a "poor amount of data available." (nacAvoy, 'r., p. 27r1).

-ir. Professor :ausman testified that ten data points were too few, and mould result in unreliable elasticity estimates. (::ausnan, Tr., p. 7r4r)

rli. :lean ::acAvoy testified that Professor Lausman's injury calculations relied on innaccurate elasticity estinates. (nacAvoy, Tr., pp. 41,.2'111-297.2).

"17. Nan %acAvoy cites Consumer ^emand in the United States: Analyses nni Projects., ry :.C. :louthaner and Lester D. Taylor, as support for the aethod used to estimate 'pis elasticities, specifically with respect to using only last year's price lot bis estimation. (nacAvoy, Tr., p.

M''. 7rofessor ::ausnan states that none of the Cl demand equations used :butha::ler and 'Taylor use only the price from last year, and that the hoc": describes tbe use of t1'. current price of tIle product as "the standard approac:: to denan'1 analysis." ..':ices !rom a prior period are assigned ti'e status of an "additional rredictor." (=-571, pp. 11-12)

'14. roth compininant and respondents believe that elasticities differ by end-nse raarl:et. (:!acAvoy, p. 't; C::-¹27; flacAvoy, Tr., p..26"!'; Cardinal, P. !"r⁷)-

^15. rean ::1c:vo:, estimated only an industry-wile elasticity, and did not'estinate elasticities for individual ens'-usc marlets. (CN-13, p. ?6; !!ncAvoy, Tr., pp. 27^1-7.7^¹).

^1(:. Penn :!acAvoy pointed tc internal ^u Port documents for adeitionnl support for his oun elasticity estimates of from 5 to 15. These documents are contained in r-X-r,(1', (nacAvoy, p. 12).

017. Cxhibits nX-107, n::-r67, and '::-:1072 include sales representatives' reports, !7hich contain the representatives.' assessments of the effect of a 25 percent 7evlar price decrease on 7evlar sales volume. `although the sales representatives' often gave no forecast, some price senstitivity forecasts were given. 77or tlYa aircraft, friction materials, ballistics, protective clothing, ropes and cahles, and water craft markets, a 25 percent price'decline 'ias forecasted to increase the volume of aramid sales by from 10 percent to 7n percent, sugesting an elasticity ranging from n.4 to 1.1. These reports are generally from the 1 21-12 period. M-2067, pp. 41nn';?e, 41nrf'2r, 4100r;47, 41 0f652, 41•0663; R::-3P(Y pp. AlPrS1P, 410011L, 41.0 051(;,n::-1072, pp. 41 007^3, 1.100311, 41007'14, 4100323, 411('125; 41D827, •,1P' 32 Z1PW".7, 41 1P144, A1 003",e, 410°.24n, 4101350, 410P37L, 4100356, 1'1c1751,, 47.^r16(7, 111007(4, 4100150).

11r. The other cited exhihits (nx-nrr, rz-31-71, and C:-144), generally included qualitative assessments of the sensitivity of quantity to price, from tIlich no clear quantitative price sensitivity estimate could be made. (see, for example, a-164, p. P(`nn11, p. 210,2 n^3).

11r. r, 1^74 TNecutive Committee Authorization for the expansion of Pu Pont's narl'et development facility at Spruance states that "radinl crud: tire carcass . . . . shipments can reach :7::' [million! pounds et 2er pound or !I.!: pounds at per pound, and. . . ..radial passenger telt . . . . shipments of :r.! pounds soul! T-e Y•tainc1 at per pound, cr pound at per pound." p. (""C:17).

7ron the data in the previous findin::, Professor Fnusman calculated elasticties of 3 for truck tires and 17 for passenger tires. Eausman stated that these elasticities were not to be relied upon, because Du Pont's assessment of the tire market in 177r, uas overly optimif:tic, and that an elasticity estimate based on eight-year old information could not Le depended upon bedause certain conditions in the narlet (such as the price of steel cords) had changed. (:!ausman, Tr., pp. 3675-^{1}67".

"21. Professor 1:ausnln calculated "implicit elasticities" of demand for each 7.evlar end use Implicit price elasticities are defined by Hausman as the relationship used by Pu Pont to forecast the cranes in demand for nel.lar in its various end-uses ::hen prices of 7.evlar are changed, while at the sane tine maw/ other conditions are changing. (CX-1"n, p. CX-471, p. 17; c:-.327).

