In the Matter of

CERTAIN OPTICAL WAVEGUIDE FIBERS

Investigation No. 337-TA-189

USITC PUBLICATION 1754

SEPTEMBER 1985

United States International Trade Commission / Washington, DC 20436

UNITED STATES INTERNATIONAL TRADE COMMISSION

Address all communications to
Kenneth R. Mason, Secretary to the Commission
United States International Trade Commission
Washington, DC 20436

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

In the Matter of CERTAIN OPTICAL WAVEGUIDE FIBERS	Investigation No. 337-TA-189

COMMISSION ACTION AND ORDER

Introduction

On January 22, 1985, the presiding administrative law judge filed an initial determination (ID) of no violation of section 337 of the Tariff Act of 1930 (19 U.S.C. 1337) in the above-captioned investigation. Petitions for review were timely filed by both complainant Corning Glass Works (Corning) and respondents Sumitomo Electrical Industries, Ltd. and Sumitomo Electric U.S.A., Inc. (collectively Sumitomo). On March 8, 1985, the Commission ordered review of the ID with respect to the issue of tendency to substantially injure. 50 F.R. 11255 (March 20, 1985). By March 22, 1985, the parties filed their respective submissions on that issue and on remedy, the public interest, and bonding. By March 29, 1985, they each filed their respective replies. Several non-party submissions have also been received.

Action

Having considered the record in this investigation, including the submissions received in response to the Commission's notice of review, the

Commission has determined that there is no tendency to substantially injure the relevant domestic industry and hence no violation of section 337. The Commission expects to issue a written opinion in this investigation shortly.

Order

Accordingly, it is hereby ORDERED THAT--

1. Investigation No. 337-TA-189 is terminated.

2. The Secretary shall serve copies of this Commission Action and Order upon each party of record to this investigation and publish notice thereof in the Federal Register.

By order of the Commission.

Kenneth R. Mason
Secretary

Issued: April 19, 1985

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

In the Matter of

CERTAIN OPTICAL WAVEGUIDE FIBERS

Investigation No. 337-TA-189

COMMISSION MEMORANDUM OPINION

Views of Chairwoman Stern, Commissioner Eckes, Commissioner Lodwick and Commissioner Rohr

This investigation, conducted under section 337 of the Tariff Act of 1930, 1/ was instituted on the basis of a complaint filed by Corning Glass Works (Corning). The complaint alleged unfair practices in the importation and sale of certain optical waveguide fibers by Sumitomo Electric Industries, Ltd. and Sumitomo Electric U.S.A., Inc. (Sumitomo), the alleged effect or tendency of which is to destroy or substantially injure an industry, efficiently and economically operated, in the United States. 2/ The unfair practices alleged were (1) direct infringement of claims 1 and 2 of Corning's U.S. Letters Patent 3,659,915 (the '915 patent), covering certain optical waveguide fibers, and (2) unauthorized importation of optical waveguide fibers manufactured abroad using a process claimed in claims 1, 3 and 8 of Corning's U.S. Letters Patent 3,933,454 (the '454 patent), covering a flame hydrolysis method for making optical waveguide fibers.

1/ 19 U.S.C. § 1337.
2/ 49 F.R. 15287 (April 18, 1984).

On January 22, 1985, the administrative law judge (ALJ) filed an initial determination (ID) of no violation of section 337 in the above-captioned investigation. 3/ The ALJ found that Corning's patents were valid and enforceable and that certain Sumitomo products infringed the '915 patent and were manufactured abroad by the method covered by the '454 patent. He also found that there were two domestic industries, one under each of the two patents, and that both of these industries were efficiently and economically operated. However, he found that Sumitomo's imports did not have the effect or tendency to destroy or substantially injure either of those industries. He therefore found no violation of section 337.

Petitions for review were timely filed by both Corning and Sumitomo. On March 8, 1985, the Commission ordered review of the ID but only with respect to the issue of whether the importation or sale of Sumitomo's optical waveguide fiber had the tendency to substantially injure an industry in the United States. 4/ By March 22, 1985, the parties filed their respective submissions on that issue and on remedy, the public interest, and bonding. By March 29, 1985, they each filed their respective replies. Several non-party submissions were also received.

On April 18, 1985, the Commission determined to affirm the ALJ's conclusion of no violation of section 337.

EFFECT OF THE COMMISSION'S DETERMINATION

The effect of the Commission's determination on review of the ID is to affirm the ID in its entirety. Those findings of fact and conclusions of law

3/ The procedural history of this investigation up to the filing of the ID is recounted in the ID itself (ID pages 1-4).

4/ 50 F.R. 11255 (March 20, 1985).

in the ID which were not reviewed have become the Commission's determination by operation of law, specifically, 19 C.F.R. § 210.53(h). The conclusions of law and supporting findings of fact with respect to the issue which was reviewed have specifically been affirmed on review and thus have also become the Commission's determination. Thus, the Commission has found that (1) Corning's '915 and '454 patents are valid and enforceable; (2) certain Sumitomo fibers infringe the '915 patent, and are made abroad by a process covered by the '454 patent; 5/ (3) there are two industries in the United States, one under the '915 patent, the other under the '454 patent; (4) both industries are economically and efficiently operated; and (5) the importation and sale of the Sumitomo fiber does not have the effect or tendency to destroy or substantially injure either of those two industries. 6/ Consequently, the Commission has found no violation of section 337.

DISCUSSION

The Commission's determination on the question of tendency to substantially injure, the only question on review, is discussed below. First, however, certain preliminary matters and motions must be addressed.

1. Preliminary Matters

In response to its notice of review of the ID in this investigation, the Commission has received submissions from the parties on the issue under review relating to whether a violation of section 337 exists (i.e., tendency to

5/ Specifically, as stated by the ALJ in his conclusions of law at ID 296, Sumitomo's M-1 and S-1 fibers infringe claims 1 and 2 of the '915 patent, its S-2 and S-3 fibers infringe claim 1 of the '915 patent and all four fibers are made abroad by the process of claims 1 and 8 of the '454 patent.

6/ This is true whether there are two industries, one under each of the patents, as we have found, or whether there is one industry, defined in terms of both patents.

substantially injure) and on remedy, the public interest, and bonding. In addition, the Commission has received numerous submissions from non-parties. Some of these submissions are the subject of motions to strike and will be discussed further below. However, with respect to all submissions the following discussion is pertinent.

Section 337 investigations, unique among the Commission's proceedings, are required by section 337(c) to be conducted "on the record after notice and opportunity for a hearing in conformity with the provisions of subchapter II of chapter 5 of Title 5 [of the U.S. Code]," i.e., the adjudicative provisions of the Administrative Procedure Act ("APA"). Those provisions require that full administrative due process be accorded all parties, and, indeed, this is precisely what Congress intended when it placed section 337 proceedings under the APA in the Trade Act of 1974. It is essential that the integrity of the administrative process not be compromised. This means, among other things, that in reviewing the correctness of the ID on violation, the Commission is limited to the record certified to the Commission by the ALJ. Some parties have filed review briefs with affidavits and documentary evidence attached which are not of record. Those affidavits and documents may not be and were not considered by the Commission in reviewing the question of violation. Some non-party submissions contain argument and exhibits on the question of violation. Those arguments and exhibits may not be and were not considered by the Commission in reviewing the question of violation. Non-parties are not permitted to submit argument or evidence on violation at any time. Compare, 19 C.F.R. § 210.56(a) with 19 C.F.R. § 210.58(a)(4), and see notice of Commission review in this investigation, 50 F.R. 11255 (March 20, 1985). The foregoing applies to all submissions on review. Some of these submissions are subject to motions to strike, requiring further discussion.

(a) Sumitomo Motion to Strike Siecor Submission

On March 22, 1985, Siecor Corporation, a non-party, filed a 43-page document (with 42 pages of exhibits) in response to the Commission's notice inviting written submissions from non-parties on remedy, the public interest, and bonding. On March 25, respondent Sumitomo filed a motion to strike this submission as being directed toward the issue of violation, rather than remedy, the public interest, and bonding. Siecor, Corning, and the Commission investigative attorney have responded to the motion. Sumitomo has filed a reply to Siecor's response. It is clear from our examination of the Siecor submission that Sumitomo's motion is meritorious. Most of the Siecor submission [pages 6-31, and items 8 and 9 on page 32] is devoted to questions of injury and tendency to injure, i.e., elements of a violation of section 337. As noted above, non-parties are not permitted to comment on the issue of violation during Commission review of an initial determination. Furthermore, to permit non-parties to argue and/or submit evidence on substantive issues after the close of the record would clearly violate the APA and deny administrative due process. We therefore grant Sumitomo's motion to strike the pages indicated in brackets above, including the appended exhibit 1 relating thereto. The other portions of the Siecor submission referred to by Sumitomo [pp. 33-39] may fairly be characterized as relating to the public interest factors enumerated in 19 U.S.C. § 1337(d)-(f). We therefore deny Sumitomo's motion with respect to those portions of the Siecor submission.

However, we note that we have not considered the Siecor submission in arriving at our determination of no violation of section 337.

Sumitomo's motion also alleges a breach of ethics and the protective order and asks an investigation thereof; it also asks for an award of costs and attorney's fees for preparing the motion. We do not believe that a violation of the code of ethics has been made out and there is insufficient information with respect to an alleged breach of the protective order to justify an investigation thereof. As to costs and attorney's fees, the Commission's rules do not currently provide for these. We therefore deny those portions of Sumitomo's motion.

(b) Sumitomo Motion to Strike ITT Submission

On March 22, 1985, ITT Corporation, a non-party, filed a document in response to the Commission's notice inviting written submissions on remedy, the public interest, and bonding. On March 25, respondent Sumitomo filed a motion to strike the ITT submission as being directed toward the issue of violation, rather than remedy, the public interest, and bonding. ITT, Corning, and the Commission investigative attorney have responded to this motion. While an examination of the ITT submission reveals that some statements therein could be characterized as relating to the questions of injury and tendency to injure, these are limited and it is not sufficiently clear that striking them is appropriate. We therefore deny the Sumitomo motion. However, we note that we have not considered the ITT submission in arriving at our determination of no violation of section 337.

(c) Corning "Contingent Motion" for Additional Time

On March 28, 1985, Corning filed a "contingent motion" for additional time to respond to "four third party submissions . . . purportedly on behalf of Sumitomo." The motion was contingent on the Commission granting Sumitomo additional time to respond to the above-mentioned submissions of Siecor and ITT. Sumitomo timely filed responses to those submissions, mooting its request for additional time and thus Corning's motion as well. The Corning motion is dismissed as moot.

(d) Corning's Motion for Oral Argument

On March 29, 1985, Corning filed a motion for oral argument. The Commission has already considered this matter and decided not to hold a hearing, as is clear from the notice of review. The motion is denied. Corning's motion to strike Sumitomo's opposition to Corning's motion for oral argument is denied as moot.

2. Violation; Tendency to Substantially Injure

(a) The ALJ's findings

As found by the ALJ, there are two industries, one under each patent, each composed of Corning and its licensees which are producing under those patents. For the industry defined in terms of the '915 patent, the domestic industry is composed of Corning and its licensees ATT, ITT and SpecTran. ID 99. None of Corning's licensees are parties to this investigation. For the industry defined in terms of the '454 patent, the industry is composed solely of Corning. 7/ ID 99. It should be noted that [

7/ ATT and ITT [

].

] ID 241 (FF 411); ID 242 (FF 421); ID 244 (FF 431).

The only respondent named was Sumitomo, although Corning was apparently aware of the existence of other foreign optical waveguide fiber manufacturers when it filed its complaint.

The ALJ stated that tendency to substantially injure refers to probable future injury from imports. In this case, he found that Sumitomo's imports had been [ ] since Sumitomo began importing in 1980 and that any increase in Sumitomo's currently [ ] market share "will largely be sustained by production of fiber in respondents' new U.S. facility, Sumitomo Electric Research Triangle (SERT) in Raleigh, North Carolina." ID 111. The ALJ found that SERT was approved in [ ] that fiber production machinery was ordered in [ ] that construction commenced in [ ] 1983; and that commercial production of all types of fiber and cable [ ] previously imported by Sumitomo was scheduled for [ ] 1984. ID 111. He found that Sumitomo was committed to invest [ ] in the first stage of SERT [ ] of which has admittedly been spent); that expected production capacity is [ ] and that SERT has a current workforce of at least [ ] ID 112. The ALJ found SERT to be intended as the principal source of fiber and cable for Sumitomo in the U.S. market and that the facility was established [ ] ID 112.

The ALJ rejected the argument that SERT production should be considered injurious. He analyzed section 337, its legislative history, and Commission precedent to conclude that the focus of the "tendency" inquiry is on future importations and sales thereof. ID 115.

The ALJ found that some [ ] but that SERT will [ ] ID 113. He also found that [ ] He found that in any event, Sumitomo [ ] an import level consistent with his findings with respect to Sumitomo capacity and commitments to [ ] markets. ID 113. In the absence of evidence as to Sumitomo's capacity beyond 1985 or controverting Sumitomo's intent to supply the U.S. market from SERT, the ALJ found that future importation would be insubstantial. ID 113. He noted that any further attempt to quantify imports would be speculative. ID 113.

The ALJ found that Sumitomo [ ]

Based on the testimony of Sumitomo's managing director, the ALJ found that Sumitomo's current capacity in Japan was [ ] but was largely [ ] directed to [ ] markets. ID 110-111. The ALJ found that it was reasonable to assume that "at least a significant portion of [Sumitomo's] immediate capacity [ ] will be directed to non-U.S. markets." ID 111. He found the evidence of foreign cost advantage to be "scant and inconclusive."

The ALJ noted that the U.S. market is rapidly expanding and is expected to continue to do so throughout the decade; that Corning estimates that its [ ] that its sales are projected to [ ] from 1984 to 1985 and then [ ] in 1988; and that [ ] ID 114. [ ] the domestic industry had failed to meet the consistently growing demand. ID 104.

(b) <u>Applicable law</u>

As noted, section 337 proceedings are conducted under the adjudicative provisions of the Administrative Procedure Act. Under 5 U.S.C. § 556(d), "the proponent of a rule or order has the burden of proof," except as otherwise provided by statute, an exception which does not apply here. This means that complainant Corning has the burden of proof on all issues on violation including "tendency to substantially injure." 8/ Under 5 U.S.C. § 556(d), Corning must meet that burden by reliable, probative, and substantial evidence of record.

8/ We are aware of the ALJ's statement that because of the complex nature of the market, Corning is subject to a stricter standard of proof. Our review does not indicate that the ALJ actually subjected Corning to a standard of proof higher than that ordinarily applied. Apparently the ALJ was referring to the numerous additional factors which had to be considered in this case because of the complex and rapidly expanding nature of the U.S. market. We also note that on review of the question of tendency to substantially injure, we did not subject Corning to a standard of proof higher than that ordinarily applied.

The leading case interpreting the phrase "effect or tendency . . . to destroy or substantially injure" is the decision of our reviewing court, the U.S. Court of Appeals for the Federal Circuit (CAFC) in Textron, Inc. v. U.S. International Trade Commission, 753 F.2d 1019 (Fed. Cir. 1985). In Textron, the CAFC made it clear that the injury provision of section 337 is to be taken seriously as an independent element of a section 337 violation, even in intellectual-property-based cases. The CAFC specifically rejected the argument that the Commission must find the injury requirement to have been met once it finds infringement. The CAFC stated that such an interpretation "would read the injury requirement entirely out of the statute." Textron, 753 F.2d at 1028. The CAFC explained the basis for its decision as follows, referring to Commission precedent and legislative history:

> Contrary to Textron's assertion, section 337 does not function merely as the international extension of our patent, trademark and copyright laws. See In-the-Ear Hearing Aids, Tariff Commission Pub. No. 182 at 28 (July 1966). Instead, section 337 has consistently been interpreted to contain a distinct injury requirement of independent proof. Id. Congress may well have included this separate requirement in the original 1930 version of section 337 to insure that the extreme and internationally provocative remedy contemplated therein — exclusion of imports from particular countries — would be implemented only when this is compelled by strong economic reasons. See, e.g., S. Rep. No. 93-1298, 93rd Cong., 2d Sess. 199 (1974); reprinted in 1974 U.S. Code Cong. & Ad. News 7186, 7331. Although the contemplated range of remedies was expanded by the Trade Act of 1974 to include "softer" sanctions such as cease-and-desist orders, Congress has never altered the statute's injury requirement. In fact, Congress expressly rejected a Nixon Administration attempt to eliminate the injury requirement in its proposed Trade Reform Act of 1973. See H. Kaye, et al., International Trade Practice § 6.05 n. 1 (1984). [Textron, 753 F.2d at 1028-29.]

The CAFC stated that there was no all-inclusive definition of injury, but noted that it and the Commission had "acknowledged that the quantum of proof of injury is less in the context of patent, trademark, or copyright infringement, however, than in other types of unfair trade practices, because the holder of the former type of rights is entitled to exclude competitors entirely from using the intellectual property covered by those rights," i.e., by exercising his rights under the intellectual property laws. Textron, 753 F.2d at 1029. However, as regards section 337, the CAFC cautioned:

> Even in the context of patent, trademark or copyright infringement, the domestic industry must normally establish that the infringer holds, or threatens to hold, a significant share of the domestic market in the covered articles or has made a significant amount of sales of the articles. [Textron, 753 F.2d at 1029] [Emphasis supplied.]

The distinction drawn by the CAFC in Textron between section 337 and the intellectual property laws is important. The former is a trade statute and protects the actual operations of the relevant domestic industry; the latter protect property rights per se, irrespective of any such injury or, indeed, irrespective of the very existence of a domestic industry. Of course, a patent-based domestic industry which can demonstrate the requisite injury to its operations can take advantage of both section 337 and the intellectual property laws because section 337(a) provides that section 337 is "in addition to any other provisions of law." The converse is not true, however, as Textron points out, i.e., infringement alone is not sufficient to establish a section 337 violation.

As the CAFC noted in Textron, however, the quantum of proof of injury (or tendency) is less in intellectual-property-based section 337 cases because of the right of the intellectual property holder under the intellectual property laws to exclude competitors. Essentially this means that in intellectual-property-based cases it is easier to infer lost sales and attribute them to imports, i.e., to show that the domestic industry would have made the sales but for the alleged infringer. The inference is rebuttable. For example, it is possible to show that the imports are not in fact being purchased as a substitute for the product of the domestic industry or that the patent owner and his licensees are not capable of making the sales. Furthermore, as Textron makes clear, the mere existence or threat of some lost sales is not necessarily sufficient, for what is required is a sufficient number (or threatened number) of lost sales to capture a "significant share" of the market, or a "significant amount" of such sales (or some other significant effect). And finally, the language of section 337 makes it clear that any injury, present or future, must come from imports.

The ALJ's discussion of the applicable law is consistent with and indeed anticipates Textron. 9/ ID 107, 110. And, of course, he was manifestly correct in considering only imported fiber.

9/ The phrase "effect or tendency . . . to destroy or substantially injure" has always been part of section 337 and indeed appeared in its predecessor, section 316 of the Tariff Act of 1922. It has never been amended. The only explanation of the phrase provided in the legislative history of section 316 is contained in the Conference reports:

> The Senate amendment [inserting Section 316] inserts a new section making unlawful unfair methods of competition and unfair acts in the importation of merchandise into the United States, which threaten the stability or existence of American industry [H. REP. No. 1207, 67th Cong., 2d. Sess. 146 (1922)].

The legislative history of section 337 itself, as originally enacted, contains no further articulation of the meaning of tendency to substantially injure. The House report on the Trade Act of 1974, which reenacted section 337, contains the single sentence: "Where unfair methods and acts have resulted in conceivable losses of sales, a tendency to substantially injure such industry has been established (cf., In re Von Clemm, 229 F.2d 441 (CCPA 1955))." H. Rep. No. 571, 93rd Cong., 1st Sess. 78 (1973). The sentence is an apparent attempt to characterize the holding in Von Clemm, rather than a concurrent explanation of the provision relating to tendency to substantially injure. (The provision had been enacted over a half a century earlier and was not amended by the Trade Act of 1974.) The majority opinion in Von Clemm did not explicitly refer to "conceivable losses of sales" but affirmed the

(Footnote continued)

(c) Corning's arguments

In its brief on review (Br.), Corning argues that Sumitomo's imports of infringing optical waveguide fibers have the tendency to substantially injure the domestic industry. Corning discusses what it regards as the pertinent law (Br. 12-16) and then argues that:

(1) Sumitomo intends to dominate the market (Br. 16-17);

(2) Sumitomo aggressively markets its product (Br. 17-19);

(3) Sumitomo is willing to cut prices (Br. 19-21);

(4) Sumitomo must import to meet its projected market share (Br. 21-23);

(5) SERT will lead to increased imports because (a) SERT will overcome present import barriers and (b) the record shows that Sumitomo will continue to import (Br. 23-29);

(6) Sumitomo's self serving declarations cannot support a finding of no tendency (Br. 29-31);

(7) Sumitomo will increase its imports because (a) the U.S. market is important, (b) the U.S. industry is targeted, (c) Sumitomo has excess capacity in Japan, and (d) Sumitomo has lower manufacturing costs in Japan (Br. 31-39);

(8) The domestic industry is vulnerable to imports (Br. 39-43);

(9) Corning and its licensees can supply the U.S. market (Br. 43-48); and

(10) The existence of other sources of fiber is not applicable to tendency. (Br. 48-51).

As to arguments (1) and (2), while the record shows that Sumitomo is attempting to expand its U.S. market presence, the central issue in this investigation is whether such expansion, if it occurs, will come from imports,

---

(Footnote continued)
Commission's determination on tendency to injure which was made on the basis of ever increasing imports which undersold complainant's articles. Beyond this, an important piece of legislative history in the Trade Act of 1974 is the rebuff by Congress of a proposal to eliminate the injury requirement, referred to in Textron.

i.e., in view of the fact that Sumitomo will be producing fiber in the United States, will Sumitomo also import fiber into the United States in such quantities that its imported fiber will have an injurious effect on the domestic industry.

As to argument (3), the ALJ did not discuss or rely on pricing in finding the absence of a tendency to substantially injure. The ALJ did discuss pricing in finding no present substantial injury, but found that while Sumitomo's pricing may have affected the pricing of the domestic industry in isolated instances, the overall downward pricing trend in the U.S. optical fiber market is due to other, more significant factors, such as active market-wide price competition and reduced manufacturing costs. ID 107-109. The record supports these findings. 10/ Corning presents no argument that these more significant factors will not continue to operate as they have in the past. More importantly, whatever pricing policy Sumitomo may adopt, the question remains whether the fiber sold will be from SERT production or from imports and, if the latter, whether imports will be so significant (as they have not been in the past) that they will be able to adversely affect the pricing policy of the domestic industry. This is something which has not been sufficiently established by "reliable, probative and substantial evidence" on the present record. 11/

10/ The ALJ noted that [ ] had stated that Sumitomo had had no effect on their pricing. ID 108. Furthermore there are several known instances where Sumitomo has been underbid. ID 108.

11/ In a footnote on page 20 of its main brief on violation, Corning states a figure which it asserts reflects potential revenue losses from price reductions. This assumes what has not been established, i.e., that future Sumitomo imports will be so significant and so priced as to force such reductions.

As to argument (4), this is ultimately premised on the implicit assumptions that Sumitomo will meet its U.S. market share projections [ ] and that SERT will not increase capacity to meet U.S. demand (but that Sumitomo will increase capacity in Japan), thus compelling increasing reliance on imports. However, there was testimony that [

] RX164 (CX 103).

Corning argues that since the record was closed, [

] Sumitomo argues that [

] These arguments, based on extra-record submissions, cannot be considered.

As to argument (5), the record shows that SERT is intended to produce optical waveguide fiber for the U.S. market. There is, of course, little doubt that Sumitomo will import <u>some</u> fiber, but the record does not justify a finding that the establishment of SERT will cause Sumitomo's imports to increase beyond the present level. 13/ Corning's arguments to the contrary are speculative and not supported by the record. [

12/ In computing the amount of fiber Sumitomo would have to sell to meet its projected market share, Corning uses a market share projection based on estimates by Sumitomo in terms of dollars and multiplies that projection by a demand figure [ ]

13/ Indeed, the percentage of Sumitomo's total sales attributable to imports should fall.

] In-country manufacture is a well-known expedient for accomplishing this. 14/ 15/

As to argument (6) it is clear that the ALJ did rely on Sumitomo testimony that SERT will serve as the principal source of fiber and cable in the United States. However, he did not rely on that testimony alone, but also on undisputed testimony that SERT actually exists as a physical facility and that it will in fact produce fiber for the U.S. market. The testimony is also consistent with evidence that [

] Thus, the ALJ did not rely on mere self-serving declarations. 16/ Corning argues that the record shows that it was this investigation which prompted Sumitomo's announcement that it would begin full scale fiber manufacture at SERT. However, at best, the testimony referred to indicates that the present investigation [

] and it is undisputed that SERT was authorized in [

] that production equipment was ordered in [ ] and that

14/ Corning makes a reference to a Department of Commerce report purportedly showing increased imports of fiber from Japan in January, 1985. Not only is this report extra-record, it apparently does not refer to imports of specific companies and it should be noted that [
] ID 259-260 (FF 510-517).

15/ Corning's reference to the [ ] supply "agreement" does not change this conclusion. [

]
Corning's argument as to future agreements between [ ] are speculative.

16/ We note that the resolution of many issues raised in this investigation, including the issue on review, depends in substantial part on the credibility of the various witnesses. The ALJ, having heard and seen the witnesses testify, is generally in the best position to judge the credibility of those witnesses.

construction began by [ ] dates all well in advance of this investigation. Corning questions the intent of Sumitomo [ ] a proposition which is contradicted by Sumitomo. As noted above, these arguments are based on extra-record submissions by both parties and cannot be considered.

As to argument (7), there is no doubt that the United States market is important and the ALJ did not find otherwise, but this begs the central question in this case, as noted above, i.e., whether, in view of the fact that Sumitomo will be producing fiber in the United States, will Sumitomo also import fiber into the United States in such quantities that its imported fiber will have an injurious effect on the domestic industry. With respect to alleged "targeting", Corning failed to show that any targeting, if it exists, will result in significantly increased imports from Sumitomo. 17/ 18/ As to Corning's argument alleging an excess of Japanese capacity over Japanese demand, this rests in large part on extra-record submissions, none of which can be considered. The remaining evidence is not sufficiently probative to establish the extensive excess Corning alleges. Furthermore, Corning overlooks [ ] In any event, only Sumitomo, among Japanese producers, is a respondent in this investigation. With respect to Corning's arguments on Sumitomo capacity, they are too speculative to rely on. The ALJ relied on testimony of Sumitomo employees to determine Sumitomo capacity. These individuals are, of course, in the best

---

17/ Furthermore, Corning relies in part on the Commission's recent report on industrial targeting in Japan, which is not of record.

18/ Corning refers to [ ] However, there is testimony that [ ] TR 2543-2544.

position to know what Sumitomo's capacity in Japan is. 19/ As to foreign cost advantage, Corning relies on a general statement in a nearly three-year-old newspaper article (CX-134) by Sumitomo's president to the effect that optical fiber production costs in the United States will be much higher than in Japan, a statement Corning says is corroborated by the testimony of its expert witness to the effect that the cost of capital and labor is higher in the United States than in Japan. Corning argues that the add-on to Sumitomo's imports for duty, shipping, and freight is unreliable and not a barrier to market entry. Assuming that any weight should be given to the statement in the newspaper article, the question is whether the add-on to imports exceeds any differential in U.S. manufacturing costs. Corning refers to no evidence on this point. The ALJ was correct in finding the evidence on foreign cost advantage to be scant and inconclusive.

As to argument (8), the record does not support a finding that the industry will be vulnerable to substantial injury from imports in the future. The record clearly shows that Sumitomo's imports have had no substantial adverse effect on the domestic industry and Corning has not demonstrated that this will not continue to be the case. Corning argues that any lost sale will be significant. As the CAFC held in Textron, this is not necessarily the case. In any event, the question is whether any future sales by Sumitomo could be considered to be lost sales (or otherwise significant) in view of the serious questions about the ability of the domestic industry to meet demand

---

19/ The ALJ found that Sumitomo's Japanese capacity [ ] markets, as he found it had been in the past. Corning argues that the ALJ should not have admitted evidence of Sumitomo's [ ] because Sumitomo allegedly did not provide discovery about [ ] However, it does not appear that Corning ever applied for discovery sanctions for the alleged failure of Sumitomo to provide such discovery.

and whether any such sales will be of imports or from SERT. Only imports or sales of imports, not sales of domestically produced fiber, can be taken into account in finding a tendency to substantially injure.

As to argument (9), the starting point here must be the record evidence which shows that the domestic industry has been unable to meet demand. While Corning argues that [ ] there are indications in the record that the industry may not be able to meet future demand. For example, Corning's [ ] estimates of demand from 1984 to 1988 indicate that demand will [ ] 20/ Furthermore, Corning's [ ] Corning has submitted an affidavit with its brief on review revising its 1986 and 1987 capacity [ ] but this affidavit is not part of the record and may not be considered.

As to argument (10), the finding referred to by Corning was not used by the ALJ to find no tendency to substantially injure, but to find no present substantial injury, a question which is not on review. The question of competition from other suppliers such as licensed importers is pertinent to tendency, however. [ ]

20/ RX 414, P400 005; RX 469, Martin Statement, Table 2; RX 164 (CX 103) P274323.

In conclusion, Corning is essentially asking the Commission to find (1) that Sumitomo will significantly increase its import sales despite Sumitomo's import performance since 1980 and despite Sumitomo's construction of a U.S. facility where it intends to produce fiber for the U.S. market; and (2) that the domestic industry, though presently unable to meet demand in a rapidly expanding market, will nevertheless be able to do so in the future. The record does not justify a finding that these are both likely to occur. A finding to the contrary would be speculative. Textron permits a lower quantum of proof for showing substantial injury or tendency to substantially injure in intellectual-property-based section 337 cases; it does not, however, permit speculation. 21/

Our determination of no violation of section 337 is not a license to import infringing fiber. The Commission has found Corning's patents valid and infringed. The Commission does not condone patent infringement, but section 337 has elements in addition to the establishment of the existence of unfair practices such as patent infringement which must be satisfied before relief can be granted. It is with respect to those other elements that Corning has failed to make its case. The matter of patent infringement per se is one solely for District Courts of the United States. 22/

21/ Speculation is, of course, forbidden by the APA in any event. It should be kept in mind that not all Sumitomo fiber is infringing. Further, the '915 patent covering optical waveguide fiber per se expires in four years (1989). Any injury to the '915 industry must occur by the time of expiration. The '454 patent expires in 1993.

22/ The Commission is aware of the fact that the practice of the '454 process abroad does not constitute patent infringement under 35 U.S.C. § 271 and thus could not be redressed in a United States District Court. However, in this case all the involved fiber found to be made abroad by the '454 process has also been found to be covered by the '915 product patent. The unauthorized sale of fiber covered by the '915 patent in the United States does constitute patent infringement under 35 U.S.C. § 271 and can be redressed in a United States District Court.

Views of Vice Chairman Liebeler

The issue in this case is whether importation by respondent Sumitomo of optical waveguide fibers found to infringe valid patents owned by complainant Corning tends to cause substantial injury to the domestic industry that exploits those patents. The ALJ found that such importation lacked such a tendency. The Commission granted review and affirmed the ALJ. I dissent, believing that the majority is incorrect both in interpreting the law and in applying it to the facts.

Patents are, and should be, among the most secure forms of intellectual property; provision for their protection is embodied in our Constitution.[1] Importation of a product which infringes a valid patent will always affect the patent holder adversely. In depriving the patent owner of royalties it reduces the value of the patent and the incentive to invest in developing and producing new products. More importantly, however, failing to prevent such importation reduces the incentive of others to

----

1. U.S. Const. Art. I, Sect. 8 provides, "The Congress shall have power...to promote the progress of science and the useful arts, by securing for limited times to authors and inventors, their exclusive right to their respective writings and discoveries."

innovate, develop, and produce new products.[2] The Commission should, therefore, employ its most lenient injury test in Section 337 patent cases.[3]

There is no reason why the Commission's standards in Section 337 cases should differ significantly from those used by district courts in intellectual property cases. In that forum there is strict liability for patent infringement; infringement alone justifies an injunction. The economic rationale for providing protection of intellectual property rights is not dependent on whether infringement of those rights is of foreign or domestic origin. The construction of elaborate and strict injury tests is neither contemplated by the statute,[4] nor does it serve any public purpose.

Infringements of intellectual property rights present

----

2. "'The pirating of these [products]...can only have an adverse effect on competition in the development and manufacture of [products].... There will be little incentive for...manufacturers to devote the months or years necessary to develop a new [product] it the result of their ingenuity and workmanship can be stolen so easily and the resultant product can be instantaneously undersold by the pirated copies.'" Bally/Midway Mfg. Co. v. USITC, 714 F.2d 1117, 1124 (Fed. Cir. 1983) (quoting approvingly from the ALJ's initial determination).

3. "Both this court and the ITC have acknowledged 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, because the holder of the former type of rights is entitled to exclude competitors entirely from using the intellectual property covered by those rights." Textron Inc. v. USITC, 753 F.2d 1019, 1029 (Fed. Cir. 1985).

4. <u>See</u> text accompanying note 19 <u>infra</u>.

severe, at times intractable, problems for their owners. The rights are often difficult to define and defend. When a domestic party violates a patent, the owner can often obtain relief in a federal district court. A domestic infringer is subject to personal jurisdiction in a district court and can be enjoined from further illegal activity.

It is harder to protect intellectual property rights when the infringing product is an import. Jurisdiction over the foreign producer in the district court is difficult to obtain,[5] and enjoining the current importer will often be ineffective when there are a variety of importers available.[6] In addition, no relief is available in federal district court for violations of process patents by imports.[7]

The Commission has a comparative advantage over the district courts in deciding intellectual property cases involving imports because it does not need personal jurisdiction; the presence of

----

5. The case sub judice is unusual in that regard in that Sumitomo has built a substantial facility in the United States.

6. Neither Res Judicata nor Collateral Estoppel will apply to an importer who was not a party to an action. Hence unless the owner of the intellectual property right can join all potential importers of the infringing import, he will have to litigate separate actions against each infringer.

7. The importation, sale or use within the U.S. of a product made in another country by a process patented in the U.S. is not an infringement of the process patent. 35 U.S.C. 271 (1982). An amendment to the statute which would have made it an infringement was rejected by the Senate in the last session. See 28 Patent Trademark & Copyright Journal 716 (BNA 10/18/84).

imports is sufficient to obtain a hearing before the Commission. The Commission may also exclude the offending product, a far more certain and effective remedy than an injunction against a particular person. Moreover, the Commission decides cases more rapidly than any district court.[8] This is particularly important when money damages will not be an effective remedy. In the case of infringing imports this is likely to be the case; damages are speculative, and the party over whom jurisdiction can be obtained will often be judgment proof. The Commission's power to issue quickly an exclusion order is the primary reason why complainants choose this forum. I see no reason, either in logic or law, why we should place an unnecessary burden in the form of an unduly rigorous injury test in their path. By applying a stricter injury test, the Commission majority allows foreign manufacturers and importers to engage in behavior proscribed to domestic parties There is no policy reason for this anomaly.

The actual application of the Section 337 injury and tendency to injure standards in patent cases has been similar to the standards used by district courts. For example, in Bally/Midway the CAFC quoted from the legislative history: "'[w]here unfair methods and acts have resulted in conceivable losses of sales, a tendency to substantially injure such industry

----

8. The Commission must conclude Section 337 cases within twelve months from the publication of notice of investigation in the Federal Register, or in more complicated cases, within eighteen months. 19 U.S.C. 1337(b)(1) (1982).

has been established.'"[9]

Moreover, the Commission has stated that when a patent has been infringed, "any evidence of lost sales...or acts that would lead to lost sales,...is probative of whether the infringing imports have an effect or tendency to substantially injure."[10] Complainant is required to demonstrate only that respondents' infringing importation or sales are likely to result in injury to the domestic industry.[11] Corning has met that burden.

The mistaken view that Congress intended the Commission to apply an injury test in Section 337 determinations as strict as the one employed in anti-dumping and countervailing duty investigations may originate in the fact that both provisions are part of the Tariff Act of 1930. That view ignores, however, the nature of the acts which Section 337 is intended to address. Those acts are wrongs and are universally recognized as such. They would be actionable under domestic tort, contract, trademark, copyright, patent, or antitrust law. This is in sharp

----

9. 714 F.2d at +1124 (quoting Trade Reform Act of 1973, H.R. Rep. No. 571, 93rd Cong. 1st Sess. 78 (1973) (emphasis added).

10. Certain Trolley Wheel Assemblies, Inv. No. 337-TA-161, USITC Pub. 1605 at 11 (1984). In Trolley Wheels, the Commission found patent infringement, and in spite of trifling imports, found a tendency to injure and issued a general exclusion order.