Professor nausman's implicit elasticity estimates ranged from "." to 1.2 for different end use mae.:ets. (CN-227).

^23. "sin; the sa..:e e.sta series as did roan !!acAvoy, Professor 1.nusnan econometrically estimated the ararid price elasticity, after correcting for errors he claimed existed in rean :!acAvoy's estimation nethol. Professor :ausnan's estimates ran3ed from ".72 to 1.4, with n.72 prolAbly beinp, *the* best estimate, accordir3 to Professor 3:ausman. (CX-r71, p. f); lr7-1(^{1}"; Fausnan, p. 2rn5).

"7..A. The errors in 7ean lacAvoy's econonetric analysis cited by Professor nusman include:

(I) Dean ::acAvoy assumed that the effects of nu and marketing
1nSt for only one year. (c:$^{-671}$, p. ")
(2) Pean ausumel that only the price last year affects th
denanc' for revlar this year. (C-^{1}71, p. ::aus-an, Tr., pp.
213"-711')
(2; •ean !lac'Avoy's use of the two stage least squares estimation
teemilue uas improper then only tan observations were available:
p. 11)

VS . Professor 1:ausran continued to doubt the reliability of elasticity estimates based on ten data points, but he felt that the results frog his econometric analysis confirmed his earlier judgement about the appropriate range of elasticities upon which his actual injury calculations were based. (I:ausman, CN-1,71, pp. 1-f', 1".-1").

f!sing a range of elasticities from 0.7 to ,.^, irofessor Eaunman calculated "conservative" injury estimates to nu Pont over the years 1'7"6 to ast(, resulting fron Akzo's entry into the market. The average annual injury to Pu Pont for the different elasticities used is:

r.1asticities	Average Annual Injury (in millions of 1!'3 dollars)
1.^	?1.5
1.4	15.7
1.5	14.2
	7.n

(C:472, p. "7"r'r^7)

^27. Professor **Eausmaa testified that** he used a range of elasticities to measure injury 1.-.ecause **he** was aware that the demand elasticities usel by Du tont could be considered to be low. rausman believed the actual market elasticity would fall within this range of elasticities (Hausman, Tr., pp. 1n42-:'.043).

7% Professor Ilausraan **believes that the injury estimate using** an elasticity of **'.7** is the **best** injury estimate. (C7-''71, p. 3).

¶2'. Professor Pausnan relied on price decreases of P.1 percent in r".r.' and !'.C. percent in 1^^f in his injury calculations. These price decrease are _based **on** comparing ¯forecast" prices for the **A%zo** out of market case (C:-?17, p. n^n54) viol "probable" prices for the Aizo in market cane P. 41^1''^/).

"probaLle" price forecasts are co=pared for the years 1[1]r" and r"", the resulting price declines are 5.3 percent in 19!1 and L.1 .percent in lrnO. (CX-217, p. irCOP54; Tx-4(07, p. 4ir1rr4).

^31. Injury calculations for the sane nine of elasticities used by Professor Eausnan then price declines of 5.3 percent in 1rnr) and 4.1 percent in l',"P are used are:

<u>71rsticities</u>	<u>Average</u> Annual <u>Injury</u> (in pillions of 1r71 dollars)
0.7	22.2
1.0	18.9
1.4	14.7
1.5	13.8
2.0	8.5

(a-217, rX-Tri7, =-r177)

7rofessor Ilausnan's injury calculations rely on the following assumptions and method:

(a) 7u ?ont's initial level of shipments in the United States without Plize is based on Pu Pont focus-case, ITC protection forecasts. p. rnCr:115[1]).

h) 1:ausnan's calculation of the nargin of revenue per potill Thefore entry of Al:zo is based on subtracting ru Pont 3eneratel unit variable costs from the initial unit selling prices. (C-7.r1; c:-nl7).

(c) The "ru roa incremental profit with nc Akzo entry" is calculated by 'iultiplying ru Font's sbipnents in (a) by Du Font's margin of revenue per pound in (1). (CX-671, pp. ^7rrn^^-7Cr13).