11. Certain Cube Puzzles, Inv. No. 337-TA-112, USITC Pub. 1334 at 33 (1983). In Cube Puzzles, the Commission found infringement of a registered trademark, false representation, and passing off of look-alike Rubic's Cubes, and issued a general exclusion order barring the importation of all infringing cubes.

contrast to the acts covered by the anti-dumping and countervailing duty provisions of Title VII. Dumping and subsidization are not wrongs in the same sense.[12] Unlike infringements of intellectual property rights which are unlawful[13] and in some cases may be crimes under other federal statutes,[14] dumping and subsidization are neither criminal offenses nor are they unlawful. Rather, they are acts against which the United States levies countervailing and antidumping duties[15] for the benefit of those who have suffered adversely from subsidized and dumped imports.

It is not likely that Congress gave the Commission jurisdiction over Section 337 actions so it could apply the <u>substantive</u> injury analysis of Title VII cases to intellectual property infringements. Rather, it is the <u>procedural</u> character of Commission determinations that is most important in protecting intellectual property rights from infringement by imports. The

----

12. Many economists have suggested that subsidization by foreign governments and dumping by foreign firms provide net benefits to the nation that imports those products. <u>See, e.g.,</u> Kindleberger, Charles P., <u>International Economics</u> (1978). c. 8.

13. 19 U.S.C. 1337(a) (1982). "Unfair methods of competition and unfair acts in the importation of articles into the United States...are declared unlawful...."

14. <u>See, e.g.,</u> 17 U.S.C. 506 (1982) (declaring willful copyright violations to be a criminal offense and establishing criminal penalties) and 15 U.S.C. 1 & 2 (1982) (The Sherman Act, declaring certain trusts, restraints of trade, and monopolization to be unlawful and subject to criminal penalties).

15. 19 U.S.C. 1671-78 (1982).

Commission is simply a more efficient forum than a district court in such cases.

The majority has also incorrectly interpreted the facts in this case. Sumitomo recently completed construction of a factory in the United States to produce the same sort of fibers that are the subject of Corning's complaint. Thus, it might be argued that the infringing fibers are no longer likely to enter the U.S. market as imports.[******************************] Therefore the completion of Sumitomo's domestic plant does not signal an end to the importation of infringing fibers. The dispute has not been mooted.

Sumitomo's imported and domestically-produced fibers have a synergistic impact on the American market. Sumitomo's marketing of its imported fibers supports the market for its domestic fiber, and vice versa. [****************************] the availability of an assured stream of imports will reassure customers of the reliability of Sumitomo, a new entrant to this market, as a supplier, and thereby make its domestically-produced fibers more attractive to consumers. All of Sumitomo's expected future sales of domestically produced fibers are therefore in part made possible by its infringing imports. Thus, Sumitomo's imports have a tendency to cause substantial injury even under a relatively strict test.

Further, the completion of Sumitomo's U.S. plant, rather than signaling an end to imports, may result in their increase.[********************]Thus the infringing imports will hurt Corning both directly, through increased lost sales to imports, and indirectly, by increasing Sumitomo's sales of its domestic product.

The magnitude of Sumitomo's imports are currently small. We must keep in mind, however, that Section 337 is designed to arrest unfair methods of competition in their incipiency.[16] The optical wave guide fiber industry is in its infancy. Its expected future growth is both great in size and uncertain in form. Unlike mature industries such as autos or steel, the market for optical wave guide fibers may increase ten-fold in a few years, and take a variety of twists and turns in terms of product applications and characteristics. Sumitomo's tiny market share this year may quickly grow large. Sumitomo's access to the domestic market may also provide it with information that will allow it to injure Corning's future exploitation of its patents.

Respondents' assertions to the contrary notwithstanding, the Commission need not limit itself solely to the effect of future

----

16. See Certain Surveying Devices, Inv. No. 337-TA-68, at 33-34 (1980). In an earlier case the respondent's device had been found to infringe a patent and was excluded. The manufacturer redesigned the product and sought advice from the Commission. The redesigned product, although it had not been imported for sale in this country, was found to violate the patent and was excluded from the country.

17. See Certain Trolley Wheel Assemblies, Inv. No. 337-TA-161, USITC Pub. 1605 Initial Determination at 63 (1984) and cases cited therein.

imports or sales.[17] The infringing imports have already caused substantial injury to the domestic industry; they have enabled Sumitomo to learn about the character of the American market. Sumitomo has built a factory in the United States because it believes it can successfully market its product here. It gained valuable experience and information by testing the market through imports. Thus, those imports have already severely damaged Corning.

A finding of injury would accord with both Commission precedent and that of our reviewing court. The CAFC has generally tacitly deferred to the judgment of the Commission on factual determinations of injury. One of the few cases where it reversed the Commission was Bally/Midway Mfg. Co. v. USITC.[18] In that case the Commission determined that the Pac-Man industry had been injured by infringing imports, and that the Rally-X industry had not. The Commission based its Rally-X determination on the fact that there was no longer a domestic industry manufacturing Rally-X machines. The Commission went on to conclude that a hypothetical Rally-X industry could not have been injured. The Commission held that complainant Bally/Midway was not entitled to relief under Section 337 because a domestic industry was no longer in existence when it decided the case, having been destroyed by trademark and copyright infringing imports of the video game, Rally-X. In reversing the Commission,

----

18. 714 F.2d 1117, 1124 (Fed. Cir. 1983).

the CAFC said, "[i]t is most unlikely that Congress, which enacted section 337 to 'prevent every type and form of unfair practice' and to provide 'a more adequate protection to American industry than any anti-dumping statute the country has ever had[,]' intended the statute to have such a bizarre effect. Sen. Comm. on Finance, S. Rep. No. 595, 67th Cong. 2d Sess. 3 (1922) (accompanying Tariff Act of 1922)."[19]

Because the Commission's determination was internally inconsistent, the Bally/Midway court could not affirm the Commission and defer to its discretion on the finding of no injury to Rally-X. Bally/Midway's percentage losses on Pac-Man sales where the Commission granted relief were no greater than its losses on Rally-X. The court could hardly uphold both the finding of no injury to Rally-X and the finding of injury to Pac-Man. Forced to choose, it opted to provide relief for Rally-X. In reversing the Commission, the court stated: "Where the unfair practice is the importation of products that infringe a domestic industry's copyright, trademark, or patent right, even a relatively small loss of sales may establish, under Section 337(a) the requisite injury".[20]

---

19. Id. at 1121-22.

20. Id. at 1124.

21. All references in this opinion to the reasoning of the majority are based on conjecture. Some members of the Commission will not exchange draft opinions prior to publication.

The majority rests its determination[21] in this case on Textron Inc. v. USITC.[22] Textron appealed an ITC determination that: (1) it did not have a common law trademark right to the physical configuration and outward appearance of its vertical milling machines; and (2) that any injury caused by infringements of Textron's registered trademarks of its machines and false advertising of the imported machines portraying them with pictures of Textron's machines, was insubstantial. The Textron court affirmed the Commission and did not overturn Bally/Midway. In that respect Textron is one of the vast majority of cases in which the CAFC has deferred to the judgment of the Commission on questions that are not strictly matters of statutory construction, but rather are exercises of the Commission's expertise and discretion. It is part of a line of cases in which the court has affirmed the Commission and found a way to

----

22. 753 F.2d 1019 (Fed. Cir. 1985).

rationalize the ITC's determination.[23]

Even if the Textron court was not merely seeking to justify the Commission's determination, but was making an independent judgment on the issue of injury, the case sub judice is clearly distinguishable. After disposing of the great bulk of complainant Textron's trademark claims, the court was left with "unfair acts of the respondents consist[ing] solely of false advertising by 12 firms and infringement of the registered trademarks 'Bridgeport' and 'Quill Master' by two firms."[24] The court then noted that the unfair act of false advertising was a less serious infringement of complainant's rights than a patent or trademark infringement, and that therefore claims based on such unfair acts had to meet a higher injury standard in order to get relief under Section 337. The court found that Textron had

----

23. See, e.g., Schaper Mfg. Co. v. USITC, 717 F.2d 1368 (Fed. Cir. 1983), in which the court affirmed the Commission's finding of no domestic industry, and distinguished such a finding from the Commission's finding of sufficient domestic activity to constitute a domestic industry in Certain Cube Puzzles, Inv. No. 337-TA-112, USITC Pub. 1334 (1983), Certain Airtight Cast Iron Stoves, Inv. No. 337-TA-69, USITC Pub. 1126 (1981) and Certain Airless Paint Spray Pumps, Inv. No. 337-TA- 90, USITC Pub. 1199 (1981). In Schaper the domestic complainant was engaged in the design and quality control of imported toy trucks. The distinction between the extent of the domestic activities of the complainants' domestic activities in the other three cases, Cube Puzzles in particular, with that of Schaper, was questionable at best. In Cube Puzzles, complainant's only domestic activity was the spot checking and packaging of the imported cubes, while in Stoves and Spray Pumps it consisted of warranty repairs of imported products. Nevertheless, the CAFC managed to reconcile these determinations. In doing so, the court applied, at least in part, an 'abuse of discretion' standard. Id. at 1373.

24. 753 F.2d at 1028.

failed to meet this stricter standard.[25] With respect to the injury sustained as a result of the trademark infringement, it stated, "[t]he record shows that no attachments bearing the infringed 'Quill Master' trademark have been imported, [and] that a minuscule number of machines bearing the 'Bigport' mark were imported".[26]

The facts in this case are far different. In Textron, the CAFC was dealing with vertical milling machines, a product that had been on the market for over half a century, and for which infringing sales were 'minuscule' and showed no prospect of increasing substantially. The instant case involves a product on the technological frontier. Sales of the infringing fibers although small, are not insubstantial, and pose a very real threat to Corning.

I believe that Sumitomo's infringing imports have the effect and tendency to destroy or substantially injure an industry in the United States and I would issue a limited exclusion.

---

25. Id.

26. Id.

CERTIFICATE OF SERVICE

I, Kenneth R. Mason, hereby certify that the attached Commission Memorandum Opinion was served upon the following parties via first class mail, and air mail where necessary, on June 19, 1985.

Kenneth R. Mason, Secretary
U.S. International Trade Commission
701 E Street, N.W.
Washington, D.C. 20423

Behalf of Corning Glass Works

Lars I Kulleseid. Esq
W. Edward Bailey Esq
Fish & Neave
875 Third Avenue
New York. NY 10022

Behalf of Corning Glass Works

Jeffrey W King. Esq.
Collier. Shannon. Rill & Scott
1055 Thomas Jefferson St.. NW
Washington DC 20007

Behalf of Sumitomo Electric

Italo H. Ablondi, Esq.
ITALO H. ABLONDI, P.C.
1776 K St.. NW
Washington DC 20006

Behalf of Sumitomo (Electric & Elec Ind Ltd.)

George T. Mobille. Esq.
James R. Longacre, Esq.
Cushman. Darby & Cushman
1801 K St.. NW
Washington DC 20006

Behalf of Mailing List - Valtec Corp.

John M Calimafde Esq
Hopgood. Calimafde, Kalil.
Blaustein & Judlow
60 East 42nd Street
New York. NY 10165

Behalf of Mailing List

Ritchie T Thomas
Electronic Industries Assn.
1201 Pennsylvania Ave. N.W.
Washington, D.C. 20004

Behalf of Mailing List

LeGrande L. Young
Ericsson Inc.
Greenwich Office Park 3
Greenwich. CT 06830

Behalf of Mailing List

Ronald W. Alice. Esq.
ITT
320 Park Avenue
New York. NY 10022

CERTIFICATE OF SERVICE - Cont.

Behalf of Mailing List - General Cable Corp.

John J Kelly Jr.. Esq
Kenyon & Kenyon
1025 Connecticut Ave.. N.W
Washington D.C 20036

Behalf of Mailing List

Bernard Zucker. Esq
AT&T
195 Broadway
New York NY 10007

Behalf of Mailing List

Bernard Zucker Esq.
AT&T Technologies
222 Broadway
New York NY 10038

Behalf of Mailing List - Times Fiber Comm Inc

Jonathan Hemenway Glazier Esq
Busby Rehm & Leonard
1629 K St.. N W
Suite 1100
Washington D.C. 20006

GOVERNMENT AGENCIES:

Mr. Charles S. Stark
Antitrust Div./U.S.Dept of Justice
Room 7115, Main Justice
Pennsylvania Avenue & Tenth Street, N.W.
Washington, D.C. 20530

Edward F. Glynn, Jr., Esq.
Asst Dir for IntlAntitrust
Federal Trade Commission
Room 502-4, Logan Building
Washington, D.C. 20580

Darrel J. Grinstead, Esq.
Dept of Health and Human Svcs.
Room 5362, North Building
330 Independence Avenue, S.W.
Washington, D. C. 20201

Richard Abbey, Esq.
Chief Counsel
U.S. Customs Service
1301 Constitution Avenue, N. W.
Washington, D.C. 20229

PUBLIC VERSION

Petition due ~~UNITED STATES~~ UNITED STATES INTERNATIONAL TRADE COMMISSION
Washington, D.C.

In the Matter of	)	
	)	
CERTAIN OPTICAL WAVEGUIDE	)	Investigation No. 337-TA-189
FIBERS	)	

INITIAL DETERMINATION

Pursuant to the Notice of Investigation in this matter (49 Fed. Reg. 15287, April, 18, 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. § 210.53. The Administrative Law Judge hereby determines, after a review of the briefs of the parties and of the record developed at the hearing, that there is no violation of Section 337 of the Tariff Act of 1930, as amended, */ in the unauthorized importation into the United States, and in the sale of certain optical waveguide fibers by reason of alleged infringement of claims 1 and 2 of U.S. Letters Patent No. 3,659,915 and claims 1 and 8 of U.S. Letters Patent No. 3,933,454, with the effect or tendency to destroy or injure substantially an industry efficiently and economically operated in the United States.

*/ 19 U.S.C. §1337, hereinafter § 337.

TABLE OF CONTENTS

ABBREVIATIONS

CPFF	Corning's Proposed Findings of Fact
CPH	Corning's Post-Hearing Brief
CPHR	Corning's Post-Hearing Reply Brief
CX	Corning's Exhibits
CPX	Corning's Physical Exhibits
FF	Administrative Law Judge's Findings of Fact
RPFF	Respondents' Proposed Findings of Fact on Patent Issues
RPHE	Respondents' Post-Hearing Brief on Economic Issues
RPHP	Respondents' Post-Hearing Brief on Patent Issues
RPX	Respondents' Physical Exhibits
RX	Respondents' Exhibits
SPHR	Staff Post-Hearing Reply Brief
SX	Staff's Exhibits
Tr.	Transcript

PROCEDURAL HISTORY

On March 7, 1984, Corning Glass Works (Corning) pursuant to § 337 of the Tariff Act filed a complaint which sought an exclusion against the importation and sale in the United States of optical waveguide fibers produced and sent to the United States in cabled and uncabled form by Sumitomo Electric Industries, Ltd. (SEI). Certain of these optical waveguide fibers were said to infringe Corning's United States Patent No. 3,659,915 ('915 patent) which is a product patent and all of these fibers were said to be made by a process which infringed Corning's United States Patent No. 3,933,454 ('454 patent) which is a process patent. The effect or tendency of these unfair trade practices was alleged to substantially injure the domestic industry in optical waveguide fibers based on the '915 and '454 patents.

Having considered the complaint, the United States International Trade Commission (Commission), on April 5, 1984, ordered, pursuant to subsection (b) of § 337, that an investigation be instituted to determine whether there is a violation of subsection (a) of section 337 in the unlawful importation of certain optical waveguide fibers into the United States, or in their sale, by reason of alleged infringement of claims 1 and 2 of the '915 patent and claims 1, 3 and 8 of the '454 patent, the effect or tendency of which is to destroy or substantialy injure an industry, efficiently and economcially operated, in the United States. The Notice of Investigation was issued and published in the Federal Register on April 18, 1984, 49 Fed. Reg. 15287. With respect to the '454 patent, Corning has since limited the claims in issue to claims 1 and 8 (FF 50).

Complainant Corning is a corporation organized and existing under the laws of the State of New York. It has its principal office and place of business at Houghton Park, Corning, New York 14830 (FF 3).

The following pa. _ es were named as respondents i. _ ne Notice of Investigation:

Sumitomo Electric Industries, Ltd.
15, Kitahama 5-chome
Higashi-ku, Osaka 541, Japan

Sumitomo Electric, U.S.A., Inc. (SEUSA)
551 Madison Avenue
New York, New York 10022
(FF 4, 5, 6)

On May 6, 1984, Paul J. Luckern was designated to preside as the Administrative Law Judge over the investigation. On May 25, 1984, a prelimanary conference was held before the Judge. Appearances were made on behalf of all parties. Order No. 7, issued on June 5, 1984, set forth a schedule for the investigation and the hearing.

On April 14, 1984, Corning moved to disqualify the law firm representing respondents on the patent aspects of the investigation. Order No. 8, issued on June 1, 1984, denied a motion by respondents to suspend discovery until the resolution of Corning's motion. Order No. 10, issued on June 11, 1984, granted Corning's motion to disqualify.

On July 6, 1984, respondents moved to have this investigation designated as "more complicated." This motion was based upon the alleged difficulties encountered by respondents due to the disqualification of their original patent counsel. Order No. 18, issued on July 20, 1984, denied respondents' motion. On September 25, 1984, the Commission denied respondents' application for interlocutory review of Order No. 18.

On September 24, 1984, respondents filed a second motion seeking to have this investigation designated as "more complicated." This motion was based upon alleged discovery problems which respondents were facing from both Corning and various non-parties. In Order No. 37, issued October 3, 1984, the Administrative Law Judge denied this motion.

Order No. 40, issued on October 5, 1984, granted the parties' joint motion to modify the prehearing and hearing schedules to provide additional time for completion of iscovery and orderly preparatic of witness statements and prehearing briefs.

In Order No. 52, issued October 19, 1984, the Administrative Law Judge requested the Commission to seek immediate court enforcement of a subpoena directed to a non-party, Ericsson Inc. On November 2, 1984, the Commission directed its General Counsel to seek court enforcement of a portion of the subponea. An order to Ericsson Inc. to show cause why the subpoena , as modified, should not be enforced was thereafter issued by the U.S. District Court for the District of Columbia. In Order No. 59, issued November 15, 1984, the Administrative Law Judge certified to the Commission respondents' motion for reconsideration of the Commission's limited enforcement of the Ericsson, Inc. subpoena. On December 19, 1984, the Commission denied the motion.

A prehearing conference was held on October 31, 1984, and the hearing in this investigation commenced on November 1, 1984. Appearances were made by counsel for Corning, respondents SEI and SEUSA, and the Commission investigative attorney. The hearing concluded on November 16, 1984.

The record was reopened on November 30, 1984 for the limited purposes of receiving testimony on a British counterpart patent of the '915 patent and hearing arguments with respect to admisibility of deposition testimony.

The Commission has in personam jurisdiction over all the parties to this investigation. All parties have appeared and litigated the issues in the investigation (FF 1). It has in rem and subject matter jurisdiction under 19 U.S.C. § 1337 since the alleged unfair methods of competition and unfair acts involve the importation of optical waveguide fibers into the United States. (FF 2)

The economic issues have been briefed by the Commission investigative attorney and the patent and economic issues have been briefed by Corning and respondents. Related proposed findings of fact have been submitted by the parties. The matter is now ready for decision.

This Initial Determination is based upon the entire record of the proceedings, including the evidentiary record compiled at the final hearing, the exhibits admitted into the record 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 unsupported 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.

OPINION

Nature of the Action

Corning has asserted that respondents SEI and SEUSA have committed unfair acts by the importation of optical waveguide fibers which infringe claims 1 and 2 of Corning's '915 patent and which are made by a process which infrnges claims 1 and 8 of Corning's '454 patent.

Corning also asserts that respondents' unfair acts have the effect and tendency to substantially injure a domestic industry within the meaning of Section 337 of the Tariff Act.

Respondents contend that each of the '915 and '454 patents are unenforceable because of actions by Corning before the United States Patent and Trademark Office during the prosecution of the applications which led to these patents.1/ Respondents further contend that each of the '915 and '454 patents is invalid under Sections 102, 103 and 112 of 35 U.S.C. Assuming arguendo their validity, respondents contend they do not infringe the '915 and '454 patents.

Respondents also contend that Corning has failed to establish that any U.S. activities of Corning or Corning's licensees under the claims in issue of the '915 and '454 patents constitute an industry in the United States as that phrase is used in Section 337; that assuming, arguendo, an industry in the United States does exist with respect to the claims in issue, it is clear under Commission precedent, that

---

1/ Respondents' allegation, in this investigation, of patent unenforceability by reason of anti-competitive licensing practices has been withdrawn (RPHP, pp. 3-4).

certain entities, alle[illegible] by Corning to be part of the [illegible]mestic industry are not part of that industry. Respondents further contend that Corning has not established that there is an effect or tendency to substantially injure any U.S. industry.2/ 3/

Patent Issues - '915 Patent

I. The '915 Patent and its Claims 1 and 2

The '915 patent titled "Fused Silica Optical Waveguide" issued on May 2, 1972 in the names of Robert D. Maurer and Peter C. Schultz and is assigned on its face to Corning (FF 61). The patent is based on application Ser. No. 36,109 filed May 11, 1970. (FF 61). Claims 1 and 2 are in issue.

Claim 1 of the '915 patent is directed to an optical waveguide comprising (1) a cladding layer of either pure fused silica or fused silica to which a dopant material on at least an elemental basis has been added, and (2) a core formed of fused silica to which a dopant material on at least an elemental basis has been added to a degree in excess of that of the cladding layer so that the index of refraction of the core is of a value greater than the index of refraction of the

2/ Respondents have stipulated that at least Corning and its U.S. licensees are efficiently and economically operated as that phrase is used under Section 337, without conceding that they constitute a U.S. industry under Section 337 (RPHE pp. 4-5; CX 380).

3/ Respondents have asserted that they have not raised before the Administrative Law Judge the issue of lack of due process relating to the Commission's conduct of Inv. No. 337-TA-172, but preserve this issue for consideration by the Commission, if necessary (RPHE 1) cladding layer, said core being formed of at least 85 percent by weight of fused silica and an effective amount of up to 15 percent by weight of the dopant material.[4/] Claim 2 specifies that the waveguide of claim 1 has a cladding layer that is substantially pure fused silica. (FF 64).

The inventors of the '915 patent represent that their invention takes a "completely new and novel approach" to the type of material used in the production of optical waveguides (FF 73). At the time of filing the application on May 11, 1970 the increase in the amount of traffic that communication systems were required to handle had forced the development of higher capacity systems. (FF 66). The systems then in use, which operated between 10^6hz (hertz) and 10^9hz, although relatively new had become saturated in some frequency bands due to excessive traffic. (FF 66). To allow for needed increase in traffic which communication systems, as of May 11, 1970, could not

---

4/ An optical waveguide fiber has been defined as a transmitting media for frequencies around 10^{15}hz and as a thin fiber made of a transparent material and capable of transmitting a predetermined number of modes of light. (FF 11). A mode has been defined as a family of light rays traveling through fiber at a particular angle with respect to the fiber axis. (FF 11). While in the conventional optical fiber substantially all of the transmitted light is retained within the core, and the light transmission qualities of the cladding layer are therefore of no consequence, optical waveguides are a unique type of optical fiber in that many of the physical characteristics and parameters must be carefully coordinated. (FF 68).

A core is known as the central portion of an optical waveguide fiber through which light primarily travels. (FF 11). The outer portion of an optical waveguide fiber is the cladding which acts to confine light rays to the core. (FF 11).

Index of refraction is a number which indicates the speed with which light travels through a material. (FF 11). Bandwidth (BW) is a property expressed by a number which indicates the rate at which information can be transmitted over a fiber. The higher the Bandwidth of an optical waveguide fiber, the more information that can be transmitted over the fiber in a given time. (FF 11). Megahertz (MHz) is a measure of bandwidth, for example an optical fiber might have a bandwidth of 500 MHz (FF 11).

accomodate, commercial communication groups, were installing high capacity systems that operated between 10^9hz and 10^{12}hz. (FF 66). Even with this increased capacity, traffic growth was so rapid that saturation of such systems was anticipated in the "very near" future. (FF 66). Hence to accomodate even more traffic, higher capacity communication systems operating around 10^{15}hz, which is within the frequency spectrum of light, were needed. (FF 66).

Waveguides have been desirable for effective transmission of information by systems operating at frequencies above 10^9hz. (FF 66). Although systems operating at frequencies between 10^9hz and 10^{12}hz normally used an electrical conductive waveguide as a transmitting medium, conventional electrical conductive waveguides were not satisfactory for transmitting information at frequencies around 10^{15}hz. (FF 66).

Producing a satisfactory transmitting media for frequencies around 10^{15}hz, as of May 11, 1970, had been one of the more difficult problems in the development of an effective optical communication system. (FF 66). An optical waveguide to be an effective transmitting media for an optical communication system, should transmit light without excessive attenuation[5/] and should not cause dispersion or scattering of the transmitted light. In addition an optical waveguide should allow only preselected modes of light to propagate along the fiber. (FF 67).

5/ Attenution is a property expressed by a number, which indicates the ability of a material to transmit energy, unually a signal. The lower the attenuation, the greater the amount of energy which will be transmitted through the material. With respect to optical waveguide fibers, attenuation is usually expressed in decibels per kilometer (dB/km), expressed mathematically as -10 x log (light output/light input). (FF 11).

II. Infringement Issue

A. Accused Fibers

Respondents have imported five different types of optical waveguide fiber: multimode fibers M-1 and M-2 and single mode fibers S-1, S-2 and S-3. (FF 8-10,12-49). Corning has charged the M-1, S-1, S-2 and S-3 fibers with infringement of claim 1 and/or claim 2 of the'915 patent. (FF 50). Corning does not charge the M-2 fiber with infringement of claims 1 and/or claim 2 of the '915 patent. (FF 50).

The M-1 fiber is a

(FF

9,45-46). It is a

It has a

(FF 9, 45-46).

The S-1 fiber is a

(FF 9, 30-31). It is

(FF 9, 30-31).

The S-2 fiber is a

(FF 9, 34-35). It is a

(FF 9,

34-35).

The S-3 fiber is a

(FF 9, 39-41). It is a

(FF 9, 39-41). Its

(FF 9, 39-41).

B. Positions of the Parties

The positions of Corning and respondents on the infringement issue can be summarized as follows:

Fiber	Corning	Respondents
M-1	, and hence M-1 literally infringes claims 1 and 2 (CPH 26, 27)	M-1 fiber is Corning is clearly estopped to assert the doctrine of equivalents for the purpose of including a within the scope of the '915 patent claims in issue (RPHP6)
S-1	"	"
S-2	hence S-2 literally infringes claim 1; claim 2 is not literally infringed because S-2 , (CPH 26, 27)	S-2 fiber is not within the scope of the '915 patent claims in issue through the doctrine of equivalents because the S-2 (RPHP6)

S-3	S-3 fiber is the equivalent of the fiber of claims 1 and 2 of the '915 patent. CPH 28).	S-3 fiber is not within the scope of the '915 patent claims in issue through the doctrine of equivalent because S-3 fiber has an ((RPHP 6).

1. Corning's Argument

In support of Corning's position as to fibers M-1, S-1 and S-2, Corning argues that it is undisputed that acts as a dopant to increase the index of refraction; and that was in use as a dopant within a year or two after the application for the '915 patent was filed on May 11, 1970. Corning further argues that U.S. patent 4,008,388 assigned to SEI and listing respondents' witnesses Nakahara and Hoshikawa as co-inventors and which claims a priorty date in Japan of October 13, 1972, (five months after the May 2, 1972 issuance of the '915 patent) adds to the list of dopants "copied from the '915 patent". (CX 361, cover page, col. 4, ll 38-44). (CPH 27).

Referring to testimony of the inventors, Corning admits that was not mentioned as a dopant in the '915 patent because the inventors had done insufficient work with as a dopant, when the '915 patent was filed and were not sure would work as a dopant. Corning argues however that methods did exist in 1970 for getting into silica in appropriate quantities to act as a dopant to alter the index of refraction and such methods were taught in the '915 patent (CPH 27); that even if was not known as a dopant in 1970 and even if could not have been added as a dopant in 1970, infringement is not avoided. (CPH 27).

Corning argues that the S-3 fiber "performs substantially the same function in substantially the same way to obtain the same result" as the optical waveguide fiber compositions "literally" claimed in the '915 patent. (CBH 28). In support it argues that the refractive index differences of the S-1, S-2 and S-3 fibers are identical, and that respondents' Mr. Hoshikawa admitted at the hearing that the S-1 fiber with the in the fused silica core raises the index of refraction of the core a certain amount above that of the fused silica cladding; that while the S-2 fiber with the slightly lower content of the fused silica core causes the index of refraction of the core to be slightly lower than the refractive index of the core of the S-1 fiber, the same difference in the index of refraction as in the S-1 fiber is maintained in the S-2 fiber by adding some (CPH 29); that while the S-3 fiber has no dopant in

Accordingly, Corning contends that for each of the S-1, S-2 and S-3 fibers the index of refraction differences between core and cladding are virtually indential; that the index of refraction difference in the S-2 and S-3 fibers is achieved simply by substitution of one dopant, for another dopant, (CPH 29). Corning argues that while the '915 patent specification refers to dopants which increase the index of refraction, the specification does not exclude dopants which decrease the index of refraction; that the inventors did not intend to exclude dopants such as which decrease the index of refraction; that while at the time of filing the '915 specification on

May 11, 1970, was not known to the inventors, as a dopant, which it was known that would decrease the index of refraction; and that it was known to add to the cladding of a fiber optic to control the refractive index thereof (CPH 29). Corning further argues that during the prosecution of the '915 patent, Corning provided the U.S. Patent Office with the same definition of dopant as Corning assert now, viz a substance purposely added to pure fused silica to alter its refractive index, but which does not absorb or scatter light to any appreciable extent. Hence Corning concludes that its position is entirely consistent with the position it took in 1970 and that the definition of dopant then, as well as now, included chemicals which the index of refraction (CPH 29).

2. Respondents' Argument

Respondents argue that Corning's position that the '915 patent claims in issue cover any optical fiber whose core has a higher index of refraction than its cladding regardless of the means used to achieve that difference ignores the fact that the concept of cladding an optical silica glass fiber core with a silica glass having a lower index of refraction is not a Corning invention (RPHP 5). It is argued that Corning disregards the representations made to the United States Patent Office by the inventors in the patent specification, and by the Corning attorney, Mr. Zebrowski when he convinced the Patent Examiner to allow the '915 patent (RPHP 5, 6); and that the '915 patent specification and claims, as well as the file history of the '915 patent limit the '915 invention to a fiber having a fused silica core doped with one or more compounds that increase its index of refraction and in an amount not exceeding 15% by weight with the cladding thereof being either pure fuseu silica or fused silica doped with one or more of such compound. (RPHP 6).

Respondents urge that M-1 and S-2 fibers are doped with and Corning is clearly estopped to assert the doctrine of equivalents for the purpose of including a additive within the scope of the '915 patent in issue. (RPHP 6). As to the 15% limitation, they state that today Corning is commercially marketing and has commercially marketed in the past several fibers that use as a dopant in amounts (Tr. 3188); that "Corning has [another] patent that says that you use but it's got to be over 15%" (Tr. 3188). That patent has been identified as U.S. Patent 3,884,550 which issued to the inventors of the '915 patent on May 20, 1975 on an application filed Jan 4, 1973. Hence respondents argue that since obviously can be used as a dopant at over 15 percent, could not have been contemplated by the '915 patent (Tr 3189). As far as respondents are concerned there is "no magic above 15 percent" but Corning is making a clear statement in its '915 patent that there is something magic about 15 percent"[6/] (Tr 3189-90).

Respondents argue that the S-2 and S-3 fibers cannot be brought within the scope of the '915 patent claims in issue through the doctrine of equivalents; that the S-2 and S-3 are doped of the

---

6/ Corning has charged the M-1, S-1 and S-2 fibers which contain about 10 percent, about 6 percent and about 5 percent respectively of germania. (FF 46, 31, 35) with infringement of claims 1 and 2 of the '915 patent (FF 50). It has not charged the M-2 fiber with infringement of the '915 patent because the the M-2 fiber contains more than 15 percent germania (CPHB 26). The M-2 fiber contains about 20 percent germainia (FF 49).

that the S-3 fiber has an and that the S-2 fiber is doped with (RPHP 6). It is argued that based on the clear language of the claims added to overcome the prior art, Corning is estopped to include such fibers within the scope of the claims; that any other interpretation would require a holding that the claimed language contemplates a dopant that decreases the index of refraction or a fiber core that is undoped, which is "exactly contrary to the representations made to the Patent Office and that resulted in the issuance of the '915 patent." (RPHP 6-7).

C. Corning's Burden

Corning has the burden of proving by a preponderance of evidence that the respondents have infringed claim 1 and 2 of the '915 patent because Corning is the patent owner. Envirotech Corp. v. Al George, Inc., 730 F.2d 753, 221 USPQ 473, 477 (Fed. Cir. 1984); Roberts Dairy Co. v. United States, 530 F.2d 1342, 1357, 182 USPQ 218,225 (Ct. Cl. 1976).

Generally, in order to constitute direct infringement, the alleged infringing composition must be substantially similar in composition, mode of operation, and results accomplished as the composition covered by the patent. Weidman Metal Masters Co. Inc. v. Glass Master Corp., 623 F.2d 1024 1030, 207 USPQ 101, 106 (5th Cir. 1980), cert. denied, 450 U.S. 982, 211 USPQ 400 (1981). In applying this general test of infringement, courts use a two step analysis. The first step involves an inquiry into whether the accused device literally infringes the patent in suit. If not, then the court's attention is directed to an application of the doctrine of equivalents.

As the Supreme Court described literal infringement in Graver Tank & Mfg. Co. v. Linde Air Products Co., 339 U.S. 605, 607, 85 USPQ 328, 330 (1950): "resort must be had in the first instance to the words of the claim. If accused matter falls clearly within the claim, infringement is made out and that is the end of it." (Emphasis added) See also Lam, Inc v. Johns-Manville Corp., 668 F.2d 462, 471, 213 USPQ 1061, 1067-68 (10th Cir. 1982); Studiengesellschaft Kohle mbH. v. Eastman Kodak Co., 616 F.2d 1315, 1324, 206 USPQ 577, 585-86 (5th Cir. 1980); John Zink Co. v. National Airoil Burner Co., 613 F.2d 547,555, 205 USPQ 494 500-01 (5th Cir. 1980). In other words, "[a] device may infringe ... 'literally' by matching each feature of th patent claim ..." Lam, Inc. v. Johns-Manville Corp., at 471, 213 USPQ at 1067-68. In applying the claims in such a manner, the patent claims are always to be read or interpreted in light of the patent specification. Schriber-Schroth v. Cleveland Trust Co., 311 US. 211, 217, 47 USPQ 345, 347-348 (1940); Adams v. United States, 383 U.S. 39, 49, 148 USPQ 479, 482 (1966).

Direct infringement may also be proved under the doctrine of equivalents. No mere colorable departure from a literal reading of claims will avoid infringement. Otherwise a patent would be turned into a hollow thing.

D. Literal Infringement

Determining infringement requires claim construction as a preliminary step. See, Fromson v. Advance Offset Plate, Inc., 720 F.2d 1565, 1569, 219 USPQ 1137, 1140 (Fed. Cir. 1983). If the properly construed claims read on the infringing product, there is literal infringement. However, to understand the meaning of claims they must be construed in connection with other parts of the patent instrument and with the circumstances surrounding the inception of the patent application. Id. at 1571, 219 USPQ at 1142.

Interpreting claims 1 and 2 of the '915 patent in light of the patent specification and the circumstances surrounding the inception of the '915 application, the Administrative Law Judge finds that Corning has not met its burden by a preponderance of evidence in proving that the M-1, S-1 and S-2 fibers literally infringe, or fall "clearly" within any of the claims in issue. While the optical waveguide of independent claim 1 comprises a cladding layer formed of pure fused silica or fused silica to which a "dopant material" has been added and a core formed of fused silica to which a "dopant material" has been added (FF 64), the specification does not disclose as a dopant material for the core which is the dopant material in the cores of respondents' M-1, S-1, S-2 fibers, and does not disclose as a dopant material for the which is a dopant material in the respondents 'S-2 fiber. (FF 65-88). If claims 1 and 2 are limited to the dopant materials specifically disclosed in the '915 specification, without reference to either the file wrapper history or the generic nature of the term "dopant material", then dopant materials would only be those that "can be added to fused silica in minute quantities to increase its index of refraction to a predetermined level" (FF 78), viz. "multivalent metal oxides as titanium oxide, tantalum oxide, tin oxide, niobium oxide, zirconium oxide, ytterbium oxide, lanthanum oxide and aluminum oxide" (FF 78) or dopant materials containing alkali ions as "cesium and rubidium" (FF 78).