(c) riusman's calculation of the decrease in price due to Akno competition is base:; on Pu 'cnt's Focus *case* forecasts of the price before A%7:o entry with the price after Akzo entry. E•usmar considers this corroarison to yield a more conservative estinate cf pricE teclines than uould price forecasts containe(' in the 7:ase *case* forecasts. (a-717; C:-21^, !'aushan, 7r., pp. 1"67-1"60).

(d) •nsed on the forecasted decrease in price and the chosen elasticity, Nausman calculates the market e epansion reeulting ror the price decrease. for example,,in 13(the estimated price lecrense of 7.[1] percent combined with 3n assumed elasticity of r.7 results in a market expansion of 5.1 percent, './high is applied to the initial shipment figures in (a) to arrive at the expanded market size. (C:er'7l, pp. g7orrm-!•7r0(11).

(e) Akzo forecasted shipments for l'!'r-l^[1]7 are based cn Akzo's Nov̤ember •14 Tri forecast (r_X-11(;, p. 7.7(..), and for 1^ "-1 ^^ are based on assuming that Akzo maintains its l^r7 marl:et share in l^^^-1C. (CN-472, p. T7nn[1]).

(f) nu Pont's shipments after ;kzo's entry are calculated 11 subtracting Ahzo's forecasted shipment level in (e) fron the market forecact'in (d). (=-671, pp. f.T00'.1-170e01[1]).

(g) Nausman's calculation of Du Pont's margin of revenue per pound after the entry of Akzo is based on subtracting the unit variable cost fron the lower unit price resulting from Akzo's entry. *(C:er7l,* pp. •^7rrnfr-•7("[1](113).

(h) The "Du 7ont incremental profit with Ahzo entry" is calculated by multiplying nu Pont's shipments's in (f) by Du Dont's margin of revenue per pound in (g). (=-67l, pp. (7N"Prel—f771r11^).

(i) The injury to ru Tont resulting from the entry of Akzo into the U.C. marhet is calculated by subtracting the incremental profit with Ahzo entry (h) from the incremental profit without Ahzo entry (c). (CX-''7l, pp. r27'7'C0r17-17DP012).

(j) nersman'n inju,. estimates generally rely on the use of constant (1".3 prose) rather than current prices (CX-1.1(', pp. 33, [1]7, 4r7•; pp. ^7n"=-^7CnC24).

'723. The "eluilibrium principle" is an econonic theory otherwise known by economists as "the law of one price." (::ausman, CX-60(1, p. 1; ::acAvoy, C'; 654, pp. 20-21; Tr., p. 2664).

934. The "equilibriur principle" holds that for sone products that are sold worldwide, changes in supply and denand conditions are "transmitted frori one part of the world to another, and prices will adjust until an equilibrium in established." (R•-13, pp. 13-11).

'ean rac,'.voy bilieves that there will be no nexus tetween imports into the U.S. by Atzo and injury to Pu Pont because tu Pont wou14. be injured even if Atzo's ,arhet entry was confined to rurope. (racAvoy, 1!::-13, pp. 2-4).

necn 7:acAvoy'relieves that whether Akzo exports fibers directly to the rrited 7,tates or whether Pu Pont reallocates its own quantities supplied to the United 17tates in responne to Atzo competition in airope, the impact on price will the same. (racAvoy, T: 13, p. 22).

Sone "u Pcnt eNfecctives believe that if ALzo sold only in 7urone, the U.S. aranid nae et wuld be affected by Atzn's 7uropean actions, specifically with respect to the eff.ict of lower prices in :urope on C.S. prices. 1,1:echert, pp. 114-11% 12% Cardinal, nx-500, pp. 143-14^; Tdkv)rian, pp. 77-r).

nin Henry believes that although Akzo's entry into Europe alone will cause some price erosion in the United States, the degree of price erosion would be greater if Akzo were to compete directly in the U.S. aramid market. This belief is based on the existence of different competitive conditions between Europe and the United States if Akzo competes in one market but not in the other. (I:enry, pp. 2-4).

Professor ::ausman believes that "a firm will charge different prices in two markets so long as arbitrage cannot take place and the demand conditions in the two markets are not substantially similar. **If** Pu Pont receives ITC protection, two different markets will exist in the :EC and the U.S." (rsesman, p. 2f!).

^!•'1. Professor Kausman provided examples of products that sold at different prices in the United States, Japan, and Europe as a result of trade barriers in the United States. Prices were reported for five metal and steel products for sales in _up to six different countries. In 1N32, prices in the foreign countries' were an average Of .1!1 percent lower than in the United States. (Kausan, C.::7.4ne•, PP. 6¯r)-

^42. Professor linesman provided examples of products that sold at different prices in different geographic markets. In the first quarter of PT?,, carbon and alloy steel prices in the 77.0 and the world were 77 percent and 4' percent lower, respectively, than in the United States. (1:ausnan, a-67l, pp. 22-7_3).

CV. Penn ::acAvoy believes that "where a product is supplied by a single supplier from a single plant, and where the cost of transporting the product is not excessive, it is not possible to have separate geographic • markets unless there are impenetrable trade barriers." (nacAvoy, n:;-l3, P. 17).

147. Pean nacfmoy testified that ru Pont could maintain a price differential between the United States and European markets over a .period of years, but that the equilihriating principle will go to work over a length of time to bring the prices together. (nacAvoy, Tr., p. r31).

944. Dean nacAvoy testified that even where the equilibrium principle is at ciork, the equalization can he achieved only over a length of time or during the long run. The "long run" refers to the period 19P6-1/90, according to Pean I:acAvoy. (nacAvoy, Tr., pp. 2331, 2853).

945. 'tr. 3roekneyer testified that Akzo would try to maintain a higher price in the United States than in Europe. (Broekmeyer, .r., P. 116n).

146. Professor ::ausman cited a paper by 7udiger Dornbusch, an international economist, which states that are relatively persistent and often large deviations from [the law of one pricer, and "all available evidence sug3ests that [the law of one price] does not apply in the same f'ishion to manufactured goods."'(emphasis in original, V.acAvoy Exhibit 1, pp. 13-14).

CONCLUSIONS OF LAW

1. Claim 13 of Letters Patent No. 3,,767,756.(the '.756 patent) is not invalid under 35 U.S.C. 5!102, 103 and 112.

2. Claim 13 of the '756 patent is not unenforceable because of any misconduct, violation of the antitrust laws or patent misuse or for any reason based on the record before the administrative law judge.

3. Claim 13 of the '756 patent has been infringed by.each of the respondents.

4. There is a domestic industry in the manufacture of aramid fiber which is efficiently and economically operated.

5. Importation of the aramid fiber made by claim 13 of the '756 patent has not substantially injured the domestic industry.

6. Importation of the aramid fiber made by claim 13 of the '756 patent does have the tendency to substantially injure the domestic industry.

7. There is a violation of Section 337, of the Tariff Act of 1930, as amended, 19 U.S.C. rj 1337 by each of the respondents.

I`:TT/AL nETrwiv:ATIoN txr CPDEF.

Based on the foregoing findings of fact, conclusions of law, the opinion and the record as a whole, and having considered all of the pleadings and arguments presented orally and in briefs, as well as proposed findings of fact and conclusions of law, it is the Administrative Law Judge's DETTLTIINA7I0:7 that there is a violation of Section 337 in the unauthorized importation and sale in the United States of the accused aramid fibers.

The Administrative Law Judge 'hereby CERTIFIES to the Commission the Initial Determination, together with the record of the hearing in this investigation consisting of the following:

1.. The transcript of the hearing, with appropriate corrections as may hereafter be ordered by the Administrative Law Judge; and

The Exhibits at'oel:te.' into evidence in the course of the hearing.

The pleadings of the parties are not certified, since they are already in the Commission's possession in accordance with Commission Rules of Practice, and Procedure.

Further, it is ORDERED that:

1. In accordance with Rule 210.44(b), all material heretofore marked in camera because of business, financial, and marketing data found by the Administrative Law Judge to be cognizable as confidential business information under Rule 201.6(a), is to be given five years in camera treatment from the date this investigation is terminated; and further

2. The Secretary shall serve a copy of the public version of this Initial Determination upon all parties of record and the confidential version upon all counsel of record who are signatories to the protective order issued by the Administrative Law Judge in this investigation; and further

3. This Initial Determination shall become the determination of the Commission forty-five (45) days after the service thereof, unless the Commission, within forty-five (45) days after the date of filing of the Initial Determination shall have ordered review of the Initial Determination or certain issues therein pursuant to 19 C.F.R. 210(b) or 210.55 or by order shall have changed the effective date of the Initial Determination.