Admittedly the term "dopant material" is a generic term. However, the testimony conclusively establishes that at the time of the May 11, 1970 filing of the '915 application, while germamia used in the cores of the M-1, S-1 and S-2 fibers was not excluded purposely from the '915 specification, there had been insufficient work performed with at Corning to name it as a "dopant material" (FF 301,315); that neither inventor Maurer nor inventor Schultz knew about dopants as used in the of the S-2 fiber, that the refractive index of nor had they conducted any experimentation with dopants which (FF 307, 310, 312, 313). Moreover the record does not establish that was considered by anyone to be within the generic term "dopant material" when the '915 application was filed on May 11, 1970.[7]

Accordingly, the M-1, S-1 and S-2 fibers do not fall "clearly" within any of the claims in issue. Corning has not met its burden in establishing a literal infringement of the claimed subject matter in issue.

E. Doctrine of Equivalents

The role of the doctrine of equivalents in modern patent law was spelled out by the Supreme Court in the classic case Graver Tank & Mfg. Co. Inc. v. Linde Air Products Co., supra where the Court stated:

> Originating almost a century ago in the case of Winans v. Denmead, 15 How 330, it [doctrine of equivalents] has been consistently applied by this Court and the lower federal courts, and continues today ready

---

7/ There was testimony that a Dr. McChesney believed he had invented a better dopant than titania which was and that "he was able to make low loss fibers of " (Macedo, Tr. 2817). The Administrative Law Judge finds the record absent any contemporaneous documentary evidence about the McChesney invention. There is nothing in the record to establish the timing of this McChesney invention.

> and a...lable for utilization when the proper cirumstances for its application arise. 'To temper unsparing logic and prevent an infringer from stealing the benefit of an invention' [quoting from Judge L. Hand in Royal Typewriter Co. v. Remington Rand 168 F.2d, 691,692, 77 U.S.P.Q. 517 518 (2nd Cir. 1948)] a patentee may invoke this doctrine to proceed against the producer of a device 'if it performs substantially the same function in substantially the same function in substantially the same way to obtain the same result.' Sanitary Regrigerator Co. v. Winters, 280 U.S. 30, 42 [3 USPQ 40, 44].

1. Claims 1 and 2 in Issue

Regarding claims 1 and 2 in issue, no argument has been made by Corning that the particular components of the claimed waveguides, in and of themselves, were novel. Fused silica and doped fused silica were known when the '915 application was filed on May 11, 1970. (FF 155). Also, it was known since 1954 that introduction of a material as into certain glasses affects the index of refraction of the glass. (FF 310).

No argument has been made by Corning that optical fiber with a cladding of transparent material of lower refractive index than that of the fiber was novel. Such fibers were widely used when the '915 application was filed on May 11, 1970. (FF 237).

Invention of the claimed subject matter is in the combination of particular materials used in the claimed optical waveguides such that an optical waveguide is provided wherein, as the claims specify, the index of refraction of the core of the waveguide is of a "value greater than the index of refraction of ... [its] cladding layer". (FF 64). Not denied by respondents, with respect to each of the accused M-1, S-1, S-2 and S-3 fibers, is that the index of refraction of the core or center region of the accused fiber is of a value greater than the index of refraction of the surrounding region or cladding of the fiber.

As of the May 11, 1970 filing date of the '915 application insufficient work had been done at Corning to name in the '915 application as a dopant material which the accused M-1, S-1, and S-2 fibers use in their to attain a (FF 301). In addition while the claims in issue specify adding dopant material to the fused silica core to attain a refractive index value greater in the core than in the cladding, they do not state adding to the to of the either over the as with the accused S-3 fiber, or over a as with the accused S-2 fiber, to attain greater in the than in the Accordingly, the doctrine of equivalents has to be considered to determine the coverage which the claims in issue should have. Should the claimed invention include a fused silica optical waveguide containing a dopant so as to selectively increase the refractive index the core of the waveguide over the refractive index of the cladding, irrespective of the means used to obtain the relective difference? To arrive at an answer, the context of the '915 patent specification, the prosecution of the '915 application, including the cited prior art, and the particular circumstances of the case must be looked at. SSIH Equipment S.A. v. U.S. International Trade Commission, 718 F.2d 365, 218 USPQ 678, 688 (Fed. Cir. 1983), Sealed Air Corp. v. U.S. International Trade Commission, 645 F.2d 976, 209 USPQ 469,476 (CCPA 1981).

2.. The '915 Specification

The specification discloses a "completely new and novel approach ... taken as to the type of material to be used in the production of optical waveguides." (FF 73). Contrary to the soft and easily worked materials normally used in the production of optical waveguides, it was discovered that substantially pure fused silica, containing no impurities in an amount greater than 0.1% by weight except for hydrogen-oxygen groups, and which is extremely hard and difficult to work can be economically and readily used as a material from which the claimed optical waveguides can be produced. (FF 73).

The specification discloses that many of the difficulties normally encountered in the formation of waveguides can be substantially eliminated if both the core and the cladding layer possess similar physical characteristics such as viscosity, softening point and coefficient of expansion. (FF 73). Significantly it discloses that if a very small yet precise difference can be maintained between the indices of refraction of the core and of the cladding layer the diameter of the core may be made proportionally larger and therefore more easily controlled, and the waveguide will still maintain its ability to limit light propagation to preselected modes. (FF 73). Also significant are the finding of the inventors that pure fused silica has a very predictable index of refraction,and therefore adding a precise percentage by weight of doping materials to pure fused silica will produce "doped fused silica" with an index of refraction predictably higher than that of pure fused silica; that because of the high purity level of fused silica, only a minimal amount of doping material will be necessary to cause an appreciable change in the index of refraction. (FF 75). In addition the inventors disclosed that pure fused silica has excellent light transmission qualities in that absorption of light energy and intrinsic scattering of light by the material is exceptionally low, and that a waveguide once formed of pure fused silica possesses the quality of being highly resistant to damage from high temperatures, corrosive atmosphere and other severe environments because pure fused silica is such a hard material. (FF 76).

The inventors characterized their invention as comprising a cladding layer formed substantially from pure fused silica, and a core formed from fused silica doped with one or more doping materials "so as to selectively increase the index of refraction above that of the cladding." (FF 72). Fused silica slightly doped with a dopant material or combination of dopant materials may be used as the cladding material. (FF 72).

In one embodiment a desired dopant material or combination of dopant materials is added to the core "in the amount effective to increase the index of refraction to the desired level above that of the cladding layer." (FF 79). A specific example shows the index of refraction of an optical fiber core was approximately 1.466 while its cladding had an index of refraction of approximately 1.4584. (FF 81).

To the Administrative Law Judge the '915 specification clearly teaches a pure fused silica optical waveguide fiber with the greater refractive index of a fused silica core, as compared to the refractive index of a fused silica cladding, selectively controlled through the use of dopant materials. Respondents' M-1, S-1, S-2 and S-3 fibers are pure fused silica optical waveguide fibers with a greater refractive index of a fused silica core, as compared to the refractive index of a fused silica cladding selectively controlled through the use of dopant materials. Admittedly the specific means utilized by the inventors in the '915 specification to control selectively the refractive index difference between the core and cladding differs from the means specifically utilized by respondents. However, a patentee should not be limited in the coverage of his claimed invention to the specific embodiments disclosed in a specification Continental Paper Bag Company v. Eastern Paper Bag Company 210 U.S. 405, 414 (1908). Infringement is not avoided if the accused means and the patented means perform substantially the same function in substantially the same way to obtain the same result. In this investigation the means used by the inventors and the means used by respondents change the index of refraction of fused silica fibers and both means selectively control a refractive index difference in the core and cladding of the fiber which is critical to the claimed invention. (FF 32, 33, 36, 37, 38, 42, 43, 44, 47, 314, 311).

3. The Prosecution History

The only independent composition of matter claim in the '915 application as filed was directed to an optical waveguide comprising a cladding of pure fused silica or doped fused silica and a core of fused silica doped to a degree in excess of the cladding layer so that the core's index of refraction is greater than the index of refraction of the cladding (FF 89). In a Patent Office action dated March 29, 1971 the Patent Examiner rejected this claim and dependent claim 7, identical with claim 2 is issue in the investigation, as anticipated under 35 U.S.C. 102 over Flam et al U.S. Patent No. 3,542,536. (FF 91).

The Examiner rejected other dependent composition claims, which specified dopant materials, under 35 U.S.C. 103 over the Flam et al patent stating that doping materials are a matter of choice and obvious over materials disclosed in the Flam et al patent. No unexpected or improved results were seen in selecting a particular dopant material. (FF 91).

The Examiner cited Koester et al U.S. Patent No. 3,445,785, which issued on May 30, 1969 on an application filed August 5, 1963, and said it disclosed yterrbium doped glass for use in rod-like lasers. (FF 91, 269). A Seitz U.S. Patent No. 3,533,013 which issued on October 6, 1970 on an application filed March 23, 1967 was said to disclose at col 3 that a variation of doping concentration produced a variable index of refraction. (FF 91, 272).

The Flam et al. patent which issued on November 24, 1970 on an application filed September 1, 1967 discloses a method of forming an optical waveguide by changing the refractive index in the interior localized region of a solid optical dielective material by irradeation such that there is a difference in refractive indexc between the interior region and the remainder of the dielective material. (FF 275-278). The irradiation is said to permit the guiding of optical energy. (FF 275).

In an amendement filed June 14, 1971 Corning argued that the claimed invention taught an optical waveguide having a cladding layer formed of pure fused silica or slightly doped fused silica and a core formed from fused silica doped with one or more doping materials so as to "selectively increase the index of refraction above that of the cladding". (FF 94). Consistent with the teaching of the '915 specification, Corning further argued that the "new and novel approach" of producing optical waveguide from fused silica resulted in the production of superior waveguides which could not be produced from the soft and easily worked materials normally used; that fused silica which is extremely hard and difficult to work would not normally be considered a suitable material for use in the formation of optical waveguides which are normally drawn down to very small diameter and must have very small differences in the index of refraction of the cladding and the core; that the difficulties normally encountered in the formation of waveguides can be substantially eliminated if both the core and the cladding layer possess similar characteristics such as, for example, viscosity, melting point and coefficient of exponsion, that fused silica is readily obtainable with exceptinally high purity; that it had been found that fused silica, in pure form, has a very predictable index of refraction, and that, therefore, adding a precise percentage by weight of doping material to fused silica will produce "doped fused silica" with an index of refraction predictably higher than that of pure fused silica; that, because of the high purity level of fused silica, only minimal amounts of doping material was necessary to cause an appreciable change in the index of refraction. (FF 95).

While Corning argued in the amendment filed June 14,1971, that a doping material that increases the index of refraction of the core of the optical waveguide fiber "is absolutely essential", that conclusion was premised on the argument that an optical waveguide according to the claimed '915 invention will not work "unless the index of refraction of the core is greater than the index of refraction of the cladding." (FF 97).

The Examiner in a final rejection dated August 18, 1971 again rejected claims 1 and 7 under 35 U.S.C. 102 as anticipated by the Flam et al patent on the basis that the Flam et al waveguide core is inherently doped with irradiating atomic parties which are used to alter the refraction index. (FF 98). Claims 1 and 7 were also rejected under 35 U.S.C. 103 as obvious over Flam et al because these claims do not name any dopant materials and one skilled in the art would recognize that the core of the Flam et al waveguide is obviously doped with atomic particles. (FF 98).

By an amendment filed October 13, 1971, Corning amended original claim 1 so that it read:

> An optical waveguide comprising a cladding layer formed of a material selected from the group consisting of pure fused silica and chemically doped fuse silica, and a core formed of fused silica chemically doped to a degree in excess of that of the cladding layer so that the index of refraction thereof is of a value greater than the index of refraction of said cladding layer.

(FF 99).

Significantly, Corning in the amendment filed October 13,1971 argued that the irradiation of a base material with subatomic particles as disclosed in the Flam et al patent, is clearly not doping as that term is understood in the art, and that it is unmistakably clear that such irradiation is not chemical doping. Doping was said to be as defined in "The Condensed Chemical Dictinary", 7th Edition, by Rhienhold Publishing Corporation as the

> "Controlled introduction of trace impurities into ultrapure crystals in order to obtain desired physical properties, especially electrical properties."

It was pointed out that the "American Heritage Dictionary of the English Language." defines a dopant as

> A small quantity of a substance such

> as phosphorous, added to another substance, such as a semiconductor, to alter the latter's properties."

(FF 101). Moreover Corning, through a Rule 132 affidavit filed with the October 13, 1971 amendment, stated that the processes described in the '915 patent specification and the Flam et al. patent were entirely different; that change in the index of refraction of glasses acted upon by these two processes is brought about by entirely different means; that a change in the index of refraction brought about by chemical doping as described in the '915 patent specification is principally due to the presence of an impurity, namely "by the presence of an element or chemical compound introduced into the glass;" that a change in the index of refraction due to irradiation as described in the Flam et al. patent is brought about by a change in the density of the material and structural displacement of the atoms or molecules out of their lattice positions as a result of radiation damage; that the process of "chemical doping" employed in the '915 patent application is clearly understood in the art to mean the introduction of chemical elements or compounds into a base material for the purpose of affecting properties of the material by virtue of the presence of such elements or compounds therein." (FF 102).

As Corning argued in its October 13,1971 filings, the means ulitized by it in the claimed invention for changing the index of refraction of pure fused silica is a chemical impurity (dopant) which is added to the pure fused silica. Respondents, in the accused fibers, add an impurity (dopant) to change the index of refraction of pure fused silica.

By Patent Office action dated November 9, 1971 the Patent Examiner stated that all of the claims were allowable and that an Examiner's amendment will follow. (FF 105). The Examiner's amendment dated November 17, 1971 further amended claim 1 then in the application to read as claim 1 of the '915 patent. (FF 105). In effect what the Examiner's amendment did in amending the claim was to delete the terms "chemically doped fused silica" and "fused silica chemically doped" and substitute therefore "fused silica to which a dopant material on at least an elemental basis has been added" and also to include the phrase "said core being formed of a least 85% by weight of fused silica and an effective amount up to 15% by weight of said dopant after material. (FF 105).

The Examiner's amendment followed telephone interviews which Corning's attorney Mr. Walter Zebrowski had with the Examiner on November 8 and 12, 1971 in which Mr. Zebrowski agreed on the amendments (FF 105). A memorandum prepared by Mr. Zebrowski dated November 8, 1971 and contemporaneously with his November 8, 1971 telephone interview with the Patent Office Examiner stated that on November 3, 1971 he had interviewed the Examiner and that they discussed the amendments which Mr. Zebrowski had submitted earlier with a Rule 132 affidavit by Herbert E. Rauscher; that the Examiner was agreeable to all the amendments and the affidavit except that he was still not convinced that distinguishing the doped fused silica in claim 1 as "chemically" doped fused silica would avoid the Flam et al. reference. According to the the memo, Mr. Zebrowski made several suggestions to the Examiner, none of which appeared acceptable to him until Mr. Zebrowski proposed what was stated in the Examiner's amendment. (FF 109).

On December 7,1971 a notice of allowance was mailed. (FF 106). The '915 patent issued on May 2, 1972. (FF 106).

It is abundantly clear from the proecution history of the '915 patent that the argument before the Patent Office on which Corning ultimately prevailed involved making an optical waveguide using fused silica as the cladding and as the core thus giving both cladding and core similar characteristics; that it was essential to have a selectively higher index of refraction in the core than in the cladding but with the difference in the refractive indices small; and that minimal amounts of impurity (dopant) added to fused silica can result in a predictable refractive index difference between the fused silica core and fused silica cladding.

The Administrative Law Judge recognizes that Corning in the '915 patent prosecution argued that the particular combination of elements recited by original claim 1, which included a core formed of fused silica doped to a degree in excess of the cladding layer so that the refractive index of the core is greater than the refractive index of the cladding (as does claim 1 in issue) "is necessary" and "absolutely essential" to overcome all of the prior art disadvantages (FF 95, 97); that in respondents' S-3 fiber dopant is and

is added to the as it is to respondents' S-2

to that

used in respondents' M-1, S-1 and S-2 fibers to increase the indices of refraction of the cores was not known, as a dopant when the '915 application was filed on May 1, 1970. However, in applying the doctrine of equivalents, the Administrative Law Judge is guided by a corollary rule, soundly developed from the sensible proposition that some inventions by their very nature deserve a liberal construction of the doctrine of equivalents; that if a patent is of pioneering status, the patent is allowed a wide range of equivalents, and if a patent is a narrow patent or the art is crowded a patentee is only allowed a corresponding narrow range.

The concept of a "pioneer" patent was recognized by the Supreme Court in Morley Sewing-Machine Co. v. Lancaster, 129 U.S. 263 (1889) where the Court, in reversing a finding that infringement of Morley's patent on a button-sewing machine was avoided by certain mechanical differences, stated:

> Morley, having been the first person who succeeded in producing an automatic machine for sewing buttons of the kind in question upon fabrics, is entitled to a liberal construction of the claims of his patent. He was not a mere improver upon a prior machine, which was capable of accomplishing the same general result, in which case his claims would properly receive a narrower interpretation. This principle is well settled in the patent law, both in this country and in England. Where an invention is one of a primary character, and the mechanical functions performed by the machine are, as a whole, entirely new, all subsequent machines which employ substantially the same means to accomplish the same result are infringements, although the subsequent machine may contain improvement in the separate mechanisms which go to make up the machine. [129 U.S. at 2733]

The Court of Customs and Patent Appeals has defined a pioneer invention as an inventon performing a function never before performed. Sealed Air Corp. v. U.S. International Trade Commission, supra 209 USPQ at 477.

4. The Pioneer Status of the '915 Patent

It had long been observed that light can be guided through a transparent medium which is surrounded by another medium of lower refractive index. From this, it was recognized that glass in a flexible fiber form in an air atmosphere serves as a conduit for light wave. (FF 217-219). In the 1950's the idea of cladding an optical waveguides was old. (FF 220). Moreover, with the invention in the 1960s of the laser, which provided a controlled source of light upon which information could be supplemented, interest in lightwave communication systems grew. (FF 225).

As early as 1963 researchers at Bell Telephone Laboratories directed their attention towards development of a suitable medium or pipe for tranmission of laser pulses. (FF 227). A Bell patent issued in 1969 on applications filed in the mid sixties for an optical waveguide design which was said to control the dielectric constant of the wavepath. (FF 227). Researchers at Bell Labs also investigated various system of light-focussing gas and glass lenses arranged within metal pipes, designed to guide beans of light around corners and to counteract the tendency of light to spread, while avoiding the high attenuation of glass fibers. While such focussing systems worked, they were costly and nearly impossible to maintain over a reasonable period of time. (FF 227).

In 1965 an article was published on an analysis of light signal propagation in a glass fiber with a graded index core. (FF 226). Also in 1965 scientists were forming luminescent glass fibers with a central core of vitreous silica containing a rare earth oxide and an outer sheath containing substantially no rare earth oxide. Thus a patent application filed in the United Kingdom on March 29, 1965 1,113,101 (U.K. '101 patent) published on May 8, 1968) and based on several United States applications filed on March 27, 1964 (FF 239-252) disclosed luminescent glass fibers comprising a central core of vitreous silica containing a rare earth oxide in amounts of 5 to 5000 rare earth atoms per million silicon atoms and an outer sheath of vitreous silica containing substantially no rare earth oxide. (FF 239-252).

The outer sheath could be readily removed, if necessary, by grinding. (FF 245).

In the U.K. '101 patent rare earth oxides, such as lanthanum or ytterbium oxides, specifically described as dopant materials in the '915 patent (FF 78), as well as oxides of praseodymium, neodymium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, lutetium or promethium may be used in the disclosed compositions. (FF 241). The silica glass fibers containing the rare earth oxides with the silica sheath in the U.K. '101 patent can be used in various luminescence devices and while they cannot be used as cathodoluminescent fibers by bombardment of elections though the sheath since the electrons will not sufficiently penetrate the sheath, they can be so employed by bombardment of the end where the luminescence glass with the rare earth oxide is exposed. Then only the end of the fiber will luminscence. (FF 243). Critical to the compositions of the U.K. '101 patent is the use of rare earth elements in the form of oxides to promote absorption of light through which luminsecence is obtained. This is to be avoided in an optical waveguide fiber. (FF 246).

In 1966 a search was going on by the British Post Office for a useful long distance light guiding structure. The goal was to achieve a structure capable of transmitting 1 percent of the light input over a distance of one kilometer. (FF 154). Such a structure would have a light attenuation of only twenty decibels per kilometer (20dB/km). (FF 154). In 1966 a typical form of fiber optics had an attenuation of approximately 1000 dB/km. This meant that over a distance of 1 kilometer, a 1000 dB/km conventional fiber could transmit only 10^{-98} percent of the input light, 98 orders of magnitude below the desired

1% or 20 dB/km. (FF 154). Putting it another way the advance from a conventional glass fiber optical with an attenuation on the order of 1000 db/km to an optical waveguide of 20dB/km required a 50 fold improvement. (FF 154).

A Kao-Hochham article published in July 1966 identified some of the problems to be overcome in obtaining a glass optical waveguide fiber. (FF 229-238). It was disclosed that a dielectric fiber with a refractive index higher than its surrounding region is a form of dielectric waveguide which represents a "possible medium" for the guided transmission of energy at optical frequencies; that the best transparent "low - loss" materials were polymethyl methacrylate and polystyrene; that the best absorption coefficient for glass gives a bulk loss of about 200 dB/km; that theoretical and experimental studies indicate a fiber of glassy material constructed in a cladded structure with a certain core diameter represents a "possible practical" optical waveguide with important potential as a new form of communication medium. (FF 230). The authors noted that the "crucial material problem" appears to be one which is difficult but not impossible; that the goal of attaining a required loss figure of around 20 db/km is "much higher" than the lower limit of loss figure imposed by fundamental mechansims. (FF 230).

In 1966 pure fused silica glass with good ultra violet transparency was used in applications where such transparency was needed. (FF 155, 283). Moreover as early as 1954 titania doped silica systems were known as. (FF 155). In a U.K. application filed in 1968 Kao referred to "conventional" cladding material for glass fibers as being another glass of lower refractive index (FF 155), Kao also observed that the cladding of optical fibers with a transparent medium of lower refractive index than that of the fiber material was "widely used" in fiber optics to eliminate light losses and contamination suffered at the fiber-air interface of uncoated fibers. (FF 237). Still Kao, who presumably is a person having at least "ordinary skill in the art to which said subject matter pertains" and who was working in communication (FF 236) offered in the 1966 Kao-Hockham article no practical solution in meeting the 20dB/km goal, said nothing about using a doped silica in an optical waveguide and proceeded to propose in 1968 the light transmitting fibre core is clad with ice. (FF 237, 238).

In 1966 inventor Maurer decided to investigate the properties of and to evaluate, Corning glasses for the use posed by the British Patent Office. (FF 154). Working with inventor Schultz who joined Corning in August 1967, they developed an optical waveguide having a core glass composition of 3 wt. % titania - silica which exhibited an attenuation of 20 dB/km, the goal set by the British Post Office. (FF 153-185). Corning internally reported this achievement in a report dated January 26, 1970 and noted that this optical wave guide fiber met the project goal set up 3 years ago for a practical waveguide system. (FF-183).[8/] Such fibers were loaned to researchers at the British Post Office, London and supplied to Bell Laboratories, Murray Hill, New Jersey and these researchers confirmed the total attenuation of 20 dB/km. (FF 190).

8/ In Corning's proposed finding 48, Corning alleges for the claimed invention of the '915 patent, a conception date of March 1, 1967 and an actual reduction to practice by August 1, 1968. The Administrative Law Judge makes no findings with repect to any conception and actual reduction to practice dates.

The 20 dB/km optical waveguide system was the break through many communication systems were waiting for. (FF 190). At 20db/km, fibers could begin to be considered for long-distance transmission of light and to be competitive with metal wires, cables, and microwave relay (FF 191). An optical waveguide, as a satisfactory transmitting media for frequencies around 10^{15} hz, and which allowed only preselected modes of light to propagate along the fiber had been produced. (FF 67).

Corning's development of optical waveguide fiber whose attenuating loss was only 20 dB/km enabled fiber losses to be further reduced steadily. (FF 192). Progress in the science and technology of fiber transmission developed thereafter along a broad front. (FF 193). Over 99% of all optical waveguide fibers which have been made and sold commercially in the world have been formed with doped fused silica, Doped fused silica optical waveguide fiber has led to a multimillion dollar industry where some fifteen years ago there was industry at all. (FF 66, 67).

Accordingly, the Administrative Law Judge finds that the record establishes that the '915 patent is of pioneer status.

5. ________

Respondents, citing <u>Halliburton Oil Well Cementing Co. v. Walker</u>, 329 U.S. 1, 13 (1946); <u>Rowell v. Linsay</u>, 113 U.S. 97, 102, (1885); <u>Fuller v. Yentzer</u>, 94 U.S. 288, 297 (1877); <u>Gill v. Wells,</u> 89 U.S. (22 Wall.) 1, 15,(1874); <u>Gould v. Ress</u>, 82 U.S. (15 Wall) 187, 192-194, (1892); <u>Seymour v. Osborne</u>, 78 U.S. (11 Wall.) 33, 42 (1871); <u>Laser Alignment, Inc. v. Woodruff & Sons, Inc.</u>, 491 F.2d 866, 873 (7th Cir. 1974); and <u>Kemart Corp. v. Printing Arts Research Labs.</u>, 201 F.2d 624, 630 (9th Cir. 1953), argue that   cannot be included within the ambit of claims 1 and 2 in issue because   could not be used for the purpose of the invention "as of the time of the issuance" of the '915 patent. (RPHP 8). Hence it is argued that accused M-1, S-1 and S-2 fibers avoid infringement.

Contrary to respondents' urgings, a - silica glass blank was successfully produced and drawn into a multimode optical waveguide by Corning prior to the May 2, 1972 insuance of the '915 patent. (FF 304). Still the record is conclusive that, is not listed as a dopant in the '915 patent (FF 299); that insufficient work had been done at Corning with when the '915 application was filed on May 11, 1970 to include it as a dopant in the application as filed (FF 301); and that as of May 11, 1970, Corning had only made fibers containing titania doped fused silica, alumina-doped fused silica and zironia-doped fused silica. (FF 308).[9/]

Language in the cases cited by respondents supports respondents' argument. For example in Gould v. Rees., the Supreme Court stated that if an alleged infringer substitutes one of the ingredients of a patentee's patented combination with one which was old "but was not known at the date of the ... [patentee's] invention as a proper substitute for the omitted ingredient, then he does not infringe." 82 U.S. at 194. Moreover, in the Graver Tank case, the Supreme Court, in determining equivalents stated an important factor to be considered is "whether persons reasonably skilled in the act would have known of the

---

9/ There is testimony that Corning did not include as a dopant material in the '915 application as filed because insufficient work had been performed with it. (FF 308). Corning however, did include oxides of tantalum, tin, niobium, ytterbium and lanthanum even though it had not made optical waveguides fibers containing such oxides. (FF 308.)

interchangeability of an ingredient not contained in the patent with one that was." Id. 85 U.S.P.Q. at 331. When the '915 application was filed on May 11, 1970 inventors Maurer and did not consider interchangeable with the specific oxides named in the '915 specification. 10/

Despite the cases relied on by respondents a number of court decisions have adopted a contrary view, viz. that the alleged equivalent need not exist or be known as an equivalent at the time the invention was made.

In Morley Machine Co. v. Lancaster, supra, the Supreme Court in finding infringement stated that the important factor was that the accused and claimed mechanisms performed each the same function in substantially the same way and are combined to produce the same result even though the accused mechanism may have been unknown at the time the claimed invention was made. Id. 129 U.S. at 284.
See also Edison Elec. Light Co. v. Boston Incandescent Lamp Co., 62 F. 397 (C.C.D. Mass 1894); Techincal Tape Corp. v. Minnesota Mining & Mfg. Co., 247 F.2d 344, 350 (2nd Cir. 1957), cert. denied. 355 U.S. 952 (1958); Finkelstein v. S.H. Kreis & Co., 113 F.2d 431,433 (2nd Cir. 1940); Lockheed Aircraft Cop. v. United States, 553 F.2d 69,84 (2nd Cir. 1977); Waterproof Insulation Corp. v. Insultating Concrete Corp., 153 F. Supp. 626, 114 U.S.P.Q. 265 (D.C. Md. 1957); Diamond Int'l Corp. v. Maryland Fresh Eggs, Inc., 374 F. Supp. 1223, 182 U.S.P.Q. 147 (D.C. Maryland 1974); Slaytex & Co. v. United States

10/ Commercial production of optical fiber by Corning, did commence at least in 1972. (FF 297). Optical fiber was first produced by SEI in 1972 and its commercial production of optical waveguide fiber did not commence until 1976. (FF 296).

Insulation Corporation, 20 F. Supp. 376, 380 (S.D.N.Y. 1937); International Nickel Company v. Ford Motor Company, 166 F. Supp. 551, 564 n. 15 (S.D.N.Y. 1958).

In Hughes Aircraft Co. v. United States, 717 F.2d 1351, 1362, 219 USPQ 471, 481 (Fed. Cir. 1983) the Federal Circuit stated that "An applicant for patent ... is not required to predict all future developments which enable the practice of his invention in substantially the same way". This language was quoted with approval by the Federal Circuit in Kinzenbaw et al v. Deer & Co. (Nos. 83-1424 and 84-523), slip opinion at 14 (August 7, 1984).

A Federal Circuit case of particular import is Altas Powder Company v. E.I. DuPont De Nemours et al., (No. 84-504), slip opinion (December 27, 1984). The similarities in that case to issues in this investigation are striking. In the Atlas Powder case in early 1966 Atlas' inventor Bluhm formulated an initmately mixed water-in-oil, water resistant emulsion blasting agent which was sensitized with entrapped air rather than high explosives or chemicals. The emulsion blasting agent was the subject matter of a patent which issued on June 3, 1969 and was in issue in the Atlas Powder case. In 1976 DuPont formed a team to study the feasibility of an emuilsion blasting agent. This team succeeded in making a water-in-oil emulsion blasting agent which DuPont began making and selling in 1978 and which led to a suit for infringement against DuPont by Atlas. The district judge found DuPont's products infringed claims of the Bluhm patent under the doctrine of equivalents. DuPont, before the Federal Circuit, argued that the district court focused on the "function, purpose, and quality" of the emulsifying agents of Du Pont and the claimed invention and that that focus ignored the Graver Tank triparite test. The Federal Circuit disagreed stating:

Though Graver Tank articulates the tripartite test of "function, way, and result," it also states that the doctrine of equivalence should not be the prisoner of a rigid formula. Moreover, Graver, which as here compared a claimed mixture with an accused mixture in which one ingredient of the claimed mixture was changed, stated:

> Consideration must be given to the purpose for which an ingredient is used in a patent, the qualities it has when combined with the other ingredients,and the function which it is intended to perform. Id at 611. [slip opinion pp. 24-25].

Significant too is the following language of the Federal Circuit in the Atlas Powder case

> We agree with Bendix Corp. v. United States, 199 U.S.P.Q. 203 (Ct. Cl. Trial Div. 1978), aff'd, 600 F.2d 1364, 204 U.S.P.Q. 617 (Ct. Cl. 1979). There the trial judge said that where defendant has appropriated the material features of the patent in suit, infringement will be found even when those features have been supplemented and modified to such an extent that the defendant may be entitled to a patent for the improvement. 19 U.S.P.Q. pp. 221-22. [slip opinion p. 27].
>
> DuPont contends that one skilled in the art in 1966 would not have known that the '978 and DuPont products were equivalent. It is not a requirement of equivalence, however, that those skilled in the art know of the equivalence when the patent application is filed or the patent issues. That question is determined

> as of the time infringement takes place. [slip opinion p. 28].

The record before me establishes that (a polyvalent metal oxide) in respondents' accused compositions performs substantially the same function in substantially the same way to yield substantially the same result as the polyvalent metal oxides specifically recited in the '915 patent. Respondents have offered no evidence to the contrary.

Respondents argue that inventors Maurer and Schultz "recognized that could not have been contemplated by the '915 patent claims in issue since these claims exclude core dopant useable in amounts exceeding 15 percent by weight." and the inventors obtained United States Patent No. 3,884,550 (the '550 patent), on a germania containing optical waveguide wherein the is in excess of 15% by weight (RPFF 27). This argument is not persuasive. The '550 patent, which issued on May 20, 1975, was based on an application filed January 4, 1973 which in turn was based on an invention disclosure dated June 19, 1972. (FF 302). All of these dates are subsequent to the May 2, 1972 issuance date of the '915 patent and subsequent to when inventor Schultz in early 1972 produced a glass blank and redrew it into a multimode optical waveguide which had very low optical laser (FF 304). Thus scientists at Corning, before SEI went into commerical product of its optical fiber waveguide fiber recognized that in amounts not exceeding 15% by weight, was a dopant material which increases the index of refraction of a fused silica core (FF 296).

6. Doped Fused Silica

Respondents argue that was not within the scope of '915 patent because inventor Schultz admitted at the hearing that the Keck-Schultz method discosed in U.S. Patent No. 3,711,762 (CX 8A) and described in column 4, ll. 4-12 of the '915 specification for producing the waveguide of the invention in issue was never used to prepare a doped fiber (RPFF 29). The evidence however shows that Dr. Schultz only stated that Corning was unsuccessful in doping silica with in amounts greater then .1%, using a flame hydrolysis technique prior to the May 11, 1970 filing of the '915 application (FF 316, 317, 330, 331, 333). Corning then was unsucessful because the early work with was done with a direct vitrification method of flame hydrolysis which involved the direct dopositing of glass in bulk form with a high temperature furnace and which was not the variant of the flame hydrolysis technique used to eventually make successful optical waveguide fibers (FF 316). The direct depositing of glass in bulk form (the boule process) involved a very high temperature in the furnace and hence volatilized as it was being deposited into the furnace. Accordingly, small amount remained in the actual boule of glass (FF 316). To the contrary the Keck-Schultz method referenced in the '915 patent is not limited to direct depositing glass in a furnace. As the specific example of the '915 patent shows, glass can be deposited onto the inside wall of a tube (FF 81). However the Keck-Schultz disclosure teaches a variety of ways by which the glass may be deposited. (FF 81). Inventor Schultz did obtain in early 1972 a multimode optical waveguide fiber from an approximately glass blank using a variant of the flames-hydrolysis technique (FF 304). There is nothing in the record to contradict Schultz's testimony that if one attempted to deposit as a dopant material, ultilizing the Keck-Schultz method, one would be able to obtain a core doped in excess of .1 percent (FF 331).

Even assuming the Keck-Schultz method incorporated in the '915 patent was unsuccessful for producing a - doped optical waveguide, this fact would not be controlling. As the Federal Circuit stated in the Atlas Powder case

> ... finding equivalence is not inconsistent with a patentee's unsuccessful attempt to make the accused product. The focus in assessing equivalence is on whether the accused product performs substantially the same as the claimed product in function, way and result -- it is not on the patentee's ability to devise a product equivalent to the patented product. Indeed, the patentee's incentive to devise an equivalent product is often less than a competitor's, which alone may account for the competitor's success and the patentee's failure in devising the equivalent product. See e.g., Leesona Corp. v. Varta Batteries, Inc., 522 F. Supp. 1304, 1328, 213 U.S.P.Q. 222, 241 (S.D.N.Y. 1981). (Slip opinion p. 29).

7.

Respondents argue that Corning's attempt to invoke the doctrine of equivalents for the purpose of including the S-2 and S-3 fibers within the scope of claims 1 and 2 of the '915 patent must be rejected. They refer to a telephone interview Corning's Mr. Walter S. Zebrowski had with the Patent Office Examiner in November, 1971, during the prosecution of the '915 patent application in which the Examiner required claimed language showing the addition of a dopant material to the fiber's core "in at least an elemental basis" in an amount not exceeding 15% by weight (FF 105). Respondents argue that it is clear that the doctrine of prosecution estoppel, also termed "file wrapper estoppel", precludes a patent owner from later broadening the description of a claimed element limited during prosecution so as to encompass a composition which a competitor should reasonably believe is not within the legal boundaries of a claim in suit. (RPHP 8).

The extent to which the doctrine of equivalents is utilized by a tribunal to benefit a patentee is measured by estoppel arising from the prosecution history Coleco Industries, Inc. v. U.S. International Trade Commission 573 F.2d 1247, 1257-1258, 197 U.S.P.Q. 472, 478-480 (CCPA 1978). Moreover the estoppel arises not only from amendments made to claims during the prosecution but even from arguments made in the prosecution Id.

The doctrine of file wrapper estoppel is a rule of ancient and honorable lineage in the law of patent infringement. It is a common law concept that lawyers and judges accustomed to construe contracts quite readily apply to patent grants.

The decision that gave file wrapper estoppel firm footing as a rule that is not overpowered even by the doctrine of equivalents is Exhibit Supply Co. v. Ace Patents Corporation 315 U.S. 126, 52 U.S.P.Q. 275 (1942) rehearing denied 315 U.S. 828 (1942). Exhibit Supply involved a patent on a part of a pinball machine. The specific point of the invention was a new and novel resilient switch that closed an electric circuit when the target pin was hit by the rolling ball. The claim of the patent was directed to a "conductor means ... embedded in the table."52 U.S.P.Q. at 279. In the accused device, the conductor means was not "embedded in" the table; instead, it was "carried by the table." The Supreme Court found that this construction did not infringe because the file wrapper showed that upon the insistence of the Examiner, the inventor changed his claim from one covering a conductor means "carried by the table" to one where the conductor means was "embedded in the table." As to this change, the Court said: "it is immaterial whether the examiner was right or wrong in rejecting the claim as filed." 52 U.S.P.Q. at 280. The reason this is "immaterial" is that:

> "what the patentee . . . has disclaimed --conductors which are carried by the table but not embedded in it--cannot now be regained by recourse to the doctrine of equivalents, which at most operates, by liberal construction, to secure to the inventor the full benefits, not disclaimed, of the claims allowed." Id

The facts in the prosecution of the '915 patent application are distinguisable from Exhibit Supply. In the '915 prosecution the amendments were made to further distinguish the doped fused silica in the claimed subject matter over the cited Flam et al. patent (FF 109). The Flam et al. patent involved the formation of an optical waveguide from solid optical dielectric material as fused silica, not by adding chemical compounds or elements to the fused silica but by changing the density, and the structural displacement of the atoms or molecules of the fused silica through irradiation (FF 275-278). Although the Examiner in prosecution of the '915 patent application cited references showing glasses doped with chemicals and showing a variation of doping concentration produces a variable index of refraction, no rejection on such references was made by the Examiner

(FF 89-105). Because the amendments to the claims in the '915 application were made to further distinguish the claimed subject matter from the Flam et al. patent which concerned only irradiating fused silica, the Administrative Law Judge can find no support for the conclusion that Corning gave up either the inclusion of a to a the which (accused S-2 and S-3 fibers) or the use of a (accused S-3 fiber) in the '915 invention. While in the Exhibit Supply case, the inventor changed his claim in prosecution from one covering a conductor means "carried by the table" to one where the conductor means was "embedded in the table", the claimed language in the '915 application consistently read on a doped core. This is shown by a comparision of original claim 1, amended claim 1 and claim 1 in issue. (FF 64, 89, 99).

Corning during the prosecution did place an upper limit on the amount of dopant material in the optical waveguide . Accordingly as Corning has recognized, it is estopped from asserting that optical waveguide fibers containing more than 15% dopant material, such as the M-2 fiber which contains about infringes the '915 patent (FF 49, 50).

Respondents point to the fact that was recognized as a compound that decreases the index of refraction of silicate glasses before the '915 application was filed and suggest that the lack of mention of index of refraction reducing dopants in the '915 specification was intentional (RPFF 20). To the contrary, the inventors consistently testified that, prior to filing the '915 application, they had not experimented with dopant materials which decreased the index of refraction of pure fused silica; that had they done so specific reference to such materials would have been made in the '915 application as filed (FF 307, 311).

8. Corning's U.K. Patent 1,322,992

Respondents argue that Corning in the British counterpart to the '915 patent, (U.K. Patent No. 1,322,992, (U.K. '992 Patent)) admitted by the definition of dopant in the U.K. '992 patent that the only dopants useable in the '915 invention are those that increase the index of refraction of fused silica (RPFF 21) (FF 319).

Corning's definition of dopant in a particular way in U.K. '992 patent however does not serve as an admission with regard to the '915 patent. The '915 patent does not require that the dopants useable in the '915 invention only increase the index of refraction (FF 78). Moreover during the prosecution of the '915 patent, Corning took the position that a dopant is a small quantity of a substance added to another substance "to alter the latter's properties" (FF 101, 102). Neither inventor Maurer nor Schultz could recall ever having seen the reference language in the U.K. '992 patent, nor had they ratified or approved the definition of dopant in the British patent. (FF 320). Both inventors believed the language in question to be more restrictive than their concept of the invention of the '915 patent. (FF 320). Moreover, the Belgian, French, Italian, Japanese, German and Canadian counterparts to the disclosure of the '915 patent do not define dopant as a material which causes the index of refaction of doped fused silica article produced therefrom to be increased only above that of pure fused silica. (FF 321-326).

9. Accused Fibers Do —ıfringe

Based on the foregoing, the Administrative Law Judge finds that Corning has met its burden by a preprondeerance of evidence in proving that the accused M-1 and S-1 fibers infringe claims 1 and 2 of the '915 patent; and that the accused S-2 and S-3 fibers infringe claim 1 of the '915 patent.

III. Validity of Claims 1 and 2 of the '915 Patent

A. 35 U.S.C. §§ 102, 103

Claims 1 and 2 of the '915 patent are entitled to the presumption of validity afforded by 35 U.S.C. § 282[11/] Structural Rubber Products Company v. Park Rubber Company, Appeal No. 83-1326, (Slip Opinion p. 13 (Fed.Cir. Nov. 9, 1984); RCA Corp. v. Applied Digital Data Systems, Inc., 730 F.2d 1440, 1443 (Fed.Cir. 1984); Preemption Devices v. Minn.Min. & Mfg. Co., 732 F.2d 903, 907 (Fed.Cir. 1984); Jones v. Hardy, 727 F.2d 1524, 1528, 220 U.S.P.Q. 1021 (Fed.Cir. 1984).

Respondents bear the burden of proving, by clear and convincing evidence, facts which establish that claims 1 and 2 of the '915 the patent are invalid. Railroad Dynamics, Inc. v. A. Stucki Co., 727 F.2d 1506, 1516 (Fed.Cir. 1984); Certain Silica-Coated Lead Chromate Pigments, 219 USPQ 1009, 1011 (U.S.I.T.C. 1983); Bio-Rad Laboratories, Inc. v. Nicolet Instrument Corp., 739 F.2d 604, 615 (Fed.Cir. 1984);

11/ 35 U.S.C. § 282 reads in pertnent part:
"A patent shall be presumed valid.... The burden of establishing invalidity of a patent or any claim thereof shall rest on the party asserting such invalidity."

American Hoist & Derrick Co. v. Sowa & Sons, Inc., 725 F.2d 1350, 1360, 220 U.S.P.Q. 763,770 (Fed. Cir. 1984) cert. denied 53 U.S.L.W. 3225, (U.S. Oct. 2, 1984). The presumption of validity remains intact. Thus, respondents not only have the procedural burden of establishing a prima-facie case, but the burden of persuasion remains on the respondents and the "clear and convincing" standard does not change. TP Laboratories v. Professional Positioners, Inc., 724 F.2d 965, 971 (Fed.Cir. 1984); SSIH Equipment S.A. v. U.S. I.T.C., 718 F.2d 365, 375 218 U.S.P.Q. 678 (Fed.Cir. 1983); RCA Corp. V. Applied Digital Data Systems, Inc., supra, 730 F.2d at 1444; Jervis B. Webb Co. v. Southern Systems,Inc., 742 F.2d 1388, 1392 @ n.4, 222 U.S.P.Q. 943, 945 & n.4 (Fed. Cir. 1984); Stratoflex, Inc. v. Aeroquip Corp., 713 F.2d 1530, 1534, 218 U.S.P.Q. 871, 875 (Fed. Cir. 1983).

While deference is due a United States Patent and Trademark Office decision to issue a patent with respect to evidence bearing on validity which it considered, no such deference is due with respect to evidence it did not consider. American Hoist & Derrick Co. v. Sowa & Sons, Inc., supra, Also the premise that doubts as to patentability should be resolved in favor of a patentee is now defunct. See In re Nabor, 503 F.2d 1059, 1059-60, 183 U.S.P.Q. 245, 246 (C.C.P.A. 1974); In re Successor In Interest to Walter Anderson, (Slip Opinion at 4).(Fed. Cir. 1984).

Respondents argue that the most pertinent prior art reference to claims 1 and 2 of the '915 patent is U.K. Patent 1,113,101 (U.K. '101 patent). It is argued that anticipation under 35 U.S.C. § 102 has been demonstrated because the U.K. '101 patent discloses an optical fiber comprising a core made up primarily of pure fused silica "doped" with lanthanum or ytterbium oxides, which are among the oxides disclosed in the '915 patent, and a cladding containing pure fused silica with, sometimes, a lesser of said oxides. (RPHP p. 14) Respondents argue that the foregoing is effectively admitted by Corning in its U.K. Patent 1,322,992 (U.K. '992 patent), the British counterpart to the '915 patent in issue (RPHP pp. 14-15). Respondents' expert Dr. Pedro B. Macedo further testified that the product of the U.K. '101 patent is within the scope of claims 1 and 2 of the '915 patent (RPX 101A para. 31).

Respondents argue that even if the U.K. '101 patent differs from claims 1 and 2 of te '915 patent, any difference, when considered in light of the Kao and Hockham article, on "Dielectric-Fiber Surface Waveguides for Optical Frequencies "in the July 1966 issue of Proceedings of the IEEE, Vol. 113, No. 7 (the Kao article) would have been obvious within the meaning of 35 U.S.C. § 103 at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains (RPHP p. 15)

It is argued that Corning cannot rely on commercial success as a secondary cosideration evidencing non-obviousness because the record shows that Corning's optical fibers currently being commercially produced are all doped with   dopants and since   is not a dopant contemplated by claims 1 and 2 of the '915 patent, such fibers fall outside the scope of those claims. Also it is alleged that there is no evidence that Corning's licensees produce a '915 fiber (RPHP p. 16)

Respondents' expert Dr. Macedo testified that each of U.S. Patent Nos. 2,326,059 to Nordberg and 3,334,982 to Mattmuller clearly discloses glasses that fall within the core glasses claimed in the '915 patent (RPX 103A, paras. 24, 25), and that the Kao article, which was not cited to the Patent Office, in combination with U.S. Patent Nos. 2,326,059 to Nordberg, 3,334,982 to Mattmuller, 3,607,322 to Brady et al and/or U.K. Patent 1,160,535 renders obvious the alleged invention of the '915 patent to one of ordinary skill in the relevant art in 1969 or 1970 (RPX 103A, paras. 26, 32, 33). Dr. Macedo further testified that the combination of Corning's well known glass Nos. 7940, said to be a pure fused silica, and 7971 said to be a high fused silica content glass doped with a small amount of titanium, publicly offered for sale by Corning prior to 1969 renders obvious the claimed invention of the '915 patent (RPX 103A, para. 34).

35 U.S.C. § 102 provides in pertinent part:

A person shall be entitled to a patent unless

> (a) the invention was ... patented or described in a printed publication in this or a foregin country, before the invention thereof by the applicant for patent, or (b) the invention was patented or described in a printed publication in this or a foreign country ... more than one year prior to the date of the application for patent in the United States, ...

Anticipation relates to a single prior art reference. Connell v. Sears, Roebuck & Co., 722 F.2d 1542, 220 U.S.P.Q. 193 (Fed. Cir. 1983); SSIH Equipment S.A. v. U.S.I.T.C., supra. Where a foreign publication is used as a reference "it is not competent to read into a foreign publication any information which it does not afford on its face." Baldwin-Southwark v. Coe, 133 F. 2d 359, 55 U.S.P.Q. 398, 407 (D.C. Cir. 1942); Nordberg Mfg. Co. v. Woolery Machine Co., 79 F.2d 685, 687 (7 Cir. 1935); Dart Industries, Inc. v. E.I. du Pont de Nemours & Co., 348 F.Supp. 1338, 1356 (N.D.Ill. 1972), reversed on other grounds 489 F.2d 1359 (7 Cir. 1973); Carboline Company v. Mobil Oil Corporation, 301 F.Supp. 141, 150 (N.D.Ill. 1969)

Each of claims 1 and 2 is drawn to an optical waveguide comprising a combination of old components. The concept of an optical fiber having a core with a higher index of refractive than a surrounding cladding was old when Dr. Maurer and Dr. Schultz filed their patent application on May 11, 1970. (FF 229). What inventors Maurer and Schultz did invent, was a fused silica optical waveguide fiber with a greater core over cladding refractive index controlled through the use of dopant material. It is immaterial that the claimed subject matter involves a combination of old components. The Federal Circuit has made it clear that there is no special or different patentability standard for "combination" patents Medtronic Inc. v. Cardiac Pacemaker Inc. 721 F..2d 1563, 2204, 220 U.S.P.Q. 97 (Fed.Cir. Nov. 1983).[12/]

35 U.S.C. 103 has been referred to as the heart of the patent system.[13/] It sets a condition of patentability. The condition is unobviousness but that is not all. The unobviousness is as of a particular time and to a particular legally fictitious, technical person, analogous to the "ordinary reasonable man" so well known to courts as a legal concept. To protect the inventor from hindsight reasoning, the time is specified to be the time when the invention was made. To prevent the use of too high a standard, the invention must have been obvious at that time to "a person having ordinary skill in the art to which said subject matter pertains". As Judge Rich observed in In re Winslow, 365 F.2d 1017, 1020 (CCPA 1966):

> [T]he proper way to apply the 103 obviousness test...is to first picture the inventor as working in his shop with the prior art references--which he is presumed to know--hanging on the walls around him. See In re Keller, 208 U.S.P.Q. 871,881 (CCPA 1981).

What must have been obvious "is the subject matter as a whole" which is the invention defined by each patent claim.

12/ Almost all inventions involve combinations. See Judge Giles S. Rich "Laying The Ghost Of The 'Invention' Requirement" APLA Journal Vol. 1 p. 43 (1972)

13/ Judge Giles S. Rich "Laying the Ghost of the 'Invention' Requirement" Id. p. 26

To invalidate the optical waveguides of claims 1 and 2 under § 103 respondents have the burden to show that a fused silica optical waveguide composed of a combination of a fused silica core and a fused silica cladding with a greater core over cladding refactive index controlled by dopant material was obvious at the time the waveguide was made. Perkin-Elmer Corp. v. Computervision Corp, 732 F.2d 888, 894 (Fed.Cir. 1984); In re Certain Surveying Devices, 208 USPQ 36, 42-43 (U.S.I.T.C 1980). To invalidate the claimed waveguides under § 102, respondents have the burden to show that all the components of the claims in issue are found "in exactly the same situation and united the same way to preform the identical function in a single prior art reference" Scott v. Inflatable Systems, Inc., 222 USPQ 460, 461 (9th Cir. 1983); W.L. Gore & Associates, Inc. v. Garlock, Inc., 721 F.2d 1540, 1548, 1554 (Fed.Cir. 1983); In re Certain Automatic Crankpin Grinders, 205 USPQ 71, 76 (ITC 1979); Structural Rubber Products Company v. Park Rubber Company, Appeal No. 83-1326, Slip Opinion p. 16 (Fed.Cir. Nov. 9, 1984).

The Supreme Court detailed the factual considerations which tribunals must apply in determining the question of obviousness in Graham v. John Deere Co., 383 U.S. 1,17-18, 148 USPQ 454,467 when it 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".

Further, the Supreme Court emphasized the importance of these factual determinations by stating "[w]e believe that strict observance of the requirements laid down here will result in that uniformity and definiteness which Congress called for in the 1952 Act". Id.

In two cases decided by the Federal Circuit in February 1984, Chief Judge Markey referred to secondary considerations evidence as "objective indicia of non-obviousness" and elevated them to the status of a fourth factual inquiry mandated by Graham, Thus the Chief Judge stated that they "must always be considered before a legal conclusion under § 103 is reached." Jones v. Hardy, supra. See also Rosemount, Inc. v. Beckman Insts., Inc., 727 F.2d 1540, 221 U.S.P.Q. 1 (Fed. Cir. 1984).

The Federal Circuit, citing Jones v. Hardy, has reversed a holding of non-obviousness specifically because a lower court excluded evidence of secondary considerations. Thus in Simmons Fastener Corp. v. Illinois Tool Works, Inc., _______ F.2d ______, _____ U.S.P.Q. _____ (Fed. Cir. July 1984) it stated:

> "The § 103 test of nonobviousness set forth in Graham is a four part inquiry comprising, not only the three familiar elements...., but also evidence of secondary considerations....
>
> Only after all evident of nonobviousness has been considered can a conclusion on obviousness be reached.

The court also has gone so far as to "vacate" a decision by the United States Patent Office Board of Appeals and remand the case for consideration of evidence of unexpected results where it determined that an appellant was not given an opportunity to submit such evidence. In re deBlauwe, 736 F.2d 699, 222 U.S.P.Q. 191 (1984). Thus the so-called "secondary considerations", such as long felt need, commercial success, expressions of disbelief by experts, and the like, have to be considered in every case for whatever probative value they have and are not to be limited to cases where patentability is a "close" question. Stratoflex, Inc. v. Aeroquip Corp., supra. See also Vandenberg v. Dairy Equipment Co., 740 F.2d 1560, 1568-69 (Fed. Cir. 1984).

In making the analysis under §103 set forth in Graham a tribunal must be careful to avoid the trap of beginning with knowledge of what the invention is and then using that knowledge as a basis to select and combine references to reach a conclusion that the invention was obvious. W.L. Gore & Associates, Inc. v. Garlock, Inc., 721 F.2d 1540, 1553 (Fed.Cir. 1983); Stevenson v. U.S.I.T.C., 612 F.2d 546, 553 (CCPA 1979). In the Gore case the Federal Circuit stated:

"To imbue one of ordinary skill in the art with knowledge of the invention in suit, when no prior art reference or references of record convey or suggest that knowledge, is to fall victim to the insidious effect of a hindsight syndrome wherein that which only the inventor taught is used against its teacher." Id.

Prior disclosures should not be combined to show obviousness where there is no suggestion in any of the disclosures that the separate concepts can be combined to produce the result achieved in the patent in issue. In re Shaffer, 229 F.2d 476, 479, 108 U.S.P.Q. 326, 328-29 (C.C.P.A. 1956); In re Hortman, 264 F.2d 911, 914, 121 U.S.P.Q. 218, 220 (C.C.P.A. 1959); Simmonds Precision Products, Inc. v. United States, 153 U.S.P.Q. 465, 469 (C. Cl. 1967).

Respondents argue anticipation under § 102 in view of the U.K. '101 patent. I have commented on the U.K. '101 patent earlier in this opinion under the subheading "The Pioneer Status of the '915 Patent". Thus the U.K. '101 patent teaches luminescent materials which may have a fused silica core which aborb radiation (FF 239-252). Light absorption by the core is precisely what must be avoided in an optical waveguide fiber (FF 246). The U.K. '101 patent does not utilize a dopant for the purpose of changing the refractive index of fused silica and it does not use a dopant to generate a controlled greater refractive index in a core over a cladding (FF 239-252) While the U.K. '101 patent discloses luminescent glass fibers wherein the central core is of fused silica containing a rare earth oxide and there is an outer sheath of fused silica, the record does not establish that such fibers are the ultra low loss light guiding "optical waveguide" fiber of the '915 invention, Respondents' expert testified that the teaching of the U.K. '101 patent that the number of rare earth atoms per million silicon atmos is from 5 to 5000 can include adding amounts of, for example, 1.3 weight % of the core (RPX-103A, para. 31). However I find no teaching in the U.K. '101 patent that the U.K. compositions necessarily include 1.3. weight % rare earth atoms in the core to obtain controlled greater index of refraction of the core over the cladding. Rather if 1.3 weight percent rare earth atoms is utilized in the U.K. patent, the atoms are used to provide a convenient brightness level under energization by readily obtainable means. (FF 243). The U.K. '101 patent is a British patent and hence is to be strictly construed according to as the legal standards already discussed. Moreover, at least as of the time the Maurer-Schultz invention was made, an accidental or unwitting duplication of an invention cannot constitute an anticipation of the Maurer-Schultz claims 1 and 2 which relate specifically to optical waveguides. Application of Felton 484 F.2d 495, 500, 179 U.S.P.Q. 295, 298 (CCPA 1973).

Respondents argue that Corning in its U.K. '992 patent, the British counterpart to the '915 patent in issue, admitted that the U.K. '101 patent is relevant prior art. Corning however in its U.K. '992 patent is disavowing any coverage for a "substantially transparent, luminescent glass" (Emphasis added) (FF 245, 251). For luminescence to occur, light must be absorbed by the core, which is precisely what is to be avoided in an optical waveguide fiber (FF 246).

Accordingly the Administrative Law Judge finds that respondents have not established that the components in the fibers of the U.K. '101 patent are in exactly the same situation and united in the same way to perform the identical function as the components of the combination in claims 1 and 2 of the '915 patent.

Respondents argue that the claimed subject matter is obvious under § 103 over the U.K.'101 patent when considered in light of the Kao-Hockham article. The Kao-Hockham article also has been commented on under the subheading "The Pioneer Status of the '915 Patent." It is only necessary to add that applicable legal precedent prevents combining disclosures without any suggestion in the disclosures they can be combined to produce the results of a claimed composition. The lack of any teaching in the U.K. '101 patent that rare earth atoms are added to the fused silica to increase its index of refraction combined with the teaching in the U.K.'101 patent that rare earth atoms are added for luminescence (FF 239-252) and the further teaching in the Kao article of the need to reduce impurities in glasses such as fused silica to one part per million (FF 231, 232) are persuasive that any suggestion to combine the U.K. 101 patent and the Kao article is lacking.

The Administrative Law Judge further finds objective indicia of non-obviousness of the claimed subject matter in issue in the record. Corning produces, and has produced single mode and multimode optical waveguide fiber with a core containing less then 15 weight of dopant and a cladding of with the index of refraction of said core greater than the index of refraction of said cladding layer (FF 346-351). Through the doctrine of equivalents, is within the claimed subject matter. Corning's claimed optical waveguide has met with commerical success (FF 194,195). There was a need for production of optical fiber in which the light loss was reduced to 20 decibels per kilometer which the claimed compositions in issue achieved (FF 154). Corning has licensed its '915 patent and some of the licensees are producing optical waveguide fiber covered by the '915 patent. (FF 196, 197). After two years of litigation Valtec, a domestic manufacturer of optical waveguide fiber and cable consented to the entry of a judgment that the '915 patent was infringed by it and also valid and Corning and Valtec compromised and settled the matter of damages (FF 199). The United States Government has entered into an agreement with Corning with a rate of compensation to be paid to Corning for the Government's procurement and/or use of optical waveguide fiber covered by Corning patents which included the '915 patent (FF 198). Prior to the Maurer-Schultz invention others had attempted, without success, to make a low light loss optical waveguide fiber (FF 229-238).

Respondents have made reference to other prior art. Such art does not persuade me that the claimed invention is invalid either under § 102 or §

103. The Nordberg patent, which was cited by the Patent Examiner but not used in rejecting any claims, merely shows that a component of the claimed invention in issue, viz. doped fused silica, was known prior to the late 1960s (FF 257-262). The Nordberg patent does not relate to optical waveguides. Moreover it does not even relate to a fiber (FF 257-262). The Mattmuller patent like the Nordberg patent, discloses doped fused silica (FF 263-268). However the patent does not relate to optical fibers (FF 263-268).

While the Brady patent discloses fiber optic devices comprising a core and cladding formed of silicate glasses, the silicate glasses of Brady are not doped fused silica (FF 279-282). The attenuation of the Brady fiber is also significantly larger than the attenuation of the claimed fibers (FF 279-282). U.K. Patent 1,160,535 has a disclosure comparable to the Brady disclosure (FF 253).

The argument has been made that the combination of Corning's pure fused silica glass and high fused silica content glass doped with a small amount of titania (glass Nos. 7940 and 7971) renders obvious the claimed invention. (FF 283) The record is lacking any evidence to show that the inventors had reason to expect that pure fused silica glass or titania-doped silica glass would have sufficiently low attenuation to be effective in a low loss optical waveguide fiber. Doped fused silica would have been expected to increase the attenuation of fused silica to an unacceptable degree (FF 231, 232). Moreover fused silica glasses require a higher working temperature than other glass. (FF 73). I am not persuaded that the record establishes that pieces of Corning's well known glass Nos. 7940 and 7971 "hanging on walls" around inventors Maurer and Schultz made the claimed invention in issue obvious.

Based on the foregoing, the Administrative Law Judge concludes that respondents have not met their burden of establishing the invalidity of claims 1 and 2 of the '915 patent. Accordingly the presumption of validity afforded the '915 patent under 35 U.S.C. §282 remains unrebutted and in full effect.

B. 35 U.S.C. §112

The first and second paragraphs of 35 U.S.C. §112 reads:

"§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.

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention."

Respondents argue that the asserted 15% claimed limitation, concerning the amount of dopant in the case, relied on in allowing the claims over the prior art was known by Corning not to be critical at the time it was asserted by Corning; and therefore, that claims 1 and 2 are invalid as not satisfying the specificity requirement of the second paragraph of 35 USC §112 because the claims do not particularly point out and distinctly claim the subject matter which inventors Maurer and Schultz regarded as their invention. (RPFF 33)

Respondents argue also that the requirements of the first paragraph of 35 USC §112 are unsatisfied by the '915 specification because an undue experimentation would be required of one of ordinary skill in the art to successfully practice the claimed invention. (RPFF 34) To establish this defense, respondents must prove by clear and convincing evidence that one skilled in the art would have found the disclosure of the '915 patent inadequate as of 1970. W.C. Gore & Associates, Inc. v. Garlock, Inc., supra, pp. 1556, 1557. Because of the presumption of validity, the disclosure of the '915 patent must be presumed enabling. The disclosure of a patent is sufficiently clear and complete (i.e., enabling) for purposes of 35 U.S.C. §

112 if a person of ordinary skill in the art could make and use the invention without undue experimentation. Lindemann Maschinenfabrik GMBH v. Am. Hoist and Derrick, 730 F. 2d 1542, 1463 (Fed,Cir. 1984); Martin v. Johnson, 454 F.2d 746, 751 (CCPA 1972). Even if additional, complex work must be performed to practice the invention, the patent is enabling if such experimentation normally is undertaken in the relevant art. In re Certain Limited Charge Cell Culture Microcarriers, 221 USPQ 1165, 1174 (U.S.I.T.C. 1983).

1. The 15 Percent Limitation

The 15% claimed limitation is in the '915 patent, viz.

> To make certain that doped fused silica possesses optical and physical characteristics almost identical to those of pure fused silica, doping materials should not exceed 15% by weight (FF 74, 975)

It was also in the '915 application as filed on May 11, 1971. (FF 75) The limitation was not something thought up by a patent attorney during prosecution when faced with a rejection by a Patent Examiner. It is highly unlikely that such happenstance could have occurred because of the statutory provision against new matter 14/, which limits the possible scope of the claimed subject matter to the disclosure of the application as orginally filed.

In 1969 inventor Schultz did produce an optical waveguide fiber containing approximately 37% alumina dopant and he reported then that the fiber exhibited "excellent single-mode transmission." (FF 329). Significantly its attenuation loss was measured to be about 450 dB/km. (FF 188). Prior to the May 11, 1970 filing date, inventors Maurer and Schultz had

14/ 35 U.S.C. § 132 states in part that "No ammendment shall introduce new matter into the disclosure of the invention."

not produced a particularly useful optical waveguide fibe containing more than 15% dopant. (FF 328). Inventor Schultz in a report dated January 26,1970 stated that a 15 weight percent titania doped glass is near the end point for homogeneous glass formation. (FF 183). Inventor Maurer recalled that the 15% limitation was his thinking when the '915 application was filed on May 11, 1970. (FF 187). In a patent application filed in the United States Patent Office on September 15, 1970, inventors stated a desirability that the doping material not exceed 15% by weight of the glass when physical properties of doped silica and silica should match closely. (FF 327). Hence there is support, viz. the wording of the '915 application as filed, contemporaneous Corning documentation and testimony of the inventors, that the inventors regarded the 15 percent limitation a part of their invention when the '915 application was filed on May 11, 1970.

Today it is apparent that the 15% limitation, from a technical sense, is not considered critical by Corning because Corning commercially produces optical waveguides containing (FF 405). However, even today, at least from a legal sense, Corning considers the 15% limitation a critical limitation. Thus, Corning has not charged respondents' M-2 fiber with infringing any claims of the '915 patent because the M-2 fiber contains dopant. (FF 50).

Admittedly, invention Maurer and Schultz in an invention disclosure dated June 19, 1972 referred to superior optical waveguide in their '915 patent and disclosed new waveguides containing from 15 to 100% concentration in combination with other oxides, primarily silica. Said invention disclosure did result in U.S. Patent No. 3,884,550 ('550 patent) following the filing of a patent application on January 4, 1973. (FF 302). However it is clear from the January 4,1973 constructive reduction to practice date of the '550 invention, that the '550 invention was conceived by inventors Maurer and

Schultz long after the May 11, 1970 filing date of the'915 patent. Hence the Administrative Law Judge finds no inconsistency in the record.

The cited Fansteel, Inc. v. Carmet Co., 210 USPQ 413, 420 (N.D. Ill. 1981) is not controllong (RPHP 10). In issue in the Fansteel case were sintered carbide compositions which had been used for many years in the metal-working industry. The expert found that the evidence established "beyond question that the only difference between the products claimed in the patent alleged to be infringed and a prior art product was that the prior art product contained 8% cobalt, whereas the claims of the patent called for products containing 9 to 20% cobalt and that the differences in properties of the compositions of the patent claims and the prior art composition were to be expected (Id. 210 USPQ at 430).

A comparison of the compositions of the claimed subject matter of the '915 patent with the compositions of the claimed subject matter of the Flam et al. patent, which the 15 percent limitation was intended to help avoid (FF 109), demonstrates that there is much more involved that a mere difference in percentages of an ingredient of the respective compositions. The claimed subject matter of the '915 patent involves a fused silica optical waveguide fiber with the core/cladding refractive index difference controlled through the use of dopant materials (FF 64); the claimed subject matter of the Flam et al. patent involved a waveguide core which is inherently doped with irradiating atomic particles that are used to alter the refractive index. (FF 275-278).

2. Undue Experimentation

Respondents argue that one of ordinary skill in the art would be required to exercise substantial ingenuity in order to sift through the myriad number of chemical compounds that are capable of altering the index of refraction of fused silica glass to determine which would produce an acceptable optical fiber and which would not; that this was vividly demonstrated by the testimony of the inventors and the experts; and that only one working example to titanium oxide is embodied in the '915 patent. (RPHP 13).

To satisfy 35 U.S.C. §112, a patent specification must be sufficiently complete to enable one of ordinary skill in the art to make the invention without undue experimentation, although the need for a minimum amount of experimentation is not fatal. Enablement is the criterion. Every experimental detail need not be set forth in the written specification if the skill in the art is such that the disclosure enables one to make the invention. Martin, Aebi and Ebner v. Johnson, 172 U.S.P.Q. 391 (C.C.P.A. 1972). A patent specification is not required to be a production blueprint, Douglas v. United States, 184 U.S.P.Q. 613 (Ct. Cl. 1978). A patentee cannot be expected to foresee every technological problem that may be encountered in adapting his idea to a particular use. Some experimentation and exercise of judgement is to be expected. Id. at 615.

The claims in issue disclose the invention concerns fused silica optical waveguide fiber with the core/cladding refractive index difference controlled through the use of dopant materials. The '915 specification teaches that the claimed waveguide should not cause depression or scattering of the transmitted light (FF 68, 72); that for certain methods of producing the optical waveguide, diffusion properties of the dopant material should be considered (FF 78); and that the fused silica core and the cladding layer should possess similar physical characteristics (FF 73). Thus the '915 specification sets forth guidelines for determining dopants that may be used. Properties of multi-valent oxides and how they affect glass were known in 1970 when the '915 application was filed (FF 335-340). To determine a suitable dopant for glass would be a trial and error process involving routine experimentation (FF 341-345). In a well-established laboratory it could be done in a week, probably, even a faster time (FF 341).

Accordingly in light of the '915 specification and knowledge in the glass art in 1970, undue experimentation would not be required of one of ordinary skill in the art to practice the claimed invention of the '915 patent. Respondents have not established by clear and convincing evidence, that the '915 disclosure as of the May 11, 1970 filing date was not enabling.

IV. Enforceability of the '915 Patent

Respondents urge that the failure by Corning to disclose that the 15 percent claimed limitation is not critical was done with an intent to mislead the Patent Examiner and that there is a substantial likelihood that the Patent Examiner would not have allowed the '915 claims in issue had he been fully advised on the point (RPHP pp. 16-17). Accordingly it is argued that the '915 patent claims in issue are unenforceable.

To establish that a patent was procured with inequitable conduct as to render it unenforceable, respondents must provide clear, unequivoval and convincing evidence of the intentional misrepresentation and withholding of a material fact from the Patent Office. Simple negligence, oversight or erroneous judgment made in good faith is not enough to render a patent unenforceable. W.L. Gore & Associates, Inc. v. Garlock, Inc., 721 F.2d at 1558; Orthopedic Equip. Co. V. All Orthopedic Appliances, Inc., 707 F.2d 1376, 1383 (Fed. Cir. 1983).15/

15/ A distinction has been drawn by courts between inequitable conduct and fraud. A misrepresentation or concealment would suffice to constitute inequitable conduct and make a patent unenforceable whereas all the elements necessary to establish a cause of action for common law deieit would have to be present to establish fraud and invalidate a patent Jack Winter, Inc., v. Koratron Co., 375 F. Supp. 1.66, 181 U.S.P.Q. 353, 380-81 (N.D. Cal. 1974). For example bad faith alone, even though the patent would have issued with disclosure of withheld prior art may establish inequitable conduct, but it can not establish fraud. Mizusawa Kagaku Kogyo Kabushiki Kaisha v. Moore Business Forms, Inc., 205 U.S.P.Q. 458,459(W.D.N.Y. 1979)

Earlier in this opinion under the heading "35 U.S.C. §112" and subheading "15% Limitation," a basis for the 15% claimed limitation when the '915 application was filed on May 11, 1970 was found.

Accordingly, the Administrative Law Judge, finds that respondents have not sustained their burden in establishing that claims 1 and 2 of '915 patent are unenforceable.

Patent Issues - 454 Patent

V. The '454 Patent

The '454 patent titled "Method of Making Optical Waveguides" issued on January 20, 1976 in the name of Robert D. De Luca and is assigned on its face to Corning (FF 110). The patent is based on application Ser. No. 462,962 fild April 22, 1974 (FF 110). Claims 1 and 8 of the '454 patent are in issue in this investigation (FF 112).

Claims 1 and 8

Claim 1 is to a method of[16/] forming a glass article. The preamble of the claim recites what is old in the art with respect to forming a glass article, viz.

16/ Claim 1 is in a Jepson-type format whereas the prior art is segregated from the features which are alleged to be entirely new, the recitation of the prior art being allegated in the preamble of the claim. Rosenberg Patent Law Fundamentals § 14.05 [1] (2d. Ed.)

1) depositing on a starting member a coating of flame hydrolysis - produced glass soot to form a soot preform, then

2) consolidating said soot preform to form a dense glass layer free from particle boundaries, and then

3) forming said dense glass layer into a desired shape.

The alleged novelty is in the consolidation step and "comprises":

> heating said soot preform to a temperature within the consolidation temperature range for a time sufficient to cause said soot particles to fuse and form a dense glass layer, and simultaneously subjecting said soot preform to a stream of a substantially dry, hydrogen-free chlorine containing atmosphere that is substantially free from contaminants that would adversely affect the optical properties of said glass article, said chlorine permeating the interstics of said soot preform during the consolidation thereof and replacing hydroxyl ions by chlorine ions, thereby resulting in a glass article that is substantially water-free.

(FF 111) Claim 8, dependent on claim 1, states that the soot has a high silica content and that the step of heating in the consolidation step "comprises" subjecting the soot preform to a maximum temperature in the range of 1200-1700°C. (FF 111).

B. <u>The '454 Specification</u>

Inventor De Luca represented the invention of his claimed method to be an improved flame hydrolysis technique of forming high optical purity blanks from which high quality optical waveguides, lens, prisons and the like can be made with a very low water content (FF 114). To understand the claimed invention, it has to be appreciated that the flame hydrolysis process for glass preparation is not novel with the inventor (FF 115). In 1934 Corning's James Franklin Hyde filed a United States patent application to a method of making a transparaent article of silica, which included vaporizing a hydrolyzable compound of silicon into a flame of combustable gas to decompose the vapor and to form finely comminuted silica, and then vitrifying the silica to a transparent body (FF 115). The Hyde application issued as a patent on February 10, 1942 (FF 254-256).

In 1939 Corning's Martin E. Nordberg filed a United States patent application to a method of making glass compounds containing from 89 percent to 95 percent of silica and over 5 percent but not over 11 percent titanium oxide. The method included vaporizing the tetrachlorides of silicon and titanium into the gas stream of an oxy-burner, depositing the resultant mixture of oxides to make a preform, vitrifying the preform at about 1500°C to make an opal glass thereof and firing the opal preform at a higher temperature to cause it to become transparent (FF 115). The Nordberg application issued as a patent on August 3, 1943 (FF 257-262).

On May 11, 1970, about four years before inventor De Luca filed his application on April 22, 1974, Corning's Keck and Schultz filed a United States patent application to a method of producing an optical waveguide by first forming a film of glass with a preselected index of refraction on the inside wall of a glass tube having a different preselected index of refractive. Keck-Schultz disclosed that the desired film of glass may be formed in a variety of methods including the flame hydrolysis method which was based on the Hyde and Nordberg methods (FF 330). Nothing was said about the water content of the products produced in the Keck-Schultz method.

Waveguides in which at least 80% of the light scattering loss can be accounted for by intrinsic glass scattering also had been made by a prior art flame hydrolysis technique (FF 116). However, it was found that due to the presence of residual water produced by the flame hydrolysis technique, absorption loses between 700 nm and 1100 nm have been excessively large (FF 116). For low optical waveguide attenuation over the entire range between 700 nm and 1100 nm, inventor De Luca disclosed that the amount of residual water within a glass waveguide fiber should be reduced to a level of less than 10 parts per million (FF 117).