Paul J. Luckern

Paul J. Luckern
Administrative Law Judge

Issued: May 9, 1985

OFFICE OF THE SECRETARY

UNITED STATES INTERNATIONAL TRADE COMMISSION

WASHINGTON, D.C. 20436

May 31, 1985

Mr. Charles S. Stark
Antitrust Division
U.S. Department of Justice
Room 7115, Main Justice
Pennsylvania Avenue & Tenth Street, N.W.
Washington, D.C. 20530

Dear Mr. Stark:

Enclosed is a copy of the. nonconfidential version of an initial determination issued recently by a Commission administrative law judge in connection with Certain Aramid Fiber

ITC Inv. No. 337 -TA - 194

The Commission would appreciate receiving any written comments your agency cares to submit regarding this initial determination. Any such comments must be filed with the Secretary, U.S. International Trade Commission within10 days of service of the initial determination. Should you have any questions regarding the initial determination, please contact Ms. Catherine Field
Office of the General Counsel, U.S. International Trade Commission, telephone 523-0189.

Sincerely yours,

Harold Sundstrom
Assistant Secretary
Public and Consumer Affairs Officer

Enclosure

OFFICE OF THE SECRETARY

UNITED STATES INTERNATIONAL TRADE COMMISSION

WASHINGTON, D.C. 20436

May 31, 1985

Darrel J. Grinstead, Esq.
Department of Health &
  Human Services
Room 5362, North Building
330 Independence Avenue, S.W.
Washington, D.C. 20201

Dear Mr. Grinstead:

Enclosed is a copy of th& nonconfidential version of an initial determination issued recently by a Commission administrative law judge in connection with Certain Aramid Fiber.

ITC Inv. No. 337-TA-194

The Commission would appreciate receiving any written comments your agency cares to submit regarding this initial determination. Any such comments must be filed with the Secretary, U.S. International Trade Commission within10 days of service of the initial determination. Should you have any questions regarding the initial determination, please contact Ms. Catherine Field
Office of the General Counsel, U.S. International Trade Commission, telephone 523-0189.

Sincerely yours,

Harold Sundstrom
Assistant Secretary/
Public and Consumer Affairs Officer

Enclosure

OFFICE OF THE SECRETARY

UNITED STATES INTERNATIONAL TRADE COMMISSION

WASHINGTON. D.C. 20436

May 31, 1985

Richard Abbey, Esq.
Chief Counsel
U.S. Customs Service
1301 Constitution Avenue, N.W.
Washington, D.C. 20229

Dear Mr. Abbey:

Enclosed is a copy of the nonconfidential version of an initial determination issued recently by a Commission administrative law judge in connection with Certain Aram-id Fiber

ITC Inv. No. 337-TA- 194

The Commission would appreciate receiving any written comments your agency cares to submit regarding this initial determination. Any such comments must be filed with the Secretary, U.S. International Trade Commission within 10 days of service of the initial determination. Should you have any questions regarding the initial determination, please contact Ms. Catherine Field
Office of the General Counsel, U.S. International Trade Commission, telephone 523- 0189.

Sincerely yourt,

Harold Sandstrom
Assistant Secretary/
Public and Consumer Affairs Officer

Enclosure

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OFFICE OF THE SECRETARY

UNITED STATES INTERNATIONAL TRADE COMMISSION

WASHINGTON. D.C. 10436

May 31, 1985

Edward F. Glynn, Jr., Esq.
Assistant Director for International
Antritrust
Federal Trade Commission
Room 502-4, Logan Building
Washington, D.C. 20580

Dear Mr. Glynn:

Enclosed is a copy of the nonconfidential version of an initial determination issued recently,by a Commission administrative law judge in connection with Certain Aramid Fiber

ITC Inv. No. 337-TA-194

The Commission would appreciate receiving any written comments your agency cares to submit regarding this initial determination. Any such comments must be filed with the Secretary, U.S. International Trade Commission within10 days of service of the initial determination. Should you have any questions regarding the initial determination, please contact NS. Catherine Field
Office of the General Counsel, U.S. International Trade Commission, telephone 523-0189.

Sincerely yours,

Harold Sundstrom
Assistant Secretary
Public and Consumer Affairs Officer

Enclosure