Because it was impossible to reduce the water content of optical waveguides to acceptable levels after flame hydrolysis - produced soot had been consolidated to form a solid glass coating, inventor De Luca knew that water must be removed before or during the consolidation process (FF 117). Inventor De Luca was not the first person involved in reducing the water content in optical waveguides produced by flame hydrolysis.

A prior art method of producing low water content fused silica included the steps of forming by flame hydrolysis a silica soot prefrom and then placing the preform in a preheated furnace at approximately 1500°C. for approximately 30 minutes. The furnace contained a reducing atmosphere of cracked ammonia or "forming" gas. During the heat treatment, the soot was sintered and consolidated into a dense glass body which was to a certain extent water-free. The amount of water remaining in the resultant glass was said to be excessive in terms of tolerable amounts for optical communication systems. (FF 119).

A method disclosed in a United States patent application filed March 30, 1972 for producing optical waveguides which exhibited attenuations as low as 30 dB/km at 950 nm involved consolidating a soot preform in an inert dry atmosphere such as nitrogen, helium, neon or argon. In accordance with this method the inert gas replaced trapped air in the preform and subsequently dissolved in the glass. Since this method included gradient sintering, gases could escape through unconsolidated parts of the preform. (FF 119).

A method of forming a glass optical waveguide containing less than 20 parts per million residual water, disclosed in a United States patent application filed by inventor De Luca on March 30, 1972, involved placing a flame hydrolysis-produced soot preform in a chamber which is evacuated to less than 10^{-5} Torr. The chamber is heated below the sintering temperature of the soot to permit entrapped gas to escape from the preform and the temperature is maintained until an equilibrium is reached between the partial pressure of the entraped gas in the porous preform and the partial pressure of the same gas in the furnace environment. A period of about 24 hours is required for equilibrium to be reached, at which time the porous preform is further heated to consolidate the soot particles and to form a dense glass member. This process is said to be disadvantageous in that it required an extremely long time for water removal, and may result in the volatilization of some dopant oxides. Also, equipment problems were said to have been encountered because of the need to maintain very low pressures for long periods of time. Also it was said that the preform could not be consolidated until after the water removal step is completed. (FF 120).

Inventor De Luca disclosed that various oxides from which glass optical waveguides are formed, especially SiO_2, have a great affinity for water but after such glass waveguides are completely formed, the inner, light propagating portion thereof is inaccessible to water. The tendency of these glasses to absorb water is said to be not detrimental to water-free glass optical waveguides after they are formed since most of the light energy is propagated in and around the core, and the presence of water on the outer surface has a negligable effect on the propagation of such energy. However, in the formation of optical waveguides by flame hydrolysis, residual water, which is produced by the flame, is said to appear throughout those portions of the waveguide that have been produced by flame hydrolysis. Also water is said to be readily absorbed by the soot during handling in air prior to the consolidation process because of the extremely high porosity thereof. (FF 116, 128).

Methods other that the flame hydrolysis technique have been employed in the soot in an attempt to make low water content glasses. Inventor De Luca disclosed that one such method involved mixing the batch ingredients together with an effective amount of a chemically-reactive chlorine containing agent as $SiCl_4$ and melting the glass in the presence of a dry atmosphere flowing directly over the glass melt. (FF 121)

Another prior art method, not involving the flame hydrolysis technique, was said by inventor De Luca to be disclosed in U.S. Patent 3,459,522 which issued to Corning's Thomas H.E. Elmer and Martin E. Nordberg on August 5, 1969 and was based on applications filed July 8, 1963 and August 1, 1967 (FF 122). The Elmer et al. patent was said to disclose a method of removing residual water from a porous high silica content glass body by subjecting the body to a flowing stream of a substantially dry atmosphere containing 10% or more of either chlorine gas or a chlorine vapor at a temperature of 600°-$1000^{\circ}C$. The treated porous glass body is thereafter consolidated in a dry, nonoxidizing atmosphere to prodcue a nonporous, transparent glass article. The porous glass body disclosed in the Elmer et al patent was said to be well known under the commercial designation "96% silica glass", and to be produced by consolidating a porous glass body characterized by a multiplicity of intercommunicating, submicroscipic pores throughout its mass. The basic production steps involved in the formation of such a porous body, are said to be described in U.S. Pat. No. 2,221,709 issued to H.P. Hood et al. and to include the steps of forming an article from a borosilicate glass, thermally treating the article at a temperature of 500°-$600^{\circ}C$. to separate the glass into a silica-rich phase and a silica-poor phase, leeching the silica-poor phase to produce a porous structure composed of the silica-rich phase, removing the leeching residue, and thermally consolidating the porous structure into a nonporous vitreous article. (FF 122).

Because of the kind of microstructure present in the porous glass body disclosed in the Elmer et al. patent and due to the fact that the chlorination process disclosed therein was carried out at a temperature below the consolidation temperature, it was said by inventor De Luca that an atmosphere containing a relatively large concentration of chlorine must be employed. Thus the Elmer et al. patent was said to require a chlorine containing atmosphere having 10% or more of either chlorine gas or a chlorine vapor. Most of its examples were said to employ chlorine gas with no diluent. Inventor De Luca stated that the Elmer et al. patent further taught that after chlorine treatment, it was undesirable to maintain the porous glass in a chlorine containing atmosphere while the temperature was increased to the consolidation temperature because of economic considerations and because this may result in retention of an excess amount of chlorine within the glass and may cause splitting of the glass; that accordingly the chlorine treated porous glass is removed from the chlorine atmosphere and transferred, in an inert atmosphere such as nitrogen, for further heat treatment consolidation being preferably performed in an inert atmosphere or vacuum at a temperature between 1200°C. and 1300°C. (FF 123).

For at least the following reasons inventor De Luca, stated that the method of the Elmer et al. patent is unsatisfactory for removing water from flame hydrolysis-produced glass soot preforms from which optical waveguides are made. The high chlorine content of the chlorine containing atmosphere employed by the Elmer et al. patent can cause reboil in subsequent heat treatment of the preform and can also introduce an unacceptable level of contamination in the glass due to the presence of contaminants in commercial grade chlorine sources; transferring the soot preform from the chlorination chamber to the consolidation chamber can permit water to reenter the porous soot blank; and whereas the Elmer et al. patent teaches separate chlorination and consolidation steps, it is more economical and efficient to remove water from the glass soot concurrently with the consolidation of such soot. (FF 124). It was said that the rate of removal of water by chlorine is temperature related, it being slower at temperatures between 600°C and 1000°C. than at the soot consolidation temperature which is between about 1250°C and 1700°C. for silica. (FF 124)

Under the heading "Summary of the Invention", inventor De Luca refers to the conventional process comprising the steps of depositing on a starting member a coating of flame hydrolysis produced glass soot particles to form a soot preform, consolidating the soot preform at a consolidation temperature range for a time sufficient to permit the soot particles to fuse or sinter and to form a "dense glass layer" which is free from particle boundaries and then forming the dense glass layer into a desired shape (FF 125). Inventor De Luca then states that according to his invention the step of consolidating in the conventional process "comprises" heating the soot preform to a temperature within the consolidation temperature range for a time sufficient to cause the particles to fuse and form a dense glass layer, and simultaneously subjecting the soot preform to a stream of a substantially dry chlorine containing atmosphere. It is said that the chlorine permeates the interstices of the soot preform during the consolidation thereof and replaces hydroxyl ions by chlorine ions, thereby resulting in a glass article that is substantially water-free. (FF 126)

The stream of a substantially dry chlorine containing atmosphere comprises helium as the diluent gas and an effective amount up to about 5 vol percent chlorine (FF 129). Example 1 employs 90 vol. percent helium and 10 vol. percent chlornic. (FF 136). Hydrogen cannot be used as the diluent gas since it tends to increase the water content of the glass (FF 129).

Inventor De Luca discloses that any amount of chlorine in the continuously flowing atmosphere in addition to the required amount may increase attenuation with no accompanying benefical end result, hence the amount of chlorine persent should be no more than that required to render the soot substantially water-free. The percentage of chlorine required in the consolidation atmosphere is said to be relatively low as compared to "prior chlorinating atmosphere "because chlorine is extremely reactive at soot consoliation temperatures. (FF 129). Chlorine may be supplied to the consolidation step as chlorine gas or as a chlorine containing compound that is gaseous or can be supplied in vapor form. (FF 129).

Inventor De Luca discloses that the consolidation temperature depends upon the composition of the glass soot and is in the range of 1250°-1700°C. for high silica content soot; that it is also time dependent, consolidation at 1250°C. requiring a very long time; that the preferred consolidation temperature for high silica content soot is between 1400°C. and 1500°C. (FF 130). Claim 8 in issue recites a range of "1200° - 1700°C." (FF 111).

There is disclosed in the '454 specification a schematic representation of a consolidation furnace and a consolidation atmosphere system. It is said that the maximum furnace temperature, preferably between 1400°C and 1500°C for high silica content soot, must be adequate to fuse the particles of glass soot and thereby consolidate the soot preform into a dense glass body in which no particle boundaries exist (FF 131, 132).

Inventor De Luca referring to the schematic representation of the consolidation furnace discloses that as soot preform enters the furnace, the chlorine containing consolidation atmosphere passes through the interstices of the soot where it lowers the water content by causing hydroxyl ions to be replaced by chlorine ions. In addition, the helium purges residual gases from the interstices of the soot. Consolidation of the soot is said to begin at the tip that is intially inserted, and it then gradually progresses to the opposite end of the preform. Four phases of the consolidation process are said to be represented by positions A through D in the furnace. In positions B through D, a part or all of the soot preform is consolidated. It is said that due to the type of microstructure present in the soot preform, the outside thereof would sinter first if the entire preform were suddenly immersed in the high temperature region of the furnace; that gases would then be entrapped in the resultant dense glass body and the chlorine present in the furnace atmosphere would be unable to completely penetrate into the interstices of the soot preform to remove water therefrom. The preform is therefore initially inserted to position A of the furnance where it is heated to a temperature just below the consolidation temperature. The preform is then further inserted to position B where it is held for a time that is sufficient to insure consolidation of the end position thereof. The preform is then lowered to positions C and D at such a rate that entrapped gases are permitted to escape and the chlorination atmosphere is permitted to penetrate and substantially remove the water therefrom. The resultant dense glass body is then slowly moved back to position A where it receives a slight annealing treatment, and then removed from the furnace. The rate of insertion between positions B and D is said to depend upon the size of the soot preform and the composition thereof, the preferred rate being between about 0.1 inch per minute and 1.0 inch per minute. (FF 133).

In Example 1 of the '454 patent a gas mixture containing 90 vol. percent helium and 10 vol. percent chlorine was admitted to a consolidation furnace at a flow rate of 30 cubic feet per hour. A preform of silica soot was placed in the furnace at position A, which was about 5 inches above the peak temperature being about 1500°C. After remaining in position A for 15 minutes, the preform was lowered at a rate of 15 inches per minute until the end of the preform was 1 inch above the 1500°C peak temperature region (position B). The preform was maintained in this position for about 10 minutes to insure consolidation of the end portion thereof. The preform was then lowered at about 50 inches per hour through the 1500°C. zone until it reached position D where it was held for 5 minutes to completely consolidate the preform. The resultant consolidated dense glass body was then withdrawn to position A at rate of 50 inches per minute and was then removed from the furnace. The consolidated vitreous silica was said to contain less than 1 part per million OH. (FF 136).

In Examples 2, 3 and 5 inventor De Luca processed soot preforms in a furnace in the manner described in Example 1 and formed the consolidated preforms into optical waveguides having low attenuation. (FF 137, 138, 140).

Example 2 uses a gas mixture containaing 3 vol. percent chlorine. In Example 3 there is 1 vol. percent chlorine. (FF 137).

Inventor De Luca's Example 4 is said to illustrate the advantage of employing chlorine during the cosolidation process using two identical preforms. One of these preforms was processed in an atmosphere containing 1 vol. percent chlorine, 0.5 vol. percent oxygen and 98.5 vol. percent helium. The attenuation of the resultant optical waveguide was less than 10 dB/km between 700 and 1100 nm. The second of the two identical blanks was processed for 30 minutes in position A of the furnace in a gas mixture containing 96.5 vol. percent helium. 3 vol. percent chlorine and 0.5 vol. percent oxygen. This preform was then processed through the remainder of the cycle of Example 1 in 100% helium. The waveguide, which was drawn from a preform which was presoaked in an atmosphere containing 3 vol. percent chlorine and then consolidated in an atmosphere containing 100% helium was said to exhibit an attenuation of 100 dB/km at 950 nm whereas a waveguide drawn from a preform, which was both presoaked and consolidated in an atmosphere containing 1 vol. percent chlorine was said to exhibit an attenuation of only about 10 dB/km at that wavelength. (FF 139).

VI. Prosecution History of the '454 Patent

In the sole independent process claim, as originally filed, the consolidation step alleged to be novel was characterized in that it comprised:

> heating said soot preform to a temperature within the consolidation temperature range for a time sufficient to cause said soot particles to fuse and form a dense glass layer, and simultaneously subjecting said soot preform to a stream of a substantially dry chlorine containing atmosphere, said chlorine permeating the interstices of said soot preform during the consolidation thereof and replacing hydroxyl ions by chlorine ions, thereby resulting in a glass article that is substantially water-free. (FF 142).

In a Patent Office action dated January 17, 1975, the Patent Examiner rejected this claim under 35 U.S.C 103 over Nordberg U.S. Patent No. 2,326,059, which had been cited by inventor De Luca in his '454 specification (FF 115) taken with Bruning U.S. Patent No. 3,850,602 and Heraeus et al U.S. Patent No. 2,904,713 (FF 144). It was the Examiner's position that it would be obvious to substitute the chlorine containing atmosphere of Bruning for the oxidizing atmosphere in the consolidation step of Nordberg in order to remove water in an optic fiber glass since the Heraeus et al reference taught that many chlorine compounds are used to remove impurities from glass (FF 144).

In an amendment filed on April 9, 1975, Corning argued that heating the soot preform to the consolidation temperature and simultaneously subjecting the soot preform to a stream of a substantially dry chlorine containing atmosphere was not recognized, suggested or taught by the cited references either taken alone or in combination (FF 146). It argued tht the Bruning patent made no mention of optical fibers, that Bruning taught a method of forming quartz glass from quartz crystal granules by first mixing the granules at an elevated temperature with one of the following salts: sodium fluride, sodium chloride, sodium bromide, silver nitrate, lithium chloride, potassium chlordie, magnesium chloride, calcium chloride, strontium chloride, and silver nitrate, or mixtures thereof; that this process could not be performed simultaneously with the consolidation of the quartz crystal granules into a dense glass body since the granules so treated were contaminated with traces of salt vapor which would result in the formation of bubbles in the quartz glass during the melting process; that to remove any doubt of the applicability of the Bruning patent to the claimed process, claim 1 was amended to state that the dry chlorine containing atmosphere is substantially free from contaminants that would adversely affect the optical properties of the glass article; that because of the salt contamination, the Bruning method requires the additional step of flowing water vapor-free gas such as dry oxygen or nitrogen over the granules at an elevated temperature; that it is only after the granules have been mixed with salt and flooded with the dry oxygen or nitrogen that the melting is performed; and that whereas the Bruning patent employs a three-step method of purifying quartz and forming a solid body, the claimed method resulted in the simultaneous purification of the soot preform and consolidation thereof into a glass article. (FF 147).

Corning argued in the April 9, 1975 filing that while the claimed process employed a chlorine atmosphere for removing hydroxyl only during consolidation of the soot preform, Heraeus et al teach the use of chlorine or other halogens to render harmless or eliminate impurities in grains of "rock cyrtals" as they are strewn upon the surface of a cylinder and that it is necessary to supply chlorine gas to the processed surface in such a manner that the chlorine molecules surround and envelop the quartz particles sho..ly before and during their melting and during built-up of the quartz glass body. (FF 148). Corning also argued the inapplicability of the Nordberg patent on the ground that oxygen is not equivalent to chlorine for the purpose of removing water from a soot preform during consolidation. (FF 149).

By Patent Office action dated July 1, 1975, the Patent Examiner stated that all the claims were allowed (FF 151). On August 5, 1975, a notice of allowance was mailed. (FF 152). The '454 patent issued on January 20. 1976. (FF 152).

VII. Validity of Claims 1 and 8 of the '454 Patent

A. 35 U.S.C. §§ 102, 103

Respondents argue that the most pertinent prior out reference to claims 1 and 8 are U.S. Patent 3,459,522 to Elmer et al., and Japanese Patent Publication No. 45-37311. It is said that both references disclose a method of dehydrating porous silica glasses in a chlorine containing atmosphere which is maintained during the consolidation step and hence anticipate the claims in issue (RPHP 72). In addition it is argued that even if these references do not in and of themselves fully anticipate claims 1 and 8 in issue, the difference, if any, between these reference and the teaching of the '454 patent would have been obvious within the meaning of § 103 at the time the invention was made to a person having ordinary skill in the pertinent Art. (RPHP 22-23)

The Elmer et al. patent was discussed in the '454 specification as filed. (FF 122-124) Hence it had to have been considered by the Patent Examiner who did not reject any claims on the patent. The presumption of validity has been said to be stronger when the most pertinent prior art patents are considered by the Patent Office Skil Corp. v. Cutler-Hammer Inc. 162 U.S.P.Q. 132, 135 (7th Cir. 1969).

Respondents argue that the record shows that Corning in its production of optical waveguide fiber does not employ a chlorine-containing atmosphere throughout consolidation and that there is no probative evidence demonstrating that any of Corning's licensees employee such a consolidation step (RPHP 23)[17/] It also asserted that a U.S. Patent 3,938,974 to Macedo et al dicloses the simultaneous consolidation and dehydration of a glass preform in a chlorine containing atmosphere so as to totally disclose the invention of the '454 patent (Macedo, RX-103A, para. 36).

Legal standards applicable to defenses of alleged anticipation and obviousiness have been discussed in connection with the '915 patent.

Novelty in the claimed method in issue involves starting with a flame-hydrolysis produced glass soot preform (FF 111). While the Jepson type claimed subject matter in issue characterizes as old "consolidating said soot preform to form a dense glass layer free from particle boundaries "(FF 111) novelty is in modifying the old consolidation step such that it "comprises" heating said preform within the consolidation temperature to form a "dense glass layer" while simultaneously subjecting said preform to a stream of substantially dry, hydrogen free chlorine containing atmosphere to form a glass article that is substantially water-free . The term "comprises" characterizes what is novel in the consolidation step. Hence the consolidation does not exclude conventional steps in the consolidation. In re

17/ In its reply to respondents' proposed finding 56, Corning stated that as far as it is aware, its licensees in this country do not practice the '454 invention because they do not use an outside process which deposits soot by flame hydrolysis

Baxter et al. 656 F.2d. 679, 210 U.S.P.Q. 795,802 (CCPA 1981); In re Cone 121 F.2d 470,50 U.S.P.Q. 54, 56 (CCPA 1941). In re Hunter 288 F.2d 930,129 U.S.P.Q. 225, 226 (CCPA 1961). In re Hally 296 F 2d 794, 132 U.S.P.Q. 16,20 (CCPA 1961). Claim 8 of the '454 patent discloses that the consolidation temperature is in the range of 1200 to 1700 degrees. (FF 111). The specification discloses that the chlorine containing atmosphere has at most 10 vol. percent chlorine. (FF 136). Any amount of chlorine in addition to the required amount may increase attenuation. (FF 129). Hydrogen cannot be used in the chlorine containing atmosphere. (FF 129). The specification discloses further that during the consolidation step "the chlorination atmosphere is permitted to penetrate and substantially remove the water thereform". (FF 126, 133). The "resultant dense glass" body continues to remain in the consolidation furnace (FF 133). While each of the examples of the '454 patent show the presence of a substantially dry, hydrogen-free, chlorine containing atmosphere throughout the entire consolidation step, produced waveguides have an attenuation of less than 15 dB/km. (FF 137).

As the prosecution history and the claims that were before the Examiner make clear, essential to inventor De Luca's novel concept is the formation of a "dense glass layer" while "simultaneously" removing water from the porous preform. (FF 142-152).

Also uncontracticted is the testimony of Corning's expert witness that substantial removal of water from the porous preform occuring "simultaneously" with the formation of a dense glass can only mean that removal of water occurs during the process of consolidating the preform; that the removal of water during the entire consolidation process would be physically impossible because the interstices of the preform close prior to completion of the consolidation to a clear glass and that once the interstices have closed the preform becomes imprevious to the chlorine containing atmosphere. (FF 364-365). The Elmer et al. patent, consistent with the testimony of Corning's expert, discloses that incipient pore closure occurs at the beginning of the consolidation step. (FF 289).

With the above understanding of the claimed invention of the '454 patent, in issue, the Administrative Law Judge is not persuaded that respondents have met their burden in establishing that the claimed subject matter is invalid over the Elmer et al. Japanese and/or Macedo references.

The Elmer et al. patent relied on in by respondents discloses a method of removing residual water from a porous high silica glass tubing, in a flowing stream of a substantially dry chlorine containing atmosphere with or without diluent at a temperature of 600 to 1000 degrees centigrade and consolidating the treated porous body in a dry, nonoxidizing atmosphere to produce a nonporous, transparent substantially water-free glass article (FF 284-289). There are several critical distinctions between the Elmer et al method and the claimed method in issue. The starting component in the Elmer et al process is a porous high silica content glass body; it is not the flame-hydrolysis produced glass soot preform of the claimed De Luca process. Significantly De Luca's treatment of the glass soot preform with a chlorine containing atmosphere is carried out at a consolidation temperature of 1200 to 1700 degrees centigrade. In contrast the Elmer et al porous high silica content glass body is first treated with a chlorine containing atmosphere at a temperature of 600 to 1000 degrees centigrade and thereafter the glass is heated to effect consolidation at a temperature which is normally 1250 to 1300 degrees centigrade. In the Elmer et al. process "chlorine containing atmosphere" may be chlorine gas without diluent. De luca cannot employ only cholorine gas and teaches that excess chlorine may increase the attenuation. In the Elmer et al. patent the porous glass may be consolidated in a chlorine containing atmosphere. However, it is only after a treatment with chlorine and while the glass is still in a porous state, without any indication that the intertices of the porous glass had closed. Moreover, unrefuted by any test data are the statements in the '454 patent that the chlorine content of the chlorine containing atmosphere in Elmer et al can cause reboil in subsequent heat treatment especially if soot preform is employed; and that transfering any soot preform from a chlorination chamber to a consolidation chamber can permit water to reenter the porous soot blank.

Respondents' expert testified that it is not desirable when consolidating a glass preform to a dense glass for use in an optical waveguide construction to do so in a chlorine-containing atmosphere because of the risk of entrapping chlorine gas bubbles and because if germania is the dopant there is a higher risk of forming volatile compounds that would also adversely effect the optical properties. (FF 368). He did not define chlorine-containing atmosphere and in the absence of test data, the Administrative Law Judge is not persuaded that the low chlorine containing atmosphere of the De Luca et al claimed method would be detrimental. De Luca's Example 2, employing germania as a dopant produced a waveguide with less than 15 dB/km. (FF 137). De Luca's Example 1 produced consolidated vitreous silica containing less than 1 part per million OH. (FF 136).

The cited Japanese patent merely discloses the use of chlorine to remove water from porous glass at low temperatures. Thereafter in a non-chlorine containing atmosphere the glass is consolidated at higher temperatures. (FF 292). Hence the removal of water is wholly separate from consolidation step, completely unlike the invention of the '454 patent.

As for the Macedo et al. patent, respondents rely on a portion of the patent under the subheading "Consolidation" which states that the consolidation step consists of heating a glass sample to a range from 700 degrees to 950 degrees centigrade (FF 290-291) which is below the consolidation temperatures of the De Luca '454 patent. (FF 130). Macedo et al. disclose that if the glass is kept at 500 to 700 degrees centigrade for 15-50 hours before heating to the 700 to 950 degrees centigrade range preferably in a reactive atmosphere as chlorine gas or $SiCl_4$ or CCl_4, most of the inhomogenities in the glass caused by the presence of water can be removed. (FF 290-291). Significantly even with a consolidation temperature lower than that in the De Luca patent, Macedo et al. disclose that removal of water is carried out at even a lower temperature before consolidation. Thus it is stated during the 500 to 700 degrees heat treatment, the "unconsolidated glass" can be efficiently controlled. (FF 290, 291). Accordingly the separate steps of first drying and then consolidating in the Macedo et al. patent are patentably distinct from the simultaneous drying and consolidating in the De Luca et al '454 claimed method in issue.[18/]

Respondents argue that Corning does not employ the De Luca '454 method in Corning's production of optical waveguide fiber. Documentary evidence and testimony however establish that Corning in the production of its commercial optical waveguide fiber passes a soot preform into

in a chlorine-containing atmosphere where the prefrom is dehydrated to form a clear, bubble-free consolidated glass preform (FF 361-363). Although the chlorine flow in Corning's dehydration - consolidation furnace does not continue through the entire period during which Corning's preforms undergo consolidation, dehydration does occur while consolidation is also occuring. (FF 361-363). Accordingly the evidence does establish that Corning employs De Luca's '454 method in producing optical waveguide fibers and provides an objective indicia of nonobviousness.

18/ Corning in its proposed finding 220 stated that ever if the Macedo et al patent is entitled to a April 27, 1973 filing date of a parent application, that date is still subsequent to the '454 actual reduction to practice date. The Administrative Law Judge makes no finding with respect to the conception and actual reduction to practice dates of the claimed De Luca invention in issue.

For the foregoing reasons, the Administrative Law Judge finds that respondents have not met their burden in proving the '454 patent is invalid.

B. <u>35 U.S.C. § 112</u>

Respondents argue that the Examiner accepted as critical the limitation in the '454 patent claims in issue requiring the use of a chlorine-containing atmosphere during both dehydration and the consolidation "in their entirety"; that now inventor De Luca has disavowed that clear representation and contends that the maintenace of the chlorine-containing atmosphere throughout the entire process is not necessary. Accordingly respondents contend that claims 1 and 8 in issue are invalid as not satisfying the specificity requirements of 35 U.S.C. § 112 since the claims do not particularly point out and distinctly claim the subject matter which inventor De Luca regarded as his invention (RPHP 31-32).

In support of the contention that Corning in the prosecution of the '454 patent argued the criticality of using a chlorine-containing atmosphere during both dehydration and consolidation "in their entirety, " respondents quote the following portion of the file wrapper:

> Whereas the Bruning patent [cited by the Examiner in rejecting the claims] employs a three-step method of purifying quartz and forming a solid body, the claimed method results in the simultaneous purification of the soot preform and consolidation thereof into a glass article. It is thus seen that the Bruning patent does not teach 'optical fiber glass' or a chlorine containing atmosphere of the type set forth in the present claims. (RPFF 48) (FF 47).

However as the file wrapper makes clear the distinction drawn in the quoted portion of the file wrapper is not between dehydrating and partially consolidating in a chlorine containing atmosphere as against dehydrating and completely consolidating in a chlorine containing atmosphere. Rather Corning was arguing against the Bruning process which involved totally separate dehydration and consolidation steps. (FF 147). The '454 claimed subject matter in issue does simultaneously remove water and consolidate to a "dense glass layer" such that the resulting "glass article" is substantially water-free. Hence the Administrative Law Judge finds nothing inconsistent with the file wrapper and the position taken by Corning. Moreover accepting respondents' contention would be in conflict with inventor De Luca's concept of his '454 invention. (FF 214).

Respondents argue that De Luca's Example 4 is conclusive evidence that the De Luca '454 patent "requires" a chlorine-containing atmosphere throughout consolidation to a dense glass, (RPFF 47). It is said that Example 4 constitutes a comparison between the results obtained of consolidating in an atmosphere containing 100 percent helium and the results obtained by consolidating entirely in a chlorine containing atmosphere. A reading however of Example 4 does not support respondents' contention. Rather Example 4 compares an embodiment wherein chlorine is only supplied at a particular temperature viz. at position A of the furnance which the '454 specification characterizes as "just below the consolidation temperature," (FF 133, 139) and which embodiment is outside the scope of the De Luca '454 invention in issue (FF 111) with an embodiment wherein chlorine is supplied during consolidation viz. up to 1500 degrees centigrade.

Accordingly the Administrative Law Judge is not persuaded that the claims in issue do not particularly point out and distinctly claim the subject matter which inventor De Luca regarded as his invention. Respondents have not met their burden in establishing that claims 1 and 8 are invalid under 35 U.S.C. §112.

VIII. Enforceability of the '454 Patent

Respondents argue that the failure by Corning to disclose to the Patent Examiner that no criticality can be attributed to the maintenance of a chlorine-containing atmosphere throughout the dehydration and consolidation steps renders the '454 patent claims 1 and 8 unenforceable for reasons that were equally applicable to the '915 patent claims in issue. Specifically they urge that the "representation that a chlorine-containing atmosphere is necessary throughout dehydration and consolidation that appears in the patent claims as well as in the specification and prosecution file history" was done with intent to mislead and that there is a substantial likelihood that the Examiner would not have allowed the claims to issue had he been fully advised on that point; that Corning clearly had reason to know that the information not disclosed to the Examiner would have been important to him in deciding whether to allow the claims; that the Elmer et al. patent was erroneously described as teaching separate chlorination and consolidation steps for the purpose of illustrating the advantages obtained by the DeLuca process in combining such steps. (RPHP 23-24). Accordingly, it is argued that claims 1 and 8 of the '454 patent are unenforceable.

Analyses of the file wrapper specification, and claims 1 and 8 have not persuaded me that a representation was made that a chlorine-containing atmosphere is "necessary throughout dehydration and consolidation." (FF 142-152). Moreover, I have found that the Elmer et al. patent discloses a chlorination step distinct from a subsequent consolidation step. (FF 288).

Accordingly, the Administrative Law Judge finds that respondents have not sustained their burden in establishing that claims 1 and 8 of the '454 patent are unenforceable.

IX. Infringement Issue

A. Accused Processes

Corning charges that respondents' processes used in making their M-1, S-1, S-2, S-3 and M-2 fibers infringe claims 1 and 8 of the '454 patent. (FF 60).

Process for M-1 Fiber

The process used by respondent SEI in the manufacture of accused M-1 fiber comprises the following steps:

(i)

burned in an flame to form a at the

(ii)

thereby forming

(iii) The is thereafter

and subjected to a

degrees centigrade to form a

(iv) The is then placed in a and heated with an flame and elongated into a

(v) The elongated is then inserted into a and this composite is with an flame causing the

thereby forming the

(vi) The is then

(FF 51).

Process for S-1 Fiber

The process used by respondent SEI in the manufacture of accused S-1 fiber comprises the following steps:

(i) are burned in an flame to form a at the

(ii) thereby forming

(iii) The is thereafter and subjected to a degrees centigrade to form a

(iv) The is then placed in a and heated with an flame and elongated into

(v) The elongated is then inserted into a and this composite is with an flame causing the thereby forming the

(vi) The is then

(FF 52).

Process for S-2 Fiber

The process used by respondent SEI in the manufacture of accused S-2 fiber involves the following:

(i) Silicon tetrachloride, and germanium tetrachloride are burned in an oxygen-hydrogen flame to form a porous soot preform at the end of a seed glass rod;

(ii)

thereby forming

(iii) The is thereafter placed in a and subjected to a degrees centigrade to form a ;

(iv) The is then placed in a and heated with an flame and elongated into a .

(v) The elongated is then inserted into a and this composite is with an flame causing the thereby forming the

(vi) The is then . (FF 53).

<u>Process for S-3 Fiber</u>

The process used by respondent SEI in the manufacture of accused S-3 fiber comprises the following steps:

(i) . are burned in an flame to form a at the

(ii)

thereby forming a fluorine-containing preform with heating over a period of time to a maximum temperature approaching about 1300°C;

(iii) The is thereafter
to form a by
degrees
centigrade;

(iv) A

(v) The
and heated with an flame and

(vi) The surface of the
state, and a

(vii) The tube is then heated with an
flame removing surface water therefrom by flowing gas into
and then causing the

(viii) The having a therein is
then placed in a and heated with an flame

(ix) The is then inserted into a
and again by the use of an flame;

(x) The resulting is then
(FF 55).

In the S-3 process, the pure silica rod used in step (vi) is produced by

The so formed is then placed in having a substantially dry, and is heated over a period of time to a Thereafter, the is removed from the furnace and placed in a ring heater having The is therein subjected to a approaching whereby article is completed. The article is later and inserted into a as in step (vi). (FF 56).

In the M-1, S-1, S-2 and S-3 processes, respondents refer to the Respondents describe the period during which the resides (FF 54, 57).

Process for M-2 Fiber

The accused process used by respondent SEI in the manufacture of M-2 fiber comprises the following steps:

(i) are burned in an flame to form a at the

(ii)

(iii) applied to the

(iv) The is then placed in a and with an flame and element;

(v) The is then inserted into a and this composite is heated with an flame causing the thereby forming the

(vi) The into the

FF 58).

B. Positions of the Parties

1. Corning's Argument

Corning argues that respondents' and falls literally within claims 1 and 8 or the '454 patent. It asserts that there does not appear to be any issue that a is used in making respondents' M-1, S-1, S-2 and S-3 fibers.

Corning, referring to respondents' interrogatory responses and Corning's electron microprobe analysis, argues that while there is a separate and distinct issue as to whether a is included at all in respondent's process for producing M-2 fiber, Corning has met its burden by a preponderance of evidence that such a is included. CPH 35-38). Corning admits that inventor DeLuca used a chlorine atmosphere throughout the consolidation process but argues that dehydration cannot physically continue throughout the entire process of consolidation and that the important thing is that there be simultaneous overlap. (CPH 36).

2. Respondents' Argument

Respondents argue that the use of is not inventor DeLuca's invention; and that DeLuca's invention lies in the use of a chlorine-containing atmosphere during both the dehydration and the consolidation steps. (RPHP 19). It is argued that the M-2 fiber does not even include a and is clearly outside the scope of the '454 patent claims and that the M-1, S-1, S-2 and S-3 fiber types are manufactured by a process wherein

(RPHP 19). Respondents assert that Corning is estopped from asserting its '454 patent claims in issue cover a process wherein

They argue that claim 1 and dependent claim 8 clearly mandate all consolidation in a chlorine-containing atmosphere; that Example 4 of the '454 patent compares the results obtained by consolidating in a chlorine-free atmosphere as compared to complete consolidation in a chlorine-containing atmosphere to emphasize the novelty of inventor DeLuca's invention; and that the arguments of counsel during the prosecution leading to the allowance of the claims emphasize the distinction over the prior art as resting upon the fact that a chlorine-containing atmosphere is maintained "throughout" consolidation in the inventor DeLuca process. (RPHP 20).

C. <u>M-1, S-1, S-2 Processes Do Infringe</u>

Respondents' M-1, S-1 and S-2 preforms are produced by formed by in the The so formed is then placed in an having a substantially dry,

Thereafter, the placed in a and the is therein subjected to

(FF 51, 52, 53).

Accordingly, respondents' method of forming M-1, S-1 and S-2 preforms into clear glass articles utilizes each of the steps of claims 1 and 8 in issue. Although respondents' Mr. Hoshikawa testified that after the dehydration step he also testified that in the accused the becomes (FF 371). Because the temperature in the accused is within the this would be expected. Moreover, unrefuted is the testimony that occurs during the accused step because of the and the fact that respondents (FF 373, 374).

On the present record, the Administrative Law Judge finds that Corning has met its burden in proving that respondents' M-1, S-1 and S-2 processes literally infringe each of claims 1 and 8 in issue.

D. <u>S-3 Process Does Infringe</u>

Respondents' S-3 optical waveguide fibers are made by a combination of (an S-3 and S-3 which is produced (FF 51, 52, 53, 55). As the processing steps for the S-3 core and cladding preforms are functionally the same as for the M-1, S-1 and S-2 preforms, respondents infringe claims 1 and 8 in issue.

On the present record, the Administrative Law Judge finds that Corning has met its burden in proving that respondents' S-3 process infringes each of claims 1 and 8 in issue.

E. Respondents' M-2 Process Does Not Infringe

The direct testimony at the hearing and deposition testimony of respondents' Mr. Hoshikawa in September 1984 are to the effect that in respondents' M-2 process there is involving as that term is used in the '454 patent. (FF 59, 377). Two answers to interrogatories by respondents indicated that the M-2 process involving a (FF 375, 376). A first answer, in July 1984, was received by Corning before the September 1984 deposition testimony of Mr. Hoshikawa. (FF 375, 377). A second answer in September 1984 was received after the September 1984 deposition testimony of Mr. Hoshikawa. (FF 376, 377).

At the hearing, Corning's position was that respondents should be bound by their answers to the interrogatories. (Tr. 1618). Respondents' position was that the direct testimony of Mr. Hoshakawa, which was received by Corning prior to the start of the hearing (Tr. 707), tells the truth (Tr. 688); and that Corning had prior notice of in the M-2 process through the deposition testimony of Mr. Hosikawa. (Tr. 718).

In support of Mr. Hoshikawa's testimony that there is respondents' M-2 process, respondents at the hearing, prior to the cross-examination of Mr. Hoshikawa, produced a collection of run sheets. (FF 380). Corning's position is that these run sheets date from October 1983 through January 1984, but no later; that they do not support its respondents' contention that M-2 preforms are currently manufactured

(CPFF 237). Corning also argues that its electron microprobe analysis of M-2 fiber shows the presence of from about

by the same process as that used for the M-1, S-1 and S-2 preforms. (CPFF 240). In contrast, Mr. Hoshikawa testified that respondents' starting raw materials in its M-2 process accounts for the in the M-2 fiber. (FF 382-384) and although the same starting raw materials is used in the S-2 process, the respective amounts used differ and this might be the reason why there is more in the M-2 fiber than in the S-2 fiber. (FF 382-384).

Corning has the burden of proving by a preponderance of evidence that the respondents have infringed its '454 patent in the production of the M-2 fiber. The Administrative Law Judge finds no direct evidence in the record that the M-2 process utilizes a

and found the live testimony of Mr. Hoshikawa credible. While Corning argues that the presence of from about

in the M-2 that the

for the M-2 fiber was

a strong suggestion does not meet the preponderance of evidence test.

Accordingly, Corning has not met its burden in establishing that respondents' M-2 fiber infringes claims 1 and 8 of the '454 patent.

X. Importation and Sale

In order to invoke the subject matter jurisdiction of the Commission and to support a finding of a violation of § 337, Corning must establish that the accused product has been imported into or sold in the United States. 19 U.S.C. § 1337(a).

The Administrative Law Judge finds that the evidence of record in this investigation demonstrates that respondents SEI and SEUSA have imported or sold the accused optical waveguide fibers in the United States. (FF 8, 385, 386).

XI. Domestic Industry

In order to prove a violation of § 337, Corning must establish that the alleged unfair methods of competition have the effect or tendency "to destroy or substantially injure an industry, efficiently and economically operated in the United States." 19 C.F.R. § 1337(a).

Corning defines the "domestic industry" for purposes of this investigation as the facilities and operations of Corning devoted to the research, development, manufacture, marketing and distribution of Corning's optical waveguide fiber, and to Corning's activities with respect to its licensees under the '915 and '454 patents in issue, and the facilities and operations of Corning's domestic licensees -- AT&T, ITT and SpecTran -- under the '915 and '454 patents in issue, and the domestic activities and facilities of NTI. (CPFF 270).

The Administrative Law Judge, based on the record before him, finds the domestic industry in this investigation not to be what Corning proposes.

and its licensees devoted to the exploitation of the patent. Certain Methods for Extruding Plastic Tubing, Inv. No. 337-TA-110, 218 U.S.P.Q. 348 (1982) (Plactic Tubing); Certain Slide Fastener Stringers and Machines and Components Thereof for Producing Such Slide Fastener Stringers, Inv. No. 337-TA-85, 216 U.S.P.Q. 907 (1981) (Slide Fastener Stringers); Trade Reform Act of 1973; Report of the House Committee on Ways and Means, at 78, H. Rep. No. 93-571 (93d Cong., 1st Sess. 1973). Where there is more than one patent at issue, the Commission determines whether the domestic activities concerning exploitation of the "entire package or system" under the patents will be treated as a single domestic industry for purposes of § 337. Certain Apparatus for Continuous Production of Cooper Rod, Inv. No. 337-TA-52, 206 U.S.P.Q. 138 (1979).

In Copper Rod, the Commission adopted the findings of the Administrative Law Judge with respect to the domestic industry. 206 U.S.P.Q. at 161. In that investigation the Administrative Law Judge found the domestic industry to consist of those divisions of the Southwire Co. devoted to the development, sale, servicing and licensing of S.C.R. systems as well as the Southwire Machinery Division (SMD), Morgan Construction Co., and Machinery Assembly Corp. (MACORP), subcontractors who manufactured portions of the S.C.R. systems for Southwire. Id. In issue in Copper Rod were patents identified as the '994, '170, '423, '430 and '532 patents. Significantly, in Copper Rod, the Administrative Law Judge's finding 552 read:

> Southwire and its primary subcontractors, Morgan and MACORP, design, manufacture, sell and service SCR systems incorporating the apparatus claimed in the '170 patent for practicing the methods claimed in the ''994, '430 and '532 patents, as well as for making the product claimed in the '423 patent. (Tr. 738, 792, 793; CDX-DBC). Southwire has developed know-how and technology associated with the manufacture and operation of the SCR systems, and incorporates this proprietary information in the SCR systems that it sells or operates. (Tr. 1094-1098).

The Administrative Law Judge does not find in the record before him domestic activities concerning exploitation of an entire package or system under the '915 and '454 patents.

Corning's breakthrough in long distance light transmission came without the '454 patent. (FF 153-193). Corning began production in the United States of optical waveguide fiber covered by the '915 patent in 1971 and its first sale of said fiber was in 1972. (FF 297, 388). The claimed method of the '454 patent was not used by Corning in its initial production of optical waveguide fiber. (FF 200-216). To the contrary, the '454 patent application was not filed until April 22, 1974. (FF 110). Currently, while a portion of Corning's commercial optical waveguide fiber is covered by claims of the '915 patent and all of Corning's commercial production of optical waveguide fiber is covered by the claims of the '454 patent, (FF 361-363, 405), licensees of Corning under the '915 and '454 patents, who domestically manufacture optical waveguide fiber under the '915 patent, do so by a method not covered by the '454 patent. (Corning's reply to RPFF 56). This is conclusive evidence that the '454 method is not critical for exploitation of the claimed invention of the '915 patent. In fact, not only can optical waveguide fiber be made under the '915 patent without exploiting the '454 patent, but the acquisition of '915 patent rights does not require '454 patent property rights. This is demonstrated by the licensing agreement between Corning and SpecTran which gives SpecTran rights under the '915 patent but no rights to the '454 patent. (FF 428).

This stands in marked contrast to the facts under which a single industry was found in Copper Rod. In Copper Rod the apparatus and method patents and fourteen trade secrets were intimately related to the sale of the complete system. The Commission held that the system was sold as a package and that each element of the system was integral to the package. Therefore, the industry could into not be segmented. Id. at 161. The Administrative Law Judge concludes that the combined domestic activities of Corning and its licensees cannot be considered as a single domestic industry. Following Commission practice of defining the domestic industry as the domestic operations of the patent owner and its licensees devoted to the exploitation of a patent, the Administrative Law Judge finds two domestic industries in this investigation. One industry is composed of the domestic activities of Corning and its domestic licensees AT&T, ITT and SpecTran in exploiting the '915 patent. Corning's domestic activities exploiting the '454 patent define the second domestic industry.

In order to accurately assess the impact of respondents' activities on the two domestic industries in this investigation, it is necessary that the Administrative Law Judge determine what portion of the domestic activities relate to the exploitation of the '915 and '454 patents. Based on the evidence adduced by Corning, the record is unclear with respect to the exploitation of the '915 patent. Corning commercially produces a type 1519 optical waveguide fiber, which comprises and a type 1508 optical waveguide fiber, which comprises (FF 405). Corning admits that both of these fibers are not covered by the '915 patent. (FF 405). While Corning asserts that "[m]ost of Corning's commercial optical waveguide fiber is covered by the '915 patent (CPFF 261), Corning has not defined the term "most", nor attempted to delineate its domestic activities which relate to optical waveguide fiber that is covered by the '915 patent and its domestic activities which relate to optical waveguide fiber not covered by the '915 patent. Moreover, the extent of the domestic activities of Corning's licensees with respect to exploitation of the '915 patent is not clear. The record indicates that of AT&T sales in each of 1983 and 1984 (FF 418), approximately of SpecTran sales for 1984 (FF 437) and approximately of ITT's sales for 1983 (FF 427) were of optical waveguide fiber under the

'915 patent. However, the record does not delineate the percentage of research, development, manufacturing, marketing and distribution that was carried on in connection with the optical waveguide fiber sold by AT&T and SpecTran under the '915 patent. It can only be assumed that the percentages are the same. Moreover, the record fails to demonstrate any percentages of sales of optical waveguide fiber by ITT, AT&T and SpecTran, if any, for years not stated above.

Corning argues for the inclusion of Northern Telecom, Inc. (NTI), within the domestic industry, citing In re Certain Airless Paint Spray Pumps, Inv. No. 337-TA-90, 216 U.S.P.Q. 465 (USITC 1981) (CPH 40). The Spray Pumps case relied upon Certain Airtight Cast-Iron Stoves, Inv. No. 337-TA-69, 215 U.S.P.Q. 963 (1963). These cases held that the significant value added by domestic operations of foreign companies to the goods in issue was the factor permitting consideraton of these domestic activities as part of the domestic industry under § 337. The goods at issue in those two investigations were serviced and repaired by the foreign companies' U.S. operations. The Commission concluded in both cases that these services contributed a discernable and significant value to the goods. Cast-Iron Stoves, at 968; Spray Pumps, at 470.

NTI markets, distributes and sells optical waveguide fiber in the United States. NTI is owned by Northern Telecom, Ltd. (NTL), a Canadian Company. NTL produces fiber in Canada under a license from Corning. (FF 438). NTI markets

(FF 439).

In contrast to Cast-Iron Stoves and Spray Pumps, Corning offers insufficient evidence with which to establish what value NTI's activities add to the fiber produced and whether this value is significant. Corning states that NTI provides engineering, installation and repair services and training in conjunction with its sales of optical fiber in the United States. (CPFF 268). However, the support cited for this proposition gives no indication of the value such services might add to the optical waveguide fiber involved. (See Jamroz, CX-304, pp. 18-22; Belboul, CX-30, pp. 15, 151-53). In contrast, for example, in Cast-Iron Stoves there was evidence that a major role of the domestic operations (Jotul USA) of the foreign company was to repair and test stoves which were the goods in issue. After arriving by ship from Norway, the stoves were brought to Jotul USA's main warehouse in Portland, Maine, and afterwards sent to several warehouses located in other parts of the United States. At the Portland facility, the staff repaired and tested the stoves, designed advertising and printed brochures, including a service manual. Jotul USA also assisted its dealers in the safe installation of wood-burning stoves. A precise value was placed on the services performed by Jotul USA. 215 U.S.P.Q. at 968. In this case, the value of NTI services is unknown. The activities of NTI are not considered part of either of the domestic industries.

XII. Efficient and Economic Operation

Respondents have stipulated that Corning and its U.S. licensees are efficiently and economically operated. (CX-380). The domestic operations of Corning and its U.S. licensees are efficiently and economically operated. (FF 442-463).

XIII. Injury

In order to prevail in a Section 337 action Corning must show that the importation and sale of optcial waveguide fibers 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. Further, Corning must establish a causal relationship between respondents' alleged unfair acts and the injury to the domestic industry suffered as a result of such acts. Certain Spring Assemblies and Components Thereof and Methods of Their Manufacture, Inv. No. 337-TA-88, at 43-44, 216 U.S.P.Q. 225, 243 (1981). (Spring Assemblies).19/

A. 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 Drill Point Screws for Drywall Construction; Inv. No. 337-TA-116, at 18 (1982) (Drill Point Screws); Certain Vacuum Bottles and Components Thereof, Inv. No. 337-TA-108, RD at 72 (1982); Spring Assemblies, at 42-49, 216 U.S.P.Q. 242, 245;; Certain Flexible Foam Sandals, Inv. No. 337-TA-47, RD at 4 (1979); Certain Roller Units, Inv. No. 337-TA-44, at 10, 208 U.S.P.Q. 141 (1979); Certain Reclosable Plastic Bags, Inv. No. 337-TA-22, 191 U.S.P.Q. 674 (1977). The determination of injury must be based upon the peculiar facts of each case. Drill Point Screws, RD at 144.

Corning contends that the domestic industry has been subtantially injured in the form of lost sales and reduced prices resulting from underselling by

19/ The scope of the domestic industry under the '454 patent is defined as encompassing only the domestic activities of Corning devoted to the production, manufacture, development, servicing, licensing, and sale of commercial optical waveguide fiber and therefore, the impact of respondents' activities upon Corning's licensees only pertains to the analysis of injury to the domestic industry under the '915 patent. However, as Corning has failed
(Footnote continued to page 103)

respondents.

Corning must establish a nexus between respondents' importation and sales and injury to the domestic indusrties. As discussed, infra, the domestic market is a complex one, one which is currently experiencing a period of rapid growth (FF 481, 497, 714, 715, 718), and under these circumstances it is appropriate to hold Corning to a stricter standard of proof on the issue of injury. See Drill Point Screws, RD at 145.

During the period of 1980 through the present, the optical waveguide fiber market in the United States has experienced a consistent increase in demand for fiber, both cabled and uncabled,[20/] while shortfalls in production prevented the satisfaction of those demands. (FF 510-561). Since 1982, the U.S. market for optical waveguide fiber has grown approximately percent annually. (FF 497). From 1984 to 1985, the U.S. market for fiber is expected to further increase by approximately (FF 481, 499).

Corning and its licensees ATT, ITT and SpecTran have made significant efforts to meet the increasing demand for fiber. Since 1980, Corning has invested close to in expansion of its waveguide production facilities and has plans to invest an additional for the

---

(Footnote continued from page 102)
to clearly delineate the scope of the domestic industry under the '915 patent, Corning has necessarily failed to demonstrate the extent to which respondents' activities have affected the domestic industry under the '915 patent.

20/ Optical waveguide fiber must be made into cable before it can be put to use. Corning, because it does not cable fiber, sells its fiber to cablers. ATT and ITT are vertically integrated companies which manufacture fiber and cable. SpecTran, also a manufacturer of optical waveguide fiber, Cabled fiber is then sold to end-users. (FF 468, 470, 471). The United States market for optical waveguide fiber, then, consists of two sub-markets: (1) cablers, who purchase the fiber for production of cable and (2) end-users who purchase the cabled fiber for various applications. Corning and its domestic licensees compete with respondents in both submarkets for sales of optical waveguide fiber.

construction of an additional manufacturing facility. Corning currently estimate its 1984 sales of fiber to be and expects to expand its capacity to over one million fiber kilometers by 1986. (FF 392, 502, 503). ATT fiber cable from fiber kilometers in 1983 to fiber kilometers in 1984 and has indicated that ITT planned Finally, SpecTran intended (FF 416, 417, 505, 452, 453, 463).

Despite such efforts by the domestic industry to meet this consistently growing demand, there is clear evidence of a failure to do so. The record reveals the following: Corning has (the number of such instances having increased in the past six months); Corning has Corning has and Corning has (FF 510, 511, 514-518, 520, 521, 535-538, 552, 553, 556, 557). Some customers of Corning have been (FF 556, 557, 561). Corning's licensees, SpecTran and ITT, as well as Northern Telecom Inc., have all conceded that current demand has outstripped supply. (FF 545, 547, 558).

In light of the clear indicia of a shortfall in supply in the U.S. market for optical waveguide fibers in general, as well as a shortfall amongst Corning and its licensees, in particular, it cannot be said that a sale by respondents necessarily represents a lost sale to the domestic industry as it is unreasonable to assume that the domestic industry could have accommodated the additional sale. The analysis of alleged lost sales is further complicated by the presence of non-licensed producers of optical waveguide fiber in the United States and competition from Corning's foreign licensee. Unlicensed and allegedly infringing producers of fiber include Lightwave Technologies, American Fiber Optics and, until recently, Valtec Corporation.21/ (FF 574, 575, 576). In addition, Northern Telecom, Inc. has been and continues to be a major supplier of cabled fiber to the United States market from its licensed production facilities at Northern Telecom, Ltd. in Canada. (FF 438-440, 469). Given these multiple sources of fiber outside of the domestic industry, it is not clear that respondents' sales and market share were gained at the expense of the domestic industry. See Spring Assemblies, at 43-44; Drill Point Screws, at 20-21.

In any event, the record indicates that respondents' importation and sales of optical waveguide fiber and cable in the United States are de minimus in comparison to both the United States market as a whole, as well as the volume of sales by Corning and its domestic licensees.

The record reveals that since 1980, respondents have imported approximately kilometers of fiber and cabled fiber, with sales of approximately (FF 489). During that same period Corning's "most likely" market forecasting model indicated that total U.S. market sales of fiber would be approximately (FF 481). For 1983, respondents' estimated fiber sales in the U.S. was fiber

---

21/ Although the fiber production of what was formerly Valtec has recently come under the Corning license to ITT, prior to September 1984 Corning alleged that this fiber production infringed the '915 patent in issue. (Complaint, para. 27) kilometers at a sales value of Corning estimated its 1983 fiber sales at ATT's 1983 estimate was cabled fiber kilometers at a value of ITT's 1983 sales were and SpecTran's 1983 estimated sales were fiber kilometers at a sales value of (FF 489, 482, 414, 422, 435). Corning estimates that the total U.S. optical waveguide fiber market for 1984 would be kilometers. (FF 481). Respondents estimate that they would import fiber kilometers that year. (FF 489).

Since 1980, respondents' share of the U.S. market for optical waveguide fibers has been (FF 490). In comparison, Corning estimates its market share at for 1984. Seicor has estimated respondents' share of the U.S. fiber cable market at as well, which compares with its estimation of U.S. market shares of fiber cable for Seicor itself of ATT, Valtec (prior to its acquisition by ITT), Northern Telecom, Ericsson, and ITT, (FF 480, 718).

While a direct correlation cannot be drawn between respondents' sales and injury to the domestic industry due to the presence of non-licensed competitors in the marketplace as well as a general inability to meet market demand, as discussed, supra, Corning has cited three instances in which domestic cablers were known to have bid against respondents for particular cable projects and lost those contracts to SEI/SESUA (CRB, p. 29). These three sales, made in 1982 and 1983, were for a total of (FF 563, 564, 566, 567, 571). Assuming, arguendo, that each of these three sales, but for SEI/SEUSA, would have been awarded to a cabler actually capable of obtaining the required quantity of fiber and that the fiber would have been fiber produced by the domestic industry, the lost sales represented by these three projects is a miniscule percentage of total market sales. Such a level of sales does not provide a basis for a determination of substantial injury to the domestic industries.

Corning's reliance on <u>Bally/Midway Mfg. Co. v. U.S.I.T.C.</u>, 714 F.2d 1117 (CAFC 1983) for the proposition that even a small loss of sales may establish injury, is misplaced. In <u>Bally/Midway</u>, the Federal Circuit found that the number of infringing products sold in the United States was <u>significant</u>, and that the products in issue (video games) had only a brief period of popularity, accompanied by high production and sales. <u>Id</u> at 1119. Moreover, the Court focused on the disparate treatment of the two products at issue -- the Rally-X and Pac Man video games. The Commission had found no substantial injury to complainant's Rally-X game because, unlike Pac Man, its sales were permanently declining. The Federal Circuit reversed the Commission's Rally-X injury analysis, holding that if the import level was sufficient to establish substantial injury as to the Pac Man video game, the <u>same</u> level of imports was sufficient to prove substantial injury as to Rally-X, regardless of the game's diminishing popularity. <u>Id</u> at 1123-1125.

Finally, complainant's own domestic licensees and some of the cablers who sell Corning fiber indicate that they are unaware of any business lost to respondents. (FF 579).

Corning also argues that underselling by SEI/SEUSA has resulted in reductions in domestic fiber and cabled fiber prices, to the detriment of the domestic industry. The record evidence indicates that while respondents' pricing may have affected the pricing behavior within the domestic market in isolated instances, the overall downward pricing trend within the domestic optical waveguide fiber market is attributable to other, more significant market forces to be discussed, <u>infra</u>.

Complainant places much emphasis on the 1982 project for Pacific Northwest Bell (PNB) for a route between Portland and Vancouver.

bid, which was based on the use of Corning's fiber, was initially higher than As a result Corning reduced its price to from 57¢ to --¢ per meter for the same quality fiber for use in this project. (FF 608). Subsequent to Corning's reduction of its fiber price to for the PNB project, Corning, in 1983, reduced its prices for its second window multimode fiber -- the type used in the PNB project -- for the entire industry. (FF 609, 654). Corning's price reduction of its second window multimode fiber was part of an overall price reduction effective March 1, 1983, applied to all of Corning's fiber. In setting these price changes for the 1983 period, Corning considered factors other than competition from respondents, <u>viz</u>,

(FF 654, 655). That bidding on the PNB project was a significant impetus to Corning's 1983 second window multimode fiber price reduction has not been established.

While it is often difficult to know with certainty what the prices of other bidders have been on any given project (FF 607), the record reveals several instances in which domestic cablers offered bids lower than those of SEI/SEUSA. (FF 613-616). Moreover, have all indicated that they are aware of no instances in which they lowered their prices for fiber in response to competition from SEI/SEUSA. (FF 649, 650, 653). Both have stated that respondents have not affected their product pricing. (FF 651, 652).

The optical waveguide fiber market in the United States is characterized by active competition -- a market in which, at various times, have underbid other cablers. (FF 637-647). Corning itself takes into consideration when establishing its prices and

(FF 619-621).

The downward movement of prices for optical waveguide fiber in the U.S. market reveals an unmistakeable and pronounced industry-wide trend. It is estimated that the price of fiber has decreased anywhere from percent, depending on fiber type, from 1980 to 1983. (FF 661).

Both Corning and have indicated that the declining prices for fiber can largely be attributed to improved methods of production and economies of scale, resulting in overall reduced manufacturing costs. (FF 662, 664, 655). As an example of this development, Corning's total manufacturing cost per kilometer fell from in the first quarter of 1981 to in the second quarter of 1983, or a decrease of in manufacturing costs per kilometer. (FF 659). Notwithstanding a decrease in the average selling price per meter from from 1979 to 1984, Corning's sales revenues rose , from in that same period. (FF 660).

In the context of a market as described, <u>supra</u>, Corning has failed to establish a sufficient correlation between respondents' pricing behavior and the decrease in domestic industry prices for optical waveguide fiber. See <u>Certain CT Scanner And Gamma Camera Medical Diagnostic Imaging Apparatus</u>, Inv. No. 337-TA-123, RD at 195 (1983).

Finally, it is noted that traditional indicia of injury, such as decreasing sales and production are not present in this investigation. Sales figures for Corning, have increased markedly in recent years. (FF 392, 414, 415, 422).

Accordingly, Corning has failed to prove by a preponderance of the evidence that either of the domestic industries, as defined by the '915 and the '454 patents, has been substantially injured by respondents' importation and sale in the United States of optical waveguide fibers.

B. 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, RD at 24 (1979). Relevant conditions or circumstances may include foreign cost advantage and production capacity, ability of the imported product to undersell complainant's product, or substantial manufacturing capacity combined with the intention to pentrate the United States market. Certain Methods for Extruding Plastic Tubing, Inv. No. 337-TA-110, 218 U.S.P.Q. 348 (1982); Certain Reclosable Plastic Bags, Inv. No. 337-TA-22, 192 U.S.P.Q. 674 (1977), Panty Hose, Tariff Commission Pub No. 471 (1972). The legislative history of Section 337 indicates that "[w]here unfair methods and acts have resulted in conceivable loss of sales, a tendency to substantially injure such industry has been established." Trade Reform Act of 1973, Report of the House Comm. 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). See also, Bally/Midway Mfg. Co. v. U.S. International Trade Commission, 219 U.S.P.Q. 97, 102 (C.A.F.C. 1983).

While the record in this investigation reveals a likelihood that respondents' imports will continue at least for the immediate future, it does not establish that the quantity of product imported will be substantial in relation to both the U.S. market in general, as well as the domestic industry. Moreover, the record indicates that importations are likely to diminish in the years ahead.

Regarding foreign cost advantage, the evidence is scant and inconclusive (Markham, Tr. 1543; CX-134). With respect to foreign production capacity, SEI's current capacity is   with projected

(FF 677). That

capacity is

(FF 676, 681). In light of SEI estimates that

(FF 676, 681) it is reasonable to assume that at least a significant portion of SEI's immediate capacity will be directed to non-U.S. markets.

As noted, supra, respondents' share of the U.S. market for optical waveguide fiber since 1980 has been While not disputing this level of import penetration, Corning and the Commission investigative attorney argue that as a result of their sales and marketing efforts in the United States to date, respondents have gained a "toe-hold" in the domestic market from which they will likely increase their market presence in the future.

However, the evidence of record indicates that any increase in market share which respondents may realize in the future will largely be sustained by production of fiber in respondents' new U.S. facility, Sumitomo Electric Research Triangle (SERT) in Raleigh, North Carolina. The establishment of SERT was approved by

(FF 682, 684). That the facility was intended early-on for the production of cable and fiber is indicated by

(FF 684). Production for commercial sale was scheduled to begin in 1984, at which time SERT was to commence production of all types of fiber and cable which SEI has imported in the past. (FF 685, 686). SERT is designed to be a

(FF 684).

With an investment of for the first stage of its new U.S. facility, an expected production capacity somewhat less than fiber kilometers per year by and a current workforce of at least employees, respondents' SERT facility is intended to serve as the principal source of fiber and cable for SEI/SEUSA's sales in the U.S. market. (FF 686, 688, 689, 692). There is insufficient evidence of record to indicate that respondents' intentions, viz-a-viz SERT, will not be realized.

From 1980 to 1984, respondents' total sales of optical fiber in the U.S. were estimated to be approximately of the total U.S. market. (FF 492).

(FF 606). Production of fiber in the U.S. enables respondent to participate in the U.S. market free of certain costs and hindrances directly associated with foreign manufacture, <u>viz</u>., customs duties and non-custom importation costs adding approximately to the cost of respondents fiber and cable,

(FF 597-601).

The evidence of record is consistent with respondents' professed intention to

Currently, respondents

The only

(FF 669, 671, 699). SEUSA has indicated that

(FF 669).

. (FF 670). While SEI

anticipates that –

(FF 690, 693). Further, SEI has indicated that

(FF 695). In any event, respondents intend to import no more than

(FF 697, 698).

(FF 717).

The record evidence is consistent with respondents' forecast for its level of importation for 1985. With an expected foreign capacity of

No evidence has been adduced with respect to respondents' expected level of imports to the U.S. in subsequent years, and lacking evidence to controvert respondents' expressed policy to make SERT its principal source of sales of fiber for the U.S. market, it is determined that future importation will be insubstantial. Any further attempt to quantify such future imports would be mere speculation. The injury contemplated under the "tendency to substantially injure" provision of §337 is one of a substantive and clearly forseen threat to the future of the industry, not based on allegation, conjecture or mere possibility. In the Matter of Certain Braiding Machines, Inc. No. 337-TA-130 (1983); In the Matter of Expanded Unsintered Polytetraflouroethylene in Tape Form, Inv. No. 337-TA-4 (1976).

Although respondents expect to increase their U.S. market share

and expand their marketing and sales efforts in the U.S. (FF 703, 704, 708, 716), the U.S. market is currently expanding at a rapid rate and is expected to continue to do so throughout the decade. Corning's U.S. market share is

and its sales are projected to

Also, Corning

intend to increase their production capacity in the near future to meet the expected increase in demand. (FF 453, 463, 496-500, 502, 503, 505, 675, 714, 715, 718).

Finally, respondents' anticipated increase in sales will be principally of fiber and fiber cable produced in respondents' new U.S. facility in North Carolina.

Corning contends that as a result of respondents' past imports, respondents have gained a "toe-hold" in the U.S. market from which they will be able to increase their level of imports from Japan, the sale and merchandising of which will be facilicated by the SERT facitlty and its support personnel. Corning relies on the alleged likelihood of an increase in imports from SEI as a basis for a tendency to substantially injure. (CPH, 44, 46-47; CPHR, 37-38). The Commission investigative attorney, on the other hand, takes the position that both the past activities of SEI/SEUSA and the future plans for both SEI/SESUA and SERT should be considered in an assessment of tendency to substantially injure, i.e., the issue of injury should be determined based upon an analysis of the likely impact of a combination of imported and domestically produced fiber. (SPHR, 5, 6).

The unfair methods of competition and unfair acts cognizable under §337 are those performed in association with the importation of goods, not in association with goods that have been produced domestically. Apart from the clear language of the statute, its legislative history indicates that American industry was to receive protection from particular activities in conjunction with the importation of articles into the United States. In its discussion of §337 and cases involving unfair methods of competition and unfair acts based upon the claims of a U.S. patent, the Report of the House Committee On Ways And Means, regarding H.R. 10710, the bill that became the Trade Reform Act of 1973, stated:22/

> Commission precendent, approved by the CCPA, establishes that the importation or domestic sale without license from the patent owner of articles manufactured abroad in accordance with the invention disclosed in an unexpired U.S. patent constitutes an unfair method of competition or unfair act within the meaning of section 337 (emphasis added).

The cornerstone of §337 is the protection of domestic industry from unfair trade practices, i.e., unfair activities in connection with the importation of articles into the United States. When the "tendency to substantially injure" provision is considered in the context of the mandate of §337, the activities to be proscribed are those current unfair methods of competition and unfair acts, which, when considered in the context of certain relevant market conditions, demonstrate that the domestic industry is likely to incur substantial injury in the future from continued importations.

As firmly established by the Commission, the assessment of tendency to substantially injure is prospective in nature, looking to the curtailment of unfair methods of competition in their incipiency. Braiding Machines, ID at

---

22/ Trade Reform Act of 1973, Report of the House Committee on Ways and Means, H. Rep. No. 93-571, 93 Cong., 1st Sess. at 8.

95; Certain Surveying Devices, Inv. No. 337-TA-68 at 33 (1980). Unlike many past investigations in which the record revealed indicia of probable increased importation in the furture and a concomitant tendency to substantially injure the domestic industry (see e.g. Certain Single Handle Faucets, Inv. No. 337-TA-167 (1984); Certain Trolley Wheel Assemblies, Inv. No. 337-TA-161 (1984); Certain Limited-Charge Cell Culture Microcarriers, Inv. No. 337-TA-129 (1983); In the Matter of Reclosable Plastic Bags, Inv. No. 337-TA-22 (1977)), the record in the instant investigation demonstrates a commitment on the part of respondents to rely upon their U.S. manufacturing facility as the primary source of production of its optical waveguide fiber intended for sale in the U.S. market.

It is reasonable to assume that respondents' importation and sales in the past and its intended importation of of fiber in the near future will serve to facilitate, at least to some degree, respondents' access to the U.S. market. Nevertheless, any future sales in the U.S. market which respondents may generate will consist predominately of U.S.-manufactured fiber. Section 337 is not intended to prevent activity of that nature.

Based upon the foregoing, Corning has failed to prove by a preponderance of the evidence that the importation and sale in the United States of optical waveguide fiber by the respondents has the tendency to substantially injure either of the domestic industries as defined by the '915 and '454 patents.

FINDINGS OF FACT

The following are the Findings of Fact of the Administrative Law Judge.

I. Jurisdiction

1. The United States International Trade Commission (Commission) has *in personam* jurisdiction over all the parties to this investigation. All parties have appeared and litigated the issues in the investigation.

2. The Commission has *in rem* and subject matter jurisdiction in this investigation under 19 U.S.C. § 1337 since the alleged unfair methods of competition and unfair acts involve the importation of optical waveguide fibers into the United States. (Notice of Investigation, April 18, 1984, 49 Fed. Reg. 15287).

II. The Parties

3. Complainant Corning Glass Works (Corning) is a corporation organized and existing under the laws of the State of New York and has its principal office and place of business at Houghton Park, Corning, New York 14830. (Complaint, para 1).

4. Respondents in this investigation, as named in the notice of investigation, are Sumitomo Electric Industries, Ltd. (SEI) of Osaka, Japan and one of its subsidiaries, Sumitomo Electric U.S.A., Inc. (SEUSA). (Notice of Investigation).

5. Respondent SEI is a Japanese corporation having its principal place of business at 15, Kitahama 5-chome, Higashi-ku, Osaka 541, Japan. (Complaint, para. 29, SEI Response to Complaint, para. 29).

6. Respondent SEUSA is a coporation of the State of New York, having its principal place of business at 551 Madison Avenue, New York, New York 10022 (Complaint, paras. 29 and 31).

III. Products in Issue

7. Corning asserts five different types of optical waveguide fibers manufactured by SEI in Japan are in issue in this investigation. Three of these are single mode optical waveguide fibers -- designated S-1, S-2 and S-3 -- and two are multimode graded index -- designated M-1 and M-2 (Cooper CX-7 para. 36-37).

8. Respondents admit to the importation by SEI of fibers designated Nos. M-1, M-2, S-1, S-2 and S-3 to the United States by SEI (Hoshikawa RPX-101A para. 4).

9. Each of the M-1, M-2, S-1, S-2 and S-3 fibers is a fused silica based fiber containing a core and cladding with the refractive index difference between such core and cladding controlled through the use of doped fused silica (Hoshikawa RPX-101A; Cooper CX-7, paras. 36-37).

10. Internally SEI has designated the S-1 fiber as type D; the S-2 fiber as type D', the S-3 fiber as type Z; the M-1 fiber as type A; and the M-2 fiber as type C. (Tr. 2287).

11. Terms used in the technology involving the subject matter of the investigation have been defined or characterized as follows:

(a) Glass ia a rigid substance without long-range atomic order. Traditionally, glasses were made by fusion of one or more raw materials cooled to a rigid condition without crystallizing. Glass can be made by other means. e.g., by vapor deposition. Glass can be transparent, opacue or anything between, depending on its composition.

(b) Silica is silicon dioxide. The chemical symbol is SiO_2. For example, cuartz sand, as it occurs in nature, is crystalline silica. Typically when melted and cooled, silica forms a glass.

(c) Germania is germanium dioxide. The chemical formula is GeO_2. Typically, when germania is melted and cooled, it forms a glass.

(d) Titania is titanium dioxide. The chemical formula is TiO_2.

(e) "Index of Refraction" is a number representing a property of all materials which transmit light. Specifically, it is a number which indicates the speed with which light travels through a material. The Refractive Index of a material is the ratio of the speed of light in a vacuum to the speed of light in the material.

(f) "Refraction" occurs when light travels from one material to another, where the materials have different refractive indices, i.e., when a light ray passes from one material to another, its direction changes. This direction change is called "refraction".

(g) As to "Reflection", when the index of refraction of two materials is different, some light rays will be reflected at the interface.

(h) Optical Waveguide Fiber is a thin fiber, made of a transparent material and capable of transmitting a predetermined number of modes of light. It is a transmitting media for frequencies around 10^{15}hz.

(i) Core is the central portion of an optical waveguide fiber through which the light primarily travels.

(j) Cladding is the outer portion of an optical waveguide fiber which acts to confine light rays to the core.

(k) Micron is one millionth of a meter.

(l) Mode is a family of light rays traveling through a fiber at a particular angle with respect to the fiber axis.

(m) Single Mode Fiber is an optical waveguide fiber having a very small core diameter, e.g., 5-10 microns, and a small index of refraction differential between core and cladding so that only one family of light rays, or mode, can pass through it.

(n) Multimode Fiber is an optical waveguide fiber having a core which is larger than a single mode fiber and a larger refractive index difference between core and cladding, such that multiple families of rays, or modes, can pass through it simultaneously.

(o) Attenuation is a property expressed by a number, which indicates the ability of a material to transmit energy, usually a signal. The lower the attenuation, the greater the amount of energy which will be transmitted through the material. Mathematically, attenuation is the relationship between the strength of the input signal to the output signal. With respect to optical waveguide fibers, attenuation is usually expressed in decibels per kilometer (dB/km), expressed mathematically as -10 x log (light output/light input).

(p) Numerical Aperture (NA) is a property expressed by a number which represents the light gathering ability of an optical waveguide fiber. It depends upon the refractive index difference between the core and cladding -- larger the difference, the greater the Numerical Aperture. Mathematically, it is the sine of the largest angle of a family of rays which will be accepted by a fiber.

(q) Bandwidth (BW) is a property expressed by a number which indicates the rate at which information can be transmitted over a fiber. The higher the Bandwidth of an optical waveguide fiber, the more information that can be transmitted over the fiber in a given time.

(r) Megahertz (MHz) is a measure of bandwidth; e.g., an optical waveguide fiber might have a bandwidth of 500 MHz. (Maurer Cx-1 para. 9, App. Glossary; Schultz CX-2 para. 17, App. Glossary; Cooper CX-7 para. 8, App. Glossary; CX-8, col. 1, ll. 30-34).

12. In general terms, the optical waveguide fibers at issue are hair-thin fibers of ultra pure silica glass. Their outside diameter can vary from 75 to a few hundred microns, although the dominant standard of the industry is now 125 microns. The fibers consist of two regions, namely a core, i.e., the central portion of the fiber through which the light rays primarily pass, and a surrounding glass cladding. The core portion is typically 5 to 100 microns in diameter. The refractive index of the core glass is higher than that of the cladding. (Maurer CX-1 para. 10; Cooper CX-7, para. 9).

13. In optical waveguide fiber use, a light source, either a laser or a light emitting diode, is coupled with the optical waveguide fiber, and the light generated in response to an electrical signal is directed into the core. The light travels the length of the fiber, through the core, and is captured by a detector, which converts it back to an electrical signal. (Maurer CX-1 para. 11; Cooper CX-7, para. 10).

14. Optical waveguide fibers may be used for telecommunications such as the transmission of telephone communications. So used, a single optical waveguide fiber of a diameter of 125 microns can provide over 1000 simultaneous voice transmissions and can replace a conventional copper cable of a diameter of greater than 5 centimeters. (Maurer CX-1, para. 12; Cooper CX-7 para. 11).

15. A section of conventional copper wire telephone cable, is made up of approximately 1800 copper wires, each pair of which typically carries one two-way telephone conversation (1 voice circuit) (Maurer CX-1 para. 13; CPX-1).

16. A section of an optical waveguide cable for use in telecommunications may be made up of 6 fibers. In currently available cables of this construction, each pair of fibers can be used to carry over 1000 simultaneous conversations. (Maurer CX-1, para. 14; CPX-2).

17. The light directed into the core of an optical waveguide fiber consists of many separate families of rays, all striking the core at different angles. Rays striking the core at too severe an angle will pass into the cladding and be lost. The remainder will be reflected back towards the center upon striking the core/cladding interface and will proceed down the core, reflecting from one side of the core to the other. (Maruer CX-1, para. 15; CX-18; Cooper CX-7, para. 12).

18. In nearly all optical waveguide fibers, the composition of the cladding, and consequently its index of refraction, are constant throughout the cladding thickness. This is not necessarily true of the core, for while the core composition and its refractive index may be maintained essentially constant across the cross-section of the core, it has been known for some time that where the core of the fiber is relatively large in relation to the wavelength of light being transmitted, the core may advantageously be made with a varying index of refraction across its diameter, the glass with the highest index of refraction being at the center of the core with the refractive index decreasing radially to that of the cladding. Such fibers are called "graded index" optical waveguides. (Maurer CX-1, para. 16; Cooper CX-7, para. 13).

19. Optical waveguide fibers in which the dimension of the core is large in relation to the wavelength of light being transmitted, are referred to as multimode optical waveguide fibers because of their ability to propagate more than one mode of light, i.e. can transmit light at various wavelengths. In a single mode optical waveguide fiber, the core dimension is small (close to the wavelength of the light being transmitted), such that propagation of only one mode of light is possible. (Maurer CX-1, para. 17; CX-19; Cooper CX-7, para. 14; SX-92, p. 58).

20. In practice, the core of single mode optical waveguide fibers contains less than 15% dopant material by weight, the remainder being silica. Multimode optical waveguide fibers may contain more or less than 15% by weight

of dopant, depending upon the numerical aperture sought. Multimode optical waveguide fibers having a numerical aperture greater than 0.25 generally contain in excess of 15% by weight of dopant material in the core. (Cooper CX-7, para. 15).

21. The three primary types of optical waveguide fibers have been called multi-mode stepped index, multi-mode graded index, and single-mode stepped index fibers. (SX-92, p. 58)

22. Multi-mode fibers are so called because they transmit light at various wavelengths. (SX-92, p. 58).

23. Due to the relatively large core diameter (generally around .125 millimeters) of a multi-mode fiber, the lightwaves propagate along different paths within the fiber core. Thus, different rays of light require varying lengths of time to travel over a given distance in such fiber. (SX-92, p. 58).

24. Multi-mode stepped index fiber, the oldest and simplest type of fiber used, has a central core of high-density glass which is relatively large and can accept light more easily. It is surrounded by another layer of glass with a lower refractive index. (SX-92, p. 58).

25. In the multi-mode stepped-index fiber, when the light from the higher density glass hits the glass with the lower density, the light is reflected back toward the center and moves onward through the fiber core being continuously reflected back towards the center. The difference in the refractive index of the two forms of glass is the "step" in the fiber. (SX-92, p. 58).

26. In multi-mode graded-index fiber, the refractive index between the core and the initial low density coating is a graduation which bends the light gradually toward the center. With proper graduation, the light rays maintain greater speed than those single-mode fibers transmitted through multi-mode stepped-index fiber. (SX-92, p. 59).

27. Single-mode fiber is normally fiber with a core diameter of less than 10 micrometers. (SX-92, p. 58).

28. Single-mode fiber propagates light at only one wavelength; thus, the rays move through this type of fiber with less dispersion than in multi-mode fiber, resulting in a sharper signal and an increased ability to handle greater amounts of information. (SX-92, p. 58).

29. The important thing in fiber used in the transmission of light is the difference in refractive index between the core and cladding. (Hoshikawa, Tr. 2088).

A. <u>S-1 Fiber</u>

30. The S-1 fiber is a type single mode fiber used in the transmission of wavelength light signals of (Hoshikawa RPX-101A para. 4(c).

31. The type S-1 fiber is a fused silica-based single mode fiber containing a core and cladding. The core region is composed of The cladding region is (Hoshikawa RPX-101A para. 4(c); Tong CX-5, para. 5-7; CX-61).

32. The type S-1 fiber is doped with The refractive index difference between the core and cladding is controlled through the use of the fused silica doped with (Day RPX-102A, paras. 2-4; Macedo RPX-103A, para. 5; Hoshikawa RPX-101A, para. 4(c); Tong CX-5, paras. 1, 5-7; CX-6).

33. In the S-1 fiber, increases the index of refraction of the core. (Hoshikawa Tr. 2088).

B. S-2 Fiber

34. The S-2 fiber is a type single mode fiber used in the transmission of wavelength light signals of (Hoshikawa RPX-101A para. 4(d)).

35. The type S-2 fiber is a fiber containing a core and cladding. The core region is composed The cladding region is composed of present in an amount of about (Hoshikawa RPX-101A para. 4(d); Tong CX-5, paras. 1, 5-7; CX-62).

36. The type S-2 fiber cladding is doped with fluorine that decreases the index of refraction. (Hoshikawa RPX-101A, para. 4(d); Tong CX-5, para. 1, 5-7; CX-62; Cooper CX-7, para. 36).

37. is a material which, when intentionally added to but which does not (Maurer CX-1, para. 9, App. Glossary, p. 2; Schultz CX-2 para. 7; CX-2 App. Glossary, p. 2; Hosikawa Tr. 2075, 2088-89).

38. In the S-2 fiber, increases the index of refraction of the core. (Hoshikawa Tr. 2088).

C. S-3 Fiber

39. The S-3 fiber is a type single mode fiber used in the transmission of wavelenght light signals of (Hoshikawa RPX-101A, para. (e)).

40. The type S-3 fiber is a fiber containing a core and cladding. The core region is composed of The cladding is composed of (Hoshikawa RPX-101A, para. (e); Tong CX-5, paras. 1, 5-7; CX-63).

41. The type S-3 fiber has an The cladding of

The core has a higher refractive index than the cladding. (Hoshikawa RPX-101A, para. (e); Cooper CX-7 para. 37).

42. The refractive index difference between the core and cladding of each of fibers S-1, S-2 and S-3 is (Hoshikawa, Tr. 2093).

43. Fiber S-1 contains about in the core; fiber S-2 contains about in the core. The refractive index of the core of fiber S-2 is, therefore, the refractive index of the core of fiber S-1. Fiber S-1 has a cladding. To maintain the as that achieved in fiber S-1, the of fiber S-2 is by approximately

of the S-1 and S-2 This is done by the addition of (Hoshikawa RPX-101A, para. 4(c), (d); Hoshikawa, Tr. 2086-90).

44. Fiber S-3 contains or other dopant material in its

The refractive index of the core of fiber S-3 is therefore the refractive index of the core of fiber S-2. To maintain the same

as that achieved in fiber S-2, the

of fiber S-3 is by approximately the

was

of fiber S-2. This is done by the addition of about

(Hoshikawa RPX-101A, para. 4(d), (e); Hoshikawa, Tr. 2090-93).

D. M-1 Fiber

45. The M-1 fiber is a (Hoshikawa RPX-101A, para. 4(a).

46. The type M-1 fiber is a fiber containing a core and cladding. The core region is (Hoshikawa RPX-101A, para. 4(a); Tong CX-5, paras. 1, 5-7; CX-64).

47. In the M-1 fiber, increases the index of refraction of the core. (Hoshikawa Tr. 2088).

E. M-2 Fiber

48. The M-2 fiber is a (Hoshikawa RPX-101A).

49. The type M-2 fiber is a fiber containing a core and cladding. The core region is composed of containing in an average amount of about in an amount of about used as a binder and a thin covering the region, i.e. the is near the The surrounding is essentially (Hoshikawa RPX-101A para. 4(b); Tong CX-5, paras. 1, 5-7; CX-65).

F. Fibers Accused of Infringing '915 Patent

50. Corning charges that respondents' multimode fiber M-1 and single mode fibers S-1, S-2 and S-3 infringe claims 1 and/or 2 of the '915 patent. Since respondents' M-2 fiber contains dopant in its core, Corning does not charge the M-2 fiber with infringement of the '915 patent. (CPH pp. 26-27; Tr., 1974-95).

IV. Processes in Issue

A. Processes for M-1, S-1 and S-2 Fibers

51. The process used by respondent SEI in the manufacture of accused M-1 fiber involves the following:

(i) are burned in an flame to form a at the

(ii) The is next placed in an having a thereby forming a by over a period of time to a maximum temperature approaching degrees centigrade;

(iii) The is thereafter placed in a having only a and subjected to a maximum temperature approaching whereby a article is formed;

(iv) The glass article is then placed in a and with an flame and elongated into a element;

(v) The element is then inserted into a tube and this composite is heated with an flame causing the thereby forming a and (vi) The is then (Hohsikawa RPX 101A, para. 3(b); Hoshikawa Tr. 2058, 2062, 2066-67, 2070-71, 2215, 2250; CX-87; CX-89; CX-90).

52. The process used by respondent SEI in the manufacture of accused S-1 fiber involves the following:

(i) are burned in an flame to form a at the

(ii) The is next placed in an having a gaseous atmosphere containing thereby forming a by heating over a period of time to a maximum temperature approaching degrees centigrade;

(iii) The is thereafter placed in a having only a and subjected to a maximum temperature approaching whereby a clear is formed;

(iv) The is then placed in a and heated with an flame and elongated into a

(v) The is then inserted into a and this composite is heated with an flame causing the thereby forming the and

(vi) The is then (Hoshikawa RPX 101A, para. 3(c); Hoshikawa Tr. 2058, 2062, 2066-67, 2070-71, 2215, 2250; CX-87; CX-89; CX-90).

53. The pro⌣ess used by respondent SEI in th⌣ manufacture of accused S-2 fiber involves the following:

(i) are burned in an flame to form a at the

(ii) The is next placed in an having a gaseous atmosphere containing and mainly thereby forming by heating over a period of time to a maximum temperature approaching

(iii) The is thereafter placed in a having only a and subjected to a maximum temperature whereby a article is formed;

(iv) The is then placed in a and heated with an flame and element;

(v) The element is then inserted into a and this composite is heated with an flame causing the thereby forming the and

(vi) The is then

(Hoshikawa RPX 101A, para. 3(d); Hoshikawa Tr. 2058, 2062, 2066-67, 2070-71, 2215, 2250; CX-87; CX-89, CX-90).

54. As to the processes for the M-1,S-1, and S-2 fibers, respondents refer to the period during which the preform resides in the . Respondents refer to the period during which the resides in the (Hoshikawa RPX-101A), para. 13).

B. Process for S-3 Fiber

55. The process used by respondent SEI in the manufacture of accused S-3 fiber involves the following:

(i) is burned in an flame to
form a at the

(ii) The is next placed in an
having a
thereby forming a by heating
over a period of time to a maximum temperature approaching

(iii) The is thereafter placed in a having only
a to form a rod by
subjecting the to a maximum temperature approaching
whereby a rod is formed;

(iv) A hole is drilled through the center of the

(v) The is then placed in a
and heated with an flame and elongated so as
to form an

(vi) The is etched to a very smooth
state, and a is inserted in the etched hole as a

(vii) The tube is then heated with an
flame removing surface water therefrom by
into the hole and then causing the to around
the glass;

(viii) The having a glass therein is then placed in a and heated with an flame and

(ix) The collapsed is then inserted into a tube and again by the use of an flame;

(x) The resulting is then

(Hoshikawa RPX-101A, 3(e); Hoshikawa Tr. 2058, 2082-83, 2215, 2250; CX-88, CX-90).

56. In the S-3 process the used in step (vi) is produced by formed by on the The so formed is then placed in an having a substantially dry, and is heated over a period of time to a maximum temperature approaching . Thereafter the is removed from the and placed in a having only a The is therein subjected to a maximum temperature approaching whereby to a is completed. This article is later and inserted into a as in step (vi). (Hoshikawa, Tr. 2083-84; 2211-19).

57. As for the processes for the S-3 core glass rod and S-3 cladding preform, respondents refer to the period during which the resides in the Respondents refer to the period during which the resides in the as a (Hoshikawa RPX-101A, para. 3).

C. Process for M-2 Fiber

58. The accused process used by respondent SEI in the manufactures of M-2 fiber involves the following:

(i) are burned in an oxygen-hydrogen flame to form a at the

(ii) The is thereafter placed in a having

(iii) A containing is thereafter applied to the surface of the

(iv) The is then placed in a and heated with an flame and into a

(v) The is then inserted into a and this composite is heated with an flame causing the thereby forming the

(vi) The is then (Hoshikawa, RPX-101A para. 3(a); Hoshikawa, Tr. 1998-99, 2000; RX-1238).

59. Respondents' witness Hoshikawa testified that fiber M-2 is currently manufactured by a process which involves of any kind in a (Hoshikawa RPX-101A, para. 3(a); Hoshikawa, Tr. 1998-99, 2000).

D. Processes Accused of Infringing '454 Patent

60. Corning charges respondents' M-1, S-1, S-2, S-3 and M-2 processes used in making their M-1, S-1, S-2, S-3 and M-2 fibers infringe claims 1 and 8 of the '454 patent (CPHP, pp. 35-36).

V. The '915 Patent

61. U.S. Letters Patent No. 3,659,915 ('915 patent) titled "Fused Silica Optical Waveguide" issued May 2, 1972 on an application Ser. No. 36,109 filed May 11, 1970. The named inventors on the issued patent are Robert D. Maurer and Peter C. Schultz. The patent on its face is assigned to Corning. The patent issued with nine composition of matter claims (CX-8 (RX 1000)).

62. Specifically, the invention of the '915 patent is a silica-based optical waveguide fiber containing, at least in part, fused silica to which a dopant or dopants have been added. (Maurer, CX-1, para. 33; Schultz, CX-2, para. 19; Cooper, CX-7, paras. 33-34; CX-8).

63. Fused silica is made by the process disclosed in Hyde U.S. patent 2,272,342 and is comprised only of vitreous silica of extreme purity. (Macedo, RPX-103A, para. 27; RX-1031, p. 1, col. 1, ll. 1-20).

A. Claims in Issue

64. Claims 1 and 2, in issue in this investigation, read:

1. An optical waveguide comprising a cladding layer formed of a material selected from the group consisting of pure fused silica and fused silica to which a dopant material on at least an elemental basis has been added, and a core formed of fused silica to which a dopant material on at least an elemental basis has been added to a

degree in excess of that of the cladding layer so that the index of refraction thereof is of a value greater than the index of refraction of said cladding layer, said core being formed of at least 85% by weight of fused silica in an effective amount up to 15% by weight of said dopant material.

2. The waveguide of claim 1 wherein the cladding layer is substantially pure fused silica. (CX-8 (RX 1000) col. 5).

B. <u>The '915 Specification</u>

65. The Abstract of the invention reads:

"An optical waveguide having a high purity fused silica cladding layer, and a core of high plurality[sic] fused silica doped with a sufficient amount of a multivalent metal oxide so as to increase the index of refraction of the core above that of the cladding layer." (CX-8 (RX-1000) title page).

66. Under the heading "Background of the Invention "and subleading "Field of the Invention" it is disclosed that the increase in the amount of traffic that communication systems are required to handle has forced the development of higher capacity systems; that the presently used systems which operate between 10^6 hz and 10^9 hz have become saturated in some frequency bands due to excessive traffic; that to allow for needed increases in traffic; commercial communication groups are presently installing high capacity systems that operate between 10^9 hz and 10^{12} hz; and that saturation of these systems is anticipated in the very near future. Thus it is said that systems operating around 10^{15} hz are needed. Waveguides are desirable for effective transmission of information by systems operating at frequencies above 10^9 hz. Systems operating at frequencies operating around 10^{15} hz are needed. Systems operating at frequences between 10^9 hz and 10^{12} hz normally use electrical conductive waveguides as a transmitting medium. However, conventional electrical conductive waveguides are not satisfactory for transmitting information at frequences around 10^{15} hz. As of May 11, 1970 producing a satisfactory transmitting media for frequencies around 10^{15} hz has been one of the more difficult problems in the development of an effective optical communication system. (CX-8 (RX-1000) Col. 1, ll. 5-33).

67. Under the heading "Background of the Invention" and subheading "Description of the Prior Art", it is disclosed that an optical waveguide, to be an effective transmitting media for an optical communication system (system operating around 10^{15} hz), should transmit light without excessive attenuation and should not cause dispersion or scattering of the transmitted light. In addition, an optical waveguide should allow only preselected modes of light to propagate along the fiber. (CX-8 (RX-1000) col. 1, ll. 35-40).

68. Under the subheading "Description of the Prior Art," it is further disclosed that optical waveguides are a unique type of optical fiber in that many of the physical characteristics and parameters must be carefully coordinated; that in the conventional optical fiber substantially all of the transmitted light is retained within the core, and the light transmission qualities of the cladding layer are therefore of no consequence; that some fibers, are purposely produced with a core possessing good transmission qualities and a cladding layer that is highly absorptive; that in order to prevent transmitted light from escaping the fiber, one of the more basic considerations in producing conventional optical fibers is that the index of refraction of the core be larger than the index of refraction of the cladding layer; and that if the difference between the two indices of refraction is increased, the amount of light escaping from the fiber will decrease (CX-8 (RX-1000) col. 1, ll. 48-64).

69. The specification discloses that it is common practice in the production of conventional fibers to make the difference between the two indices of refraction as large as possible. However, it is said, as explained by N.S. Kapany in <u>Fiber Optics - Principles and Applications</u> (Academic Press 1967), if an optical fiber is to function as an optical waveguide, that is, limiting the transmitted light to preselected modes, the diameter of the core,

the index of refraction of the core and the index of refraction of the cladding layer must be carefully coordinated. (CX-8 (RX-1000) col. 1, ll. 63-70).

70. Light is a form of electromagnetic radiation. The explanation of light transmission is often based on the concept that light waves are made up of an infinite number of modes. Each mode of light travels at its own characteristic velocity. If light is used to transmit information, it can be shown that the same information is initially suppled to all the modes transmitted. This means that, if information is transmitted by light, there will be a dispersion of the information because the transmitted modes will arrive at their destination at different times. It therefore follows that if the transmitted light is restricted to preselected modes, more effective information transmission occurs. (CX-8, col. 1, ll. 73-75, col. 2, ll. 1-8).

71. Corning admits that optical fiber which transmits light were known long prior to 1970 and that an optical fiber transmits light in accordance with a principle of physics which states that light will tend to propagate within a medium which is surrounded by another medium of lower refractive index. (CPFF 20).

72. Under the heading "Summary of the Invention" it is disclosed that an object of this invention is to provide an economical and more easily-formed waveguide that overcomes the disadvantages noted under the heading "Background of the Invention"; that another object of the invention is to provide an optical waveguide that will not absorb an excessive amount of transmitted light; and that briefly, according to the invention, an optical waveguide is produced comprising a cladding layer formed substantially from pure fused silica, and a core formed from fused silica doped with one or more doping materials so as to selectively increase the index of refraction above that of the cladding. (CX-8 (RX-1000) col. 2, ll. 65-75).

73. Under the heading "Detailed Description of the Invention" it is disclosed that a completely new and novel approach has been taken as to the type of material to be used in the production of optical waveguides; that contrary to the soft and easily worked materials normally used in the production of optical waveguides, the discovery has been made that substantially pure fused silica which is extremely hard and difficult to work can be economically and readily used as material from which a superior optical waveguide can be produced. It is said that the term "pure fused silica" is fused silica containing no impurities in an amount greater that 0.1 % by weight except for hydrogen-oxygen groups which may be present in amounts up to 5 percent by weight. The specification discussed why fused silica, apparently so unsuitable, is in reality an excellent material from which a superior optical waveguide can be produced. It is pointed out that many of the difficulties normally encountered in the formation of waveguides can be substantially eliminated if both the core and the cladding layer possess similiar physical characteristics such as, viscosity, softening point and coefficient of expansion; that if a very small, yet precise, difference can be maintained between the index of refraction of the core and the index of refraction of the cladding layer the diameter of the core may be made proportionally larger and therefore more easily controlled, and the waveguide will still maintain the ability to limit light propagation to preselected modes; that fused silica is readily attainable with exceptionally high purity, and that it has been found that fused silica in such pure form has a very predictable index of refraction. Accordingly it is said, adding a precise percentage by weight of doping materials to fused silica will produce "doped fused silica" with an index of refraction predictably higher than that of pure fused silica, that because of the high purity level of fused silica only a minimal amount of doping material will be necessary to cause [illegible] appreciable change in the index of refraction. (CX-8 (RX-1000) col. 3, ll. 13-40).

74. The specification discloses that Figs. 1 and 2 of the '915 patent shows an optical waveguide, identified as 10, having a cladding layer and a core identified respectively as 20 and 30. According to the invention it is said that pure fused silica or slightly doped fused silica is used as the cladding layer and fused silica doped with the necessary amount of dopant to increase the index of refraction to a desired level above that of the cladding layer is the material used for the core; that as a result of the minimum amount of dopant material necessary to increase the index of refraction of fused silica, at any given temperature, the physical characteristics of the doped fused silica, such as viscosity, softening point and coefficient of expansion, used for the core 30, are almost identical to the more nearly pure fused silica used for the cladding layer 20, thereby substantially eliminating many of the difficulties in drawing the waveguide and also reducing the possibility of devitrification; that to make certain that doped fused silica possesses optical and physical characteristics almost identical to those of pure fused silica, doping materials should not exceed 15 % by weight. (CX-8 (RX-1000) col. 3 ll. 42-59).

75. The '915 specification as filed on May 11, 1970 contained the language at page 7, lines 30-32, page 8 line 1:

> "To make certain that doped fused silica possesses optical and physical characteristics almost identical to those of pure fused silica, doping materials should not exceed 15% by weight"

This language is found at col. 3, lines 56-59 of the '915 patent. (RX-1001, pp. 7-8, CX-8).

76. It is disclosed that fused silica has excellent light transmission qualities in that absorption of light energy and intrinsic scattering of light by the material is exceptionally low; that scattering of light that does occur within fused silica is primarily caused by the presence

of impurities rather than the intrinsic nature of the material itself; and that fused silica is such a hard material that an optical waveguide once formed possesses the quality of being highly resistant to damage from high temperatures, corrosive atmosphere and other severe environments. (CX-8 (RX-1000) col. 3, ll. 60-69).

77. Insofar as producing a waveguide possessing a pure fused silica cladding, and a doped fused silica core it is disclosed that the waveguide may be produced by any suitable method including but not limited to: (a) inserting a rod of fused silica, doped as required to increase the index of refraction to the desired level above that of pure fused silica, into a tube of pure fused silica, raising the temperature of the rod and tube combination until said combination has a low enough viscosity for drawing, and then drawing, said rod and tube until the tube collapses around and fuses to the rod and the cross-sectional area of the combination is decreased to the desired dimension; or (b) the method set out in co-pending application "Method of Producing Optical Waveguide Fibers" by Donald B. Keck and Peter C. Schultz, Ser. No. 36,267, filed on May 11, 1970, and assigned to a common assignee (now U.S. Patent No. 3,711,262 (CX-8A)) which method comprises first forming a film of doped fused silica on the inside wall of a tube of pure fused silica, and then drawing this composite structure to reduce the cross-sectional area and to collapse the film of doped fused silica to form a fiber having a solid cross-section of the desired diameter. (CX-8 (RX-1000) col. 3, ll. 69-75, col. 4, ll. 1-12).

78. The specification discloses that there are many dopant materials that can be added to fused silica in minute quantities to increase its index of refraction to a predetermined level; that the diffusion properties of the dopant material must be considered; that for most methods of producing optical waveguides suitable dopants are those having minimum

diffusion properties so that the dopant will not diffuse out of the core and into the cladding layer; and that such diffusion would effectively increase the diameter of the core and thereby alter the mode selection abilities of the waveguide. It is said that suitable dopants having minimum diffusion properties include, for example, such multivalent metal oxides as titanium oxide, tantalum oxide, tin oxide, niobium oxide, zirconium oxide, ytterbium oxide, lanthanum oxide, and aluminum oxide; that in certain methods of producing optical waveguides the core is drawn with a small diameter, and subsequent diffusion increases the core diameter to the desired size; that doping materials containing alkali ions will readily diffuse into the fused silica cladding of an optical waveguide and increase the effective core diameter; that cesium and rubidium are examples of especially suitable materials for such use. (CX-8 (RX-1000) col. 4, ll. 14-37).

79. It is disclosed that in one embodiment of the invention, pure fused silica is used as the cladding material, and fused silica doped with a desired doping material or combination of doping materials in the amount effective to increase the index of refraction to the desired level above that of the cladding layer is used as the core material; that in a second embodiment, fused silia slightly doped with a desired doping material or combination of doping materials is used as the cladding material, and fused silica more heavily doped with a desired doping material or a combination of doping materials, either the same or different than those used in cladding, to increase the index of refraction to the desired level above that of the cladding layer is used as the core material. (CX-8 (RX-1000) col. 4, ll. 34-47).

80. The specification discloses that it has been found that light absorption properties may be decreased and light transmission qualities improved in titanium oxide doped fused silica formed into optical waveguides,

if the waveguides are drawn in an oxygen atmosphere and then "heat treated" in an oxygen atmosphere; that the "heat treatment" referred to consists of heating the waveguide in an oxygen atmosphere to between 500° and 1,000° centigrade for not less than thirty minutes, the length of treatment being related to the treatment temperature. Lower temperatures are said to require longer treatment periods, while treatment at a higher temperature allows shorter time periods. (CX-8 (RX-1000) col. 4, ll. 48-59).

81. A specific example of a waveguide produced by the practice of the invention involved a 1 1/2 to 2 micron film of fused silica doped with titanium oxide bonded to the inside wall of a 3/4 inch outside diameter, 1/4 inch inside diameter, substantially pure fused silica tube by the method described in U.S. Patent No. 3,711,262 (CX-8A) Keck-Schultz application. It is said that the deposited doped fused silica essentially consisted of 94.75 percent fused silica and 5.25 percent titanuium oxide; that the composite structure was then heated in substantially an oxygen atmosphere until it reached a temperature at which the materials had low enough viscosity for drawing (approximately 1,900° centigrade); that the composite structure was then drawn to reduce the diameter thereof until the film of titanium oxide doped fused silica was collapsed, that is, it sealed the longitudinal hole to form a solid core surrounded by pure fused silica. The resulting composite rod was then further drawn to reduce the diameter thereof to a final diameter of approximately 100 microns. The core of the optical waveguide was said to measure at approximately 3 microns in diameter. Its core index of refraction was approximately 1.466 while the cladding had an index of refraction of approximately 1.4584. After the fiber was drawn, it was heat treated at 800° centigrade in an oxygen atmosphere for approximately three hours. (CX-8 (RX-1000) col. 4, ll. 61-75, col. 5, ll. 1-7).

82. The specification concluded with the comment that although the

invention was described with respect to specific limitations, it was not intended that these limitations affect the scope of the invention except insofar as set forth in claims following the specification. (CX-8 (RX-1000) col. 5, ll. 8-11).

83. No teaching in the specification specifically excludes the use of dopant materials which negatively affect the refractive index of fused silica. There is also no suggestion in the specification that such dopant materials would not perform substantially the same function, in substantially the same way, to obtain the same result as that obtained through the use of dopant materials which positively affect the refractive index of fused silica. (CX-8; Cooper CX-7 paras. 33-34, 37).

84. The '915 patent discusses two methods by which doped fused silica optical waveguide fibers can be made, namely, the rod-in-tube method and the inside vapor deposition method described in incorporated U.S. patent 3,711,262. Flame hydrolysis is one inside vapor deposition embodiment described in incorporated U.S. patent 3,711,262. (Cooper CX-7, para. 33; CX-8, col. 3, ll. 69 to col. 4, l. 12; CX-8A in general and, col. 5, ll. 55-60, col. 7, ll. 16-54).

85. The specific examples of the '915 patent and incorporated U.S. patent 3,711,262 use flame hydrolysis methods for production of doped fused silica optical waveguide fibers. (CX-8, col. 4, l. 60 to col. 5, l. 7; CX-8A, col. 7, ll. 16-54; Schultz, Tr. 250-51).

86. The method for making optical waveguide fiber described in the specific examples of the '915 patent and incorporated U.S. patent 3,711,262 is the method generally utilized for the subsequent production of optical waveguide fibers with even lower loss. (CX-8, col. 4, l. 60 to col. 5, l. 7; CX-8A, col. 7, ll. 16-54; Schultz, CX-2, paras. 10, 13-14; Schultz, Tr. 228-45, 250-51).

87. The dopant materials specifically listed in column 4 of the '915 specification reflected the work of the inventors -- of Dr. Schultz, in particular -- prior to the May 11, 1970 filing of the application for the '915 patent. Much of the work of Dr. Schultz prior to 1970, in addition to that directed specifically to the making of optical waveguide fibers, involved the exploration of glass systems based on fused silica. This work involved the making of fused silica glasses with various dopants and the analysis and characterization of the glasses so formed. These analyses and characterizations, combined with the experience gained in the making of optical waveguide fibers, formed the basis for the selection of the materials specifically listed in the '915 patent. (CX-8, col. 4, ll. 13-33; Schultz CX-2, paras. 8-11, 16; CX-39; CX-40; CX-41; CX-42).

88. All of the suggested dopant materials listed in column 4 of the '915 specification are suitable materials for use in an optical waveguide fiber. Such a fiber can be made using each of these materials as a dopant for fused silica. (CX-8, col. 4, ll. 13-33; Schultz, Tr. 259).

C. Prosecution of the '915 Patent

89. Serial No. 36,109 which led to the '915 patent, was filed on May 11, 1970 only in the name of inventor Robert D. Maurer. It was filed with one independent and ten dependent composition of matter claims, each to an optical waveguide (original claims 1 to 11), and with two independent method claims for making an optical waveguide (orginal claims 12, and 13). Original independent composition of matter claim 1 read:

> 1. An optical waveguide comprising a cladding layer formed of a material selected from the group consisting of pure fused silica and doped fused silica, and a core of fused silica doped to a degree in

excess of that of the cladding layer so that the index of refraction thereof is of a value greater than the index of refraction of said cladding layer.

(RX-1001. pp. 12-14).

90. Original dependent claim 7 is indical to claim 2 in issue in this investigation. (RX-1001, p. 13; CX-8 (RX-1000) col. 5).

91. In a Patent Office action dated March 29, 1971, the Patent Examiner rejected the independent composition of matter claim and dependent composition of matter claim 7, wherein the cladding layer was "substantially pure fused silica" under 35 U.S.C. 102 over Flam et al. at U.S. Patent No. 3,542,536. Dependent claims, 2-6, 8-11, each of which recited various doping materials, were rejected under 35 U.S.C. 103, the Examiner stating that doping materials are a matter of choice and obvious over materials taught by the Flam et al patent. It was said that no unexpected or improved results "are seen in selecting the claimed materials". (RX-1001, pp. 17-19)

92. In the Patent Office action dated, March 29, 1971, it was said that composition of matter claims 1 to 11 and method claims 12 and 13 define distinct inventions and restriction was required; that the attorney Mr. Zebrowski elected by telephone on February 10, 1971 the composition of matter claims with traverse (RX-1001, p. 18).

93. In the Patent Office action dated March 29, 1971, Koster et al U.S. Patent No. 3,445,785 was cited and said to disclose ytterbium doped glass for use in rod like lasers, Seitz U.S. Patent No. 3,533,013 was cited and said to disclose (col. 3) that variation of doping concentration produces variable indices of refraction. (RX-1001, p. 18). The Patent Examiner did not reject any of the original claims on the Koster et al nor Seitz patents.

94. In an ammendment filed June 14, 1971, as to the rejection under 35 U.S.C. 102 on the Flam et al patent, Corning argued that the invention teaches an optical waveguide having a cladding layer formed of pure fused

silica or slightly doped fused silica and a core formed from fused silica doped with one or more doping materials so as to selectively increase the index of refraction above that of the cladding; that the invention also teaches specific dopants which may effectively be used; that the dopants include those having minimum diffusion properties such as, for example, titanium oxide, tantalum oxide, tin oxide, niobium oxide, zirconium oxide, ytterbium oxide, lanthanum oxide and aluminum oxide. Dopants having maximum diffusion properties such as cesium and rubidium may also be used. It was said that the type of dopant used will be determined by the method of forming the optical waveguide. Corning argued that Flam et al. do not teach the use of doped fused silica in making either the core or cladding of an optical waveguide; that more specifically, Flam et al. do not teach a cladding layer formed of fused silica or doped fused silica, and a core formed of fused silica doped to a degree in excess of that of the cladding layer so that the index of refraction of the core is of a value greater than the index of refraction of the cladding layer; that to the contrary, Flam et al. clearly teach, by the method of their invention, the formation of an optical waveguide from a single continuous quantity of solid optical dielectric material such as fused silica; that they further teach that differences in the index of refraction of a core region from that of the rest of the solid quantity of material is obtained by irradiating a desired region of the solid dielectric material with atomic particles, such as protons, to either ionize or displace atoms of the material in the desired region; that the Examiner can not reasonably maintain that a method of forming an optical waveguide by irradiating a solid block or an optical material with protons is the same or even similar to the claimed invention. (RX-1001, pp. 24-25).

95. Corning in the amendment filed June 14, 1971 further argued that the particular combination of elements recited by the original claim 1 is

necessary to overcome all of the prior art disadvantages described on pages 2-5 of the present specification (which relates to the subsection titled "Description of the Prior Art"). This particular combination of elements was said to be necessary to simply and economically provide an optical waveguide having excellent light transmission qualities and qualities of high resistance to damages from high temperatures, corrosive atmospheres and other severe environments; that this new and novel approach of producing optical waveguides from fused silica results in the production of superior optical waveguides which could not be produced from the soft and easily worked materials normally used. It was argued that fused silica which is extremely hard and difficult to work would not normally be considered a suitable material for use in the formation of optical waveguides which are normally drawn down to very small diameters and also which must have very small differences in the index of refraction of the cladding and the core; that, as taught in the specification, the difficulties normally encountered in the formation of waveguides can be substantially eliminated if both the core and the cladding layer possess similar characteristics such as, for example, viscosity, melting point and coefficient of expansion; that fused silica is readily obtainable with exceptionally high purity; and that it has been found that fused silica in such pure form has a very predictable index of refraction. Therefore, it was contended, adding a precise percentage by weight of doping material to fused silica will produce "doped fused silica" with an index of refraction predictably higher than that of pure fused silica; that, because of the high purity level of fused silica, only minimal amounts of doping material will be necessary to cause an appreciable change in the index of refraction. (RX-1001, p. 25).

96. It was submitted in the June 14, 1971 filing that the use of fused silica and doped fused silica in the production of optical waveguides,

and the advantages of such use as is taught in the specification patentably defines over the Flam et al. reference; that in the Flam et al. reference, the use of fused silica is merely taught as an example of a homogeneous single continuous quantity of an optical dielectric material in which the index of refraction may be readily and significantly changed by irradiation. (RX-1001, pp. 24-25).

97. In the amendment filed June 14, 1971, as to the rejection under 35 U.S.C. 103, Corning also argued that original claims 2-6 and 8-11 depended directly or indirectly from claim 1 and therefore "are at least allowable not only for their added limitations, but also for the same reasons as those urged for claim 1." Moverover it was not understood by Corning how the Examiner can maintain the position that doping materials as claimed in claims 2-6 and 8-11 were a matter of choice and obvious over materials taught by Flam et al., and that no improved results were seen in selecting the claimed dopant materials. In support it was said that nowhere, does Flam et al. teach or suggest the use of dopant materials <u>for any purpose</u> much less the specific purpose of making small precise changes in the index of refraction of fused silica. It was asked how then can the specific dopants taught in the specification for increasing the index of refraction of fused silica be obvious over materials taught by Flam et al. Corning argued that certainly, for the purposes of forming an optical waveguide as taught in the specification, the results will be improved if the index of refraction of the core is greater than the index of refraction of the cladding; that an optical waveguide will not work unless the index of refraction of the core is greater than the index of refraction of the cladding; that a doping material for purposes of increasing the index of refraction of the core not only improves the results of an optical waveguide produced in accordance with the teachings of the claimed invention, but is absolutely essential. (RX-1001, pp. 26-27).

98. In a final rejection dated August 18, 1971 the Patent Examiner again rejected composition of matter claims 1 and 7 under 35 U.S.C. 102 as anticipated by the Flam et al. patent. It was said that the Flam et al. waveguide core is inherently doped with the irradiating atomic particles that are used to alter the refractive index. In the rejection claims 1, 7 and 11 were rejected under 35 U.S.C. 103 as obvious over Flam et al. It was considered that one skilled in the art would recognize that the core of the Flam et al. waveguide is obviously doped with atomic particles; that these claims do not name any dopant materials. Claims 2-6, 8-10 were objected to as being dependent on rejected claims. (RX-1001 p. 30).

99. By an amendment filed October 13, 1971 claim 1 was amended to read:

> "1. An optical waveguide comprising a cladding layer formed of a material selected from the group consisting of pure fused silica and chemically doped fused silica, and a core formed of fused silica chemically doped to a degree in excess of that of the cladding layer so that the index of refraction thereof is of a value greater than the index of refraction of said cladding layer." (RX-1001, p. 32).

100. In the amendment filed October 13, 1971, and referring to the rejection of the claims, including claim 1, under 35 U.S.C. 102 and 35 U.S.C. 103, Corning argued that those claims have now been amended to recite that the doped fused silica of the core, and of the cladding, when applicable, is chemically doped; that chemical doping is clearly understood in the art to mean the introduction of chemical elements or compounds into a base material for the purpose of affecting physical or electrical properties of the base material by virtue of the presence of such elements or compounds in the base material; that it is similarly clear in the art that chemical doping excludes irradiation or bombardment of a material by subatomic particles such as protons, neutrons, alpha particles, electrons, and gamma rays where the change

in any physical or electrical properties is brought about not by the presence of any residual subatomic particles but rather by the change in the density of the material and the structural displacement of the atoms or molecules of the bombarded material out of their lattice positions as a result of radiation damage. In support of the above, Corning pointed to an affidavit under Rule 132, by Herbert E. Rauscher filed with the amendment and published articles referred to in the Rauscher affidavit. (RX-1001, p. 34).

101. With respect to the Examiner's contention that a waveguide core is inherently doped with the irradiating atomic particle, Corning, in the amendment filed October 13, 1971, argued that Flam et al. only teach irradiation with subatomic particles such as protons, neutrons, alpha particles, electrons, and gamma rays. It was said that when the base material is irradiated with uncharged particles such as neutrons, the neutrons generally pass completely through the irradiated material causing a change in the index of refraction which of necessity is occasioned by a change in density and structural displacement since the particles do not generally remain in the material; that when the base material is irradiated with charged particles such as protons, alpha particles, electrons, and the like, the base material itself will have an electrical charge as long as the charged particles remain; that it is clear, that such a charge can only be held momentarily and thereafter the base material would become discharged. It was said that as clearly pointed out in the Rule 132 affidavit of Herbert E. Rauscher, any such subatomic particles in the base material which may remain as residual particles do not cause a perceptible change in the index of refraction by their presence, since the change in the index of refraction of the base material resulting from irradiation is brought about by the change in density of the base material and the structural dislocation of the atoms and molecules thereof; and thus that the irradiation of a base material with

subatomic particles is clearly not doping as that term is understood in the art, and that it is unmistakably clear that such irradiation is not chemical doping. Doping was said to be defined in "The Condensed Chemical Dictionary", 7th Edition, by Rhienhold Publishing Corporation as the

> "Controlled introduction of trace impurities into ultrapure crystals in order to obtain desired physical properties, especially electrical properties."

It was pointed out that the "American Heritage Dictionary of the English Language" published by the American Heritage Publishing Company, Inc. defines a dopant as

> "A small quantity of a substance, such as phosphorous, added to another substance, such as a semiconductor, to alter the latter's properties."

Corning argued that subatomic particles employed in an irradiation process can in no understandable manner by interpreted to be a dopant or be involved in doping as understood in the art and as "hereinabove" described since the presence of such particles does not bring about a change in physical properties but rather such change is brought about as a result of the impact of such particles with the atoms and molecules of the irradiated material whereby there is a change in density of the material and structural displacement of the atoms and molecules out of their lattice position. (RX-1001 pp. 35-36).

102. In explaining the invention of the '915 patent to the Patent Office for Corning and how the invention distinguishes over the invention diclosed in the Flam et al. patent, Herbert E. Rauscher in his Rule 132 affidavit stated:

> that the processes described in [the '915 patent]... and said [Flam et al.] patent are entirely different; that change in the index of refraction of glasses or dielectric materials acted upon by these two processes is brought about by entirely different means; that a change in the index of refraction brought about by chemical doping as described in [the '915 patent]... is principally due to the presence of an impurity, namely by the presence of an element or chemical compound introduced into the glass or dielectric material; that a change in the index of refraction due to irradiation as

described in said [Flam et al] patent is brought about by a change in the density of the material and structural displacement of the atoms or molecules out of their lattice positions as a result of radiation damage; that ... the process of "chemical doping" employed in said ['915 patent] ... is clearly understood in the art to mean the introduction of chemical elements or compounds into a base material for the purpose of affecting properties of the material by virtue of the presence of such elements or compounds therin; that the term "chemical doping" is clearly understood in the art to exclude the irradiation or bombardment of material by subatomic particles such as protons, neutrons, alpha particles, electrons, and gamma rays. (RX-1001, pp. 43-44).

103. Corning with the amendment filed October 13, 1971 filed an amendment under Rule 45(c) and a "new" attached joint oath to be substituted for the inventorship oath of inventor Robert D. Maurer originally filed. A verfied statement of facts accompanied the amendment under Rule 45(c). (RX-1001, pp. 38-40).

104. Inventors Robert D. Maurer and Peter C. Schultz in the statement of facts in support of the amendment under Rule 45(c) stated in part that during May 1971 following receipt of the first office action in the '915 patent application, it appeared to W.S. Zebrowski, in his discussing the prosecution of said patent application and the patentable merit of other invention disclosures with R.D. Maurer, that Peter C. Schultz may have contributed to the inventive concept set forth in claims of the '915 application; that Mr. Zebrowski learned that two other patent applications had been filed by C.S. Janes on the complex invention disclosure submitted by P.C. Schultz and that R.D. Maurer was joined as inventor in one of them; that Mr. Zebrowski set up a meeting with R.D. Kesterson, who drafted the '915 application and reviewed this application, including the claims as now in the application, to determine the actual joint inventors of said application, said meeting being held during August 1971; that then, it was determined that P.C. Schultz had in fact contributed to the inventive concept set forth and claimed in the '915 application and that he was actually a joint inventor with R.D.

Maurer in the invention described and claimed in application Serial No. 36,109, filed May 11, 1970. (RX-1001, pp. 39-40).

105. By Patent Office action dated November 9, 1971, the Patent Examiner indicated that all of the claims were allowable and that an Examiner's amendment will follow. The Examiner's amendment dated November 17, 1971 read in part:

> "In a telephone interview on November 8 and 12, 1971 the attorney Mr. Zebrowski agreed to have the following changes made by Examiner's amendment:
> Line 4 of claim 1 has been changed to read --silica and fused silica to which a dopant material on at least an elemental basis has been added, and--. Line 5 of claim 1 has been changed to read --a core formed of fused silica to which a dopant material on at least an elemental basis has added to a degree in--
> In line 9 of claim 1 the wording --, said core being formed of at least 85% by weight of fused silica and an effective amount up to 15% by weight of said dopant material -- has been inserted immediately before the period." (RX-1001, pp. 48-49)

This amendment resulted in claim 1 which is in issue in this investigation. (CX-8, col. 5).

106. On December 7, 1971 a notice of allowance was mailed and the '915 patent, in the names of Robert D. Maurer and Peter C. Schultz, issued on May 2, 1972. (RX-1001, p. 51; CX-8(RX-1000)).

107. Inventor Maurer testified that at the time the '915 patent application was prepared he thought he felt in some cases one might be able to exceed the 15 percent slightly. (Maurer Tr. 12).

108. Inventor Maurer testified that he did not recall a specific instance of telling Mr. Zebrowski about the 15% limitation during the preparation of the '915 application. However, Maurer was aware of the fact that that was our thinking in some earlier stage during the preparation of the '915 patent application. (Maurer Tr. 31).

109. A memorandum prepared by Corning's Walter Zebrowski dated November 8, 1971 and thus contemporaneously with his November 8, 1971 telephone interview with the Patent Examiner during the prosecution of the '915 application stated that on November 3, 1971 he had interviewed the

Examiner and that they discussed the amendments under Rules 116 and 45c which Mr. Zebrowski had submitted earlier with the Rule 132 affidavit by Herbert E. Rauscher; that the Examiner was agreeable to all the filings except that he was still not convinced that distinguishing the doped fused silica in claim 1 as "chemically" doped fused silica would avoid the Flam et al. reference. The memo stated that, Mr. Zebrowski made several suggestions to the Examiner, none of which appeared acceptable to him until Mr. Zebrowski proposed what was stated in the Examiner's amendment. (RX-1211).

VI. The '454 Patent

110. U.S. Letters Patent No. 3,933,454 ('454 patent) titled "Method of Making Optical Waveguides" issued January 20, 1976 on an application Ser. No. 462, 962 filed April 22, 1974. The named inventor on the issued patent is Robert D. De Luca. The patent on its face is assigned to Corning Glass Works. The patent issued with eighteen method claims.

A. Claims in Issue

111. Claims 1 and 8 are issue in this investigation read:

1. In the method of forming a glass article comprising the steps of
depositing on a starting member a coating of flame hydrolysis-produced glass soot to form a soot preform.
consolidating said soot preform to form a dense glass layer free from particle boundaries, and
forming said dense glass layer into a desired shape, said consolidation step being characterized in that it comprises
heating said soot preform to a temperature within the consolidation temperature range for a time sufficient to cause said soot particles to fuse and form a dense glass layer, and simultaneously
subjecting said soot preform to a stream of a substantially dry, hydrogen-free, chlorine containing atmosphere that is substantially free from contaminants that would adversely affect the optical properties of said glass article, said chlo-

rine permeating the interstices of said soot preform during the consolidation thereof and replacing hydroxyl ions by chlorine ions, thereby resulting in a glass article that is substantially water-free.

8. A method in accordance with claim 1 wherein said soot has a high silica content and the step of heating comprises subjecting said soot preform to a maximum temperature in the range of 1200°-1700°C. (CX-9 (RX-1004) col. 13).

112. While the notice of investigation referred to the infringement of claims 1, 3 and 8 of the '454 patent, Corning at the hearing that commenced on November 1, 1984 limited the claims in issue, with respect to the '454 patent, to claims 1 and 8 (Tr. 1795).

B. The '454 Specification

113. The "Abstract" of the invention reads:

A method of making low loss glass optical waveguides, wherein at least one coating of glass soot is deposited by the flame hydrolysis process on a starting member. The soot coating is heated to its consolidation temperature in an atmosphere containing helium and an amount of chlorine that is effective to substantially remove the water from the glass soot while the soot is being consolidated to form a dense glass layer. The starting member is removed unless it is to form a part of the optical waveguide. The resultant structure, including the dense glass body, is then drawn into a waveguide fiber. (CX-9 (RX-1004) title page)

114. Under the heading "Background of the Invention" and subheading "Field of the Invention", it is said that the invention relates to a method of forming, by the flame hydrolysis technique, high optical purity blanks from which high quality optical waveguides, lenses, prisms and the like can be made; that the invention is particularly applicable to optical waveguides which must be formed from extremely pure materials; that high capacity communication system operating around 10^{15} hz are needed to accommodate future increases in communication traffic; that these systems are referred to as optical communication systems since 10^{15} hz is within the frequency

spectrum of light; and that optical waveguides, which are the most promising medium for transmission at such frequences, normally consist of an optical fiber having a transparent core surrounded by transparent cladding material having a refractive index lower than that of the core. (CX-9 (RX-1004) col. 1, ll. 6-21).

115. The specification disclosed that the stringent optical requirements placed on the transmission medium to be employed in optical communication systems has negated the use of conventional glass fiber optics, since attenuation therein due to both scattering and impurity absorption is much too high. Thus, unique methods had to be developed for preparing very high purity glasses in fiber optic form. Glass preparation techniques which have shown much promise were said to be based on the flame hydrolysis process which employs vapor phase reaction of high purity vapors. It is disclosed that this approach to the formation of low loss optical waveguides is based on methods described in U.S. Pat. Nos. 2,272,342 (RX-1031) and 2,326,059 (RX-1028) issued to J.F. Hyde and M.E. Nordberg, respectively; that the flame hydrolysis technique has been employed to prepare single mode waveguides and multimode waveguides of both the step-index and graded-index type; that various methods employing the flame hydrolysis technique for forming glass optical waveguide fibers are taught in U.S. Pat Nos. 3,711,262,; 3,737,292 and 3,737,293; and that a method employing the flame hydrolysis techinque to form a graded-index type waveguide is taught in U.S. patent application Ser. No. 239,496 filed March 30, 1972, entitled "Method of Forming a Light Focusing Fiber Waveguide" now U.S. Pat. No. 3,826,560. (CX-9 (RX-1004) col. 1, ll. 22-46).

116. It is disclosed in the specification that the usefulness of glass optical waveguides in optical transmission depends upon the attainment of very low loss transmission over the entire wavelength of about 700-1100

nm.; that this can be achieved by reducing attenuation due to optical scattering and absorption to a level which approaches the minimum theorectically attainable level; that waveguides in which at least 80 percent of the scattering loss can be accountered for by intrinsic glass scattering have been made by the flame hydrolysis technique. However due to the presence of residual water produced, it is said that absorption losses between 700 nm. and 1100 nm. have been excessively large. Residual water is defined as glass containing a high level of OH, H_2 and H_2O. (CX-9 (RX-1004) col. 1, ll. 47-60).

117. Inventor De Luca discloses that in 1974, to be useful in optical communication systems, optical waveguide attenuation is preferably less than 10 dB/km at the waveguide of light being propagated therein; that to achieve such low attenuation over the entire range between 700 nm. and 1100 nm. a glass waveguide fiber must have the residual water content reduced to a level of less than 10 ppm.. (CX-9 (RX-1004) col. 2, ll. 5-12).

118. The specification disclosed that residual water content in a glass waveguide may be specified in terms of an absorption coefficient referred to as the "beta value"; that to produce waveguides having an attenuation less than 20 dB/km over the range 700-1100 nm., it has been found that the waveguide glass must have a beta value of less than 0.001(CX-9 (RX-1004) col. 2, ll. 12-31).

119. Under the subheading "Description of the Prior Art" it is said that since it is impossible to reduce the water content to acceptable levels after flame hydrolysis-produced soot has been consolidated to form a solid glass coating, the water must be removed before or during the consolidation process; that heretofore, various methods were employed to reduce the water content in optical waveguides produced by flame hydrolysis; that such disadvantages as long processing times, equipment problems and incomplete

water removal were encountered. It was said that one prior art method of producing low water content fused silica included the steps of forming by flame hydrolysis a SiO_2 soot preform and then placing the preform in a preheated furnace at approximately 1500°C. for approximately 30 minutes; that the furnace contained a reducing atmosphere of cracked ammonia or forming gas; that during the heat treatment, the soot was sintered and consolidated into a dense glass body which was to a certain extent water-free (beta value approximately equal to 0.02), but the amount of water remaining in the resultant glass was excessive in terms of tolerable amounts for optical communication systems. It was said that a beta value of about 0.01 was achieved by consolidating a soot preform in an inert dry atmosphere such as nitrogen, helium, neon or argon; that in this method, disclosed in copending patent application Ser. No. 239,742 file March 30, 1972, the inert gas replaced trapped air in the preform and subsequently dissolved in the glass; that since this method included gradient sintering, gases can escape through unconsolidated parts of the preform; that optical waveguides made by the process exhibited attenuations as low as 30 dB/km at 950 nm, a value which in 1974 was not sufficently low for the propagation of optical signals. (CX-9 (RX-1004) col. 2, ll. 33-65).

120. In inventor's De Luca's copending patent application Ser. No. 239,746 filed March 30, 1972, there is said to be disclosed a method of forming a glass optical waveguide containing less than 20 ppm residual water. It is said that in accordance with the method of that application the flame hydrolysis-produced soot preform is placed in a chamber which is evacuated to less than 10^{-5} Torr; that the chamber is heated below the sintering temperature of the soot to permit entraped gas to escape from the preform and the temperature is maintained until an equilibrium is reached, at which time the porous preform is further heated to consolidate the soot particles and to

form a dense glass member; that an optical waveguide formed in accordance with this method exhibited an attenuation of less than 20 dB/km; that although relatively low loss optical waveguides can be produced, this process is disadvantageous in that it requires an extremely long time for water removal, and may result in the volatilization of some dopant oxdies; that also, equipment problems have been encountered because of the need to maintain very low pressures for long periods of time; and that the preform cannot be consolidated until after the water removal step is completed. (CX-9 (RX-1004) cols. 2, ll. 66-68, cols. 3, ll, 1-24).

121. Various methods are said to have been employed to make low water content glasses by methods other than the flame hydrolysis technique. However, it is stated that none of these methods have been found to satisfactorily remove water from a flame hydrolysis-produced soot preform which is to be used in the manufacture of optical waveguides; that for example, U.S. Patent No. 3,531,271 to W.H. Dumbaugh, Jr.. teaches a method of making a low water content glass body by mixing the batch ingredients together with an effective amount of a chemically-reactive, chlorine containing agent and melting the glass in the presence of dry atmosphere flowing directly over the glass melt; that this method cannot be adapted to the flame hydrolysis process wherein the glass article is not formed by melting batch ingredients; that even though chlorine containing compounds such as $SiCl_4$ are employed in the flame hydrolysis process to form silica containing soot preforms, the chlorine present does not result in the formation of water-free soot. (CX-9 (RX-1004) col. 3, ll. 25-44).

122. Another prior art method for removing water from glass bodies produced by a technique other than flame hydrolysis is said to be disclosed in U.S. Pat. No. 3,459,522 issued to T.H. Elmer et al. (RX-1027). This patent is said to describe a method of removing residual water from a porous, high

silica content glass body by subjecting it to a flowing stream of a substantially dry atmosphere containing 10% or more of either chlorine gas or a chlorine vapor at a temperature of 600°-1000°C with the treated porous glass body thereafter consolidated in a dry, nonoxidizing atmosphere to produce a nonporous, transparent glass article. The porous glass body disclosed in the Elmer et al. patent is said to be well known under the commercial designation "96% silica glass", which is produced by consolidating a porous glass body characterized by a multiplicity of intercommunicating, submicroscopic pores throughout its mass. The basic production steps involved in the formation of such a porous body, described in U.S. Pat. No. 2.221.709 which issued to H.P. Hood et al. are said to include the steps of forming an article from a borosilicate glass, thermally treating the article at a temperature of 500°-600°C. to separate the glass into a silica-rich phase and a silica-poor phase, leaching the silica-poor phase to produce a porous structure composed of the silica-rich phase, removing the leeching residue, and thermally consolidating the porous structure into a nonporous vitreous article. (CX-9 (RX-1004) col. 3, ll. 45-69, col. 4, ll. 1-3).

123. The specification discloses that because of the kind of microstructure present in the porous glass body disclosed in the Elmer et al. patent and due to the fact that the chlorination process disclosed therein is carried out at a temperature below the consolidation temperature an atmosphere containing a relatively large concentration of chlorine must be employed. It is said that that patent therefore requires a chlorine containing atmosphere having 10% or more of either chlorine gas or a chlorine vapor, and that most of the examples disclosed therein employ chlorine gas with no diluent. The Elmer et al. patent further is said to teach that after chlorine treatment, it is undesirable to maintain the porous glass in a chlorine containing atmosphere while the temperature is inceased to the consolidation temperature

because of economic considerations and because this may result in retention of an excess amount of chlorine within the glass and may cause splitting of the glass; that therefore, the chlorine treated porous glass is removed from the chlorine atmosphere and transferred in an inert atmosphere such as nitrogen for futher heat treatment, consolidation being preferably performed in an inert atmosphere or vacuum at a temperature between 1200°C. and 1300°C. (CX-9 (RX-1004) col. 4, ll. 4-27).

124. The specification disclosed that for at least the following reasons the method of the Elmer et al. patent is unsatisfactory for removing water from flame hydrolysis-produced glass soot preforms from which optical waveguides are made; the high chlorine content of the chlorine containing atmosphere employed by the Elmer et al. patent can cause reboil in subsequent heat treatment of the preform and can also introduce an unacceptable level of contamination in the glass due to the presence of contaminants in commercial grade chlorine sources; transferring the soot preform from the chlorination chamber to the consolidation chamber can permit water to reenter the porous soot blank; that whereas the Elmer et al. patent teaches separate chlorination and consolidation steps, it is more economical and efficient to remove water from the glass soot concurrently with the consolidation of such soot; that the rate of removal of water by chlorine is temperature related, it being slower at temperatures between 600°C, and 1000°C. than at the soot consolidation temperature which is between about 1250°C. and 1700°C. for silica. (CX-9 (RX-1004) col. 4, ll. 27-47).

125. Under the heading "Summary of the Invention" it is said that an object of the invention is to provide an effective and economical method of removing residual water from a flame hydrolysis-deposited glass soot preform during the consolidation process; that a further object is to provide a method of forming water-free optical waveguides having extremely low concentrations

of contaminants. Briefly, the invention is said to relate to an improved method of forming a glass article by the flame hydrolysis-process . It is disclosed that this process conventionally comprises the steps of depositing on a starting member a coating of flame hydrolysis-produced glass soot to form a soot preform, consolidating the soot preform to form a dense glass layer, and forming the dense glass layer into a desired shape; that the consolidation step conventionally comprises subjecting the soot preform to a temperature in the consolidation temperature range, for a time sufficient to permit the soot particles to fuse and consolidate, thereby forming a dense glass layer which is free from particle boundaries. In connection with the fusing of glass soot particles formed by flame hydrolysis, this process is said to be sometimes referred to as sintering even though no particle boundaries remain. (CX-9 (RX-1004) col. 4, ll. 57-68, col. 5, ll. 1-4).

126. The specification disclosed that in accordance with the De Luca invention, the step of consolidating "comprises" heating the soot preform to a temperature within the consolidation temperature range for a time sufficient to cause the soot particles to fuse and form a dense glass layer, and simultaneously subjecting the soot preform to a stream of a substantially dry chlorine containing atmosphere. The chlorine is said to permeate the interstices of the soot preform during the consolidation thereof and to replace hydroxyl ions by chlorine ions, thereby resulting in a glass article that is substantially water-free. It is said that the method of the invention is particularly applicable to the formation of any type of glass optical waveguide produced by flame hydrolysis; that this method involves the deposition of the desired number of soot coatings on a starting member which may form a part of the resultant waveguide structure or which may be removed during the waveguide fabrication process; that the starting member may be in the form of a solid cylindrical rod, a hollow cylinder, a flat substrate or

the like; that after the soot preform is consolidated in accordance with the De Luca invention, forth, the starting member is generally removed, and the consolidated preform drawn into a fiber; that optical waveguides formed by the method of the De Luca invention have exhibited an attenuation less than 10 dB/km betweeen 650 and 1100 nm. (CX-9 (RX-1004) col. 5, ll. 5-30).

127. Under the heading "Detailed Description of the Invention" and referring to a FIG. 1, a coating identified as 10 of glass soot is applied to a substantially cylindrical starting member or rod identified as 12 by means of a flame hydrolysis burner identified as 14. The vapor of a hydrolyzable compound is introduced into flame emitted from the burner and the gas-vapor mixture is hydrolyzed within the flame to form a glass soot that leaves the flame in a stream which is directed toward the starting member or rod. Starting member 12 is supported by means of support portion identified as 20 and is rotated for uniform deposition of the soot. To form step-index optical waveguide, a second coating of glass soot may be applied over the outside peripheral surface of first coating 10. Support member 20 is again rotated to provide a uniform deposition of coating. The composite structure including the first coating and the second coating constitutes an optical waveguide preform. (CX-9 (RX-1004) col. 5, ll. 54-69, col. 6, ll. 1-17).

128. The specification of the '454 patent teaches that silica, from which optical waveguide fibers are formed, has a great affinity for water, and that water is readily absorbed by soot in a preform prior to the consolidation process because of the extremely high porosity thereof. However, after the glass has been formed into an optical waveguide fiber, the inner portion is inaccessible to water, and therefore the water absorption tendencies of the glass is not detrimental to fiber operation once a water-free fiber has been formed. (CX-9 (RX-1004) col. 7, ll. 17-27, 31-33).

129. The specification discloses that in accordance with the De

Luca invention the soot preform deposited by flame hydrolysis is consolidated in a continuously flowing atmosphere comprising helium and an effective amount up to about 5 vol. percent chlorine or volatile chlorine containing compound to form a dense glass body having a reduced water content; that even a very small percentage of chlorine in the consolidation furnace will react with water in the soot, thereby lowering the concentration of water in the resultant device; that an appreciable reduction in water content begins to occur when the consolidation atmosphere contains about 0.5 vol percent chlorine; that helium is employed as the diluent gas since it can readily pass through the interstices of the porous soot preform and purge residual gas therefrom; that hydrogen cannot be used as the diluent gas since it tends to increase the water content of the glass. Gases heavier than helium are said to be not sufficiently effective in purging residual gas from the soot; that whereas the attenuation due to residual water is greatly decreased by the chlorine treatment, the attenuation at all wavelengths between 700 and 1100 nm. increases slightly; that therefore, the amount of chlorine present in the consolidation atmosphere should be no more than that required to render the soot substantially water-free; that any amount of chlorine in addition to the required amount may increase attenuation with no accompanying beneficial result. (CX-9 (RX-1004) col. 7, ll. 35-60; col. 88, ll, 15-20).

130. The inventor disclosed that the consolidation temperature depends upon the composition of the glass soot and is in the range of 1250°-1700°C, for high silica content soot; that it is also time dependent, consolidation at 1250°C, requiring a very long time; that the preferred consolidation temperature for high silica content soot is between 1400°C, and 1500°C. (CX-9(RX-1004) col. 8, ll. 1-8).

131. FIG. 3 of the specification is said to illustrate schematically a consolidation furnace and the chlorination consolidation

atmosphere system. (CX-9 (RX-1004) col. 8, ll. 32-34).

132. The specification discloses that in the consolidation furnace illustrated in FIG. 3, a preform identified as 30 is inserted downwardly into the furnace. The rate of invention is low enough to permit the tip of the preform to consolidate first, the consolidation process then continuing up the preform until it reaches that end of the preformerd adjacent to a support portion. It is said that the maximum furnace temperature, which is preferably between 1400°C and 1500°C for high silica content soot, must be adequate to fuse the particles of glass soot and thereby consolidate the soot preform into a dense glass body in which no particle boundaries exist. (CX-9 (RX-1004(col. 9, ll. 32-43).

133. Referring to the furnace illustrated in FIG. 3, the specification discloses that as soot preform 30 enters the furnace the chlorine containing consolidation atmosphere passes through the interstices of the soot where it lowers the water content by causing hydroxyl ions to be replaced by chlorine ions. In addition, the helium purges residual gases from the interstices of the soot; that as illustrated in a FIG. 4, consolidation of the soot begins at the tip that is initially inserted into the furnace and it then gradually progresses to the opposite end of the preform. Four phases of the consolidation process are indicated in FIG. 4 by letters A through D. In positions B through D, a part or all of the soot preform is consolidated. It is said that due to the type of microstructure present in the soot preform, the outside thereof would sinter first if the entire preform were suddenly immersed in the high temperature region of the furnace; that gases would therefore be entrapped in the resultant dense glass body and the chlorine present in the furnace atmosphere would be unable to completely penetrate into the interstices of the soot preform to remove water therefrom; that the preform is therefore initially inserted to position A of FIG. 4 where is is

heated to a temperature just below the consolidation temperature; that the preform is then further inserted to position B where it is held for a time that is sufficient to insure consolidation of the end portion thereof; that as indicated by positions C and D, the preform is then lowered at such a rate that entrapped gases are permitted to escape and the chlorination atmosphere is permitted to penetrate and substantially remove the water therefrom; that the resultant dense glass body is then slowly moved back to position A, where it receives a slight annealing treatment, and is then removed from the furnace; that the rate of insertion between positions B and D depends upon the size of the soot preform and the composition thereof, the preferred rate being between about 0.1 inch per minute and 1.0 inch per minute. (CX-9 (RX-1004) col. 9, ll. 55-68, col. 10, ll. 1-25).

134. The specification of the '454 patent teaches that the invention of the patent produces glasses containing less than 1 part per million of OH, that the method is economical and time saving in that the chlorination process, which removes water from the soot, is accomplished simultaneously with the soot consolidation process, that relatively small chlorine concentrations can be employed because of the high temperature encountered during consolidation, and therefore that the method avoids the trapping of undersirable amounts of chlorine gas in the preform which could cause detrimental effects during subsequent processing of the preform. (CX-9, (RX-1004) col. 10, ll. 25-48).

135. The specification discloses that if both the core and cladding of the optical waveguide are to be formed by the flame hydrolysis technique, a plurality of layers of soot of different compositions can be built up and thereafter, both layers can be simultaneously chlorinated and consolidated; that alternatively the first layer of soot can be chlorinated and consolidated to form a dense, water-free glass layer prior to applying a second coating of

soot thereto; that in accordance with this latter embodiment after the first soot coating is chlorinated and consolidated, the surface thereof may be polished and cleaned to remove surface irregularities prior to the applications of the second soot coating. (CX-9 (RX-1004) col. 10, ll. 39-51).

136. In Example 1, a tubular starting member of fused quartz, approximately 0.2 inch in diameter and about 10 inches long was secured to a handle. Dry oxygen was bubbled through liquid $SiCl_4$ which had been heated to 35°C, and vapors of that liquid were picked up by the oxygen. The oxygen along with the vapor entrained therewith was then passed through a gas-oxygen flame where the vapors hydrolyzed to form a steady stream of particles of SiO_2. The stream of particles was directed to the starting member, and a soot coating of these particles was applied up to about 2.0 inches in diameter. A gas mixture containing 90 vol. percent helium and 10 vol. precent chlorine was admitted to a consolidation furnace at a flow rate of 30 cubic feet per hour. The preform of silica soot was placed in the furnace at position A of FIG 4, which was said to be about 5 inches above the peak temperature region of a 3 inch ID alumina muffle that was disposed in the furnace. The temperature profile within the muffle at its peak is about 1500°C. After remaining in position A for 15 minutes, the preform was lowered at a rate of 15 inches per minute until the end of the preform was 1 inch above the 1500°, peak temperature region (position B). The preform was maintained in this position for about 10 minutes to insure consolidation of the end portion thereof. The preform was then lowered at about 50 inches per hour through the 1500°C, zone until it reached position D where it was held for 5 minutes to consolidate the preform completely. The resultant consolidated dense glass body was then withdrawn to position A at a rate of 50 inches per minute and was then removed from the furnace. The consolidated vitreous silica was said to contain less than 1 part per million OH. (CX-9,

(RX-1004), col. 11, ll. 6-40).

137. In Example 2, a soot preform from $GeCl_2$ and $SiCl_4$ was processed in a gas mixture containing 3 vol. percent chlorine, 0.5 vol. percent oxygen and 96.5 vol. percent heluim in a consolidation furnace as in Example 1. The resultant structure was thereafter drawn. The attenuation of this waveguide was less than 15 dB/km for wavelengths greater than 600 nm. (CX-9 (RX-1004), col. 11, ll. 42-68, col. 12, ll. 1-14).

138. In Example 3, an optical waveguide preform was formed in accordance with Example 2. The preform was consolidated in a gas mixture containing 1 vol. percent chlorine gas, 0.5 vol. percent oxygen and 98.5 vol. percent helium and drawn into an optical waveguide as in Example 2. The attenuation of this waveguide was said to be less than 10 dB/km at wavelengths greater than 650 nm. (CX-9 (RX-1004), col. 12, ll 15-28).

139. In Example 4, one preform was processed in an atmosphere containing 1 vol. percent chlorine, 0.5 vol. percent oxygen and 98.5 vol. percent helium as in Example 3. The attenuation of the resultant optical waveguide was said to be less than 10 dB/km between 700 and 1100 nm. A second idential preform was processed for 30 minutes in position A of the furnace in a gas mixture containing 96.5 vol. percent helium, 13 vol. percent chlorine and 0.5 vol. percent oxygen. This preform was then processed through the remainder of the cycle described in Example 1 in 100 percent helium. The attenuation of this resultant waveguide at 950 nm. was said to be about 100 dB/km. (CX-9 (RX-1004), col. 12, ll. 30-50).

140. In Example 5 an optical waveguide preform was formed in accordance with Example 2. A consolidation atmosphere was obtained by bubbling 0.5 vol. percent oxygen through silicum tetrachloride with 99.5 vol. percent helium. The preform was then consolidated in this atmosphere in accordance with the steps of Example 1, and formed into an optical waveguide

as in Example 2. The attenuation of this waveguide was said to be less than 18 dB/km between 600 and 1100 nm. except around 950 nm. where it was about 23 dB/km. Impurities were said to make for a slightly higher attenuation curve than the curves that resulted in Examples 2 and 3. (CX-9 (RX-1004), col. 12, ll. 62-68, col. 13, ll. 1-8).

141. The specification of the '454 patent teaches that hydroxyl removal, in accordance with the method of the patent, occurs as the chlorine-containing atmosphere passes through the interstices of the soot, where it lowers water content by causing hydroxyl ions to be replaced by chlorine ions. It also teaches that chlorine penetration into the soot preform and further water removal cannot be accomplished after surface sintering of the preform has occured. (CX-9 (RX-1004) col. 9, ll. 55-59, col. 9, l. 68 to col. 10, l. 7).

C. <u>Prosecution of the '454 Patent</u>

142. Serial No. 462,962 which led to the '454 patent, was filed April 22, 1974 in the name of inventor Robert De Luca with one independent claim relating to a method of forming a glass article and with twelve dependent method claims. Independent claim 1, as originally filed, read:

> 1. In the method of forming a glass article comprising the steps of
> depositing on a starting member a coating of flame hydrolysis-produced glass soot to form a soot preform,
> consolidating said soot preform to a dense glass layer free from particle boundaries, and
> forming said dense glass layer into a desired shape,
> said consolidation step being characterized in that it comprises
> heating said soot preform to a temperature within

the consolidation temperature range for a time sufficient to cause said soot particles to fuse and form a dense glass layer, and simultaneously

subjecting said soot preform to a stream of a substantially dry chlorine containing atmosphere, said chlorine permeating the interstices of said soot preform during the consolidation thereof and replacing hydroxyl ions by chlorine ions, thereby resulting in a glass article that is substantially water-free. (RX-1005, p. 29)

143. Original claim 8 in Serial No. 462,962 is identical to claim 8 in issue in this investigation. (RX-1005, p. 31; CX-9 (RX-1004) col. 13).

144. On January 17, 1975, the Patent Examiner rejected all of the claims under 35 U.S.C. 103 on Nordberg U.S. Patent 2,326,059 and Bruning U.S. Patent 3,850,602 plus Heraeus et al. U.S. Patent 2,904,713. The Examiner considered it obvious to use the chlorine containing atmosphere of Bruning, which was said to be used for reacting with the OH ion radicals in an optic fiber glass in view of Heraeus which was said to teach that many chlorine compounds are used to remove impurities from glass. It was said that it would be obvious to substitute chlorine for the oxidizing atmosphere of Nordberg. The Examiner noted that the glass of Nordberg was slowly passed through the treating furnace which was said to meet the limitations of the more specific claims. (RX-1005, p. 31).

145. By an amendment dated April 9, 1975, claim 1 was amended to read as claim 1 of the '454 patent in issue in this investigation (RX-1005, pp. 42-43).

146. In the amendment filed April 9, 1975, it was said that amended claim 1, after setting forth the steps normally employed to form a glass article by the flame hydrolysis process, indicates that the consolidation step is characterized in that "it comprises" heating the soot preform to the consolidation temperature and simultaneously subjecting the soot preform to a stream of a substantially dry chlorine containing atmosphere. (RX-1005, p.

45).

147. In the amendement filed April 9, 1975 it was argued that the Bruning patent makes no mention of optical fibers; that it teaches a method of forming quartz glass from quartz crystal granules by first mixing the granules at an elevated temperature with one of the following salts: sodium fluoride, sodium chloride, sodium bromide, sodium nitrate, lithium chloride, potassium chloride, magnesium chloride, calcium chloride, strontium chloride, and silver nitrate, or mixtures thereof; that this process could not be performed simultaneously with the consolidation of the quartz crystal granules into a dense glass body since the granules treated in the aforementioned manner are contaminatd with traces of salt vapor which would result in the formation of bubbles in the quartz glass during the melting process; that to remove any doubt as to the applicability of the Bruning patent to the claimed process, claim 1 has been amended to state that the dry chlorine containing atmosphere is substantially free from contaminants that would adversely affect the optical properties of the glass article; that because of this salt contamination, the Bruning method requires the additional step of flowing water vapor-free gas such as dry oxygen or nitrogen over the granules at an elevated temperature; that it is only after the granules have been mixed with salt and flooded with the dry oxygen or nitrogen that the melting is performed; that whereas the Bruning patent employs a three-step method of purifying quartz and forming a solid body, claim 1 results in the simultaneous purification of the soot preform and consolidation thereof into a glass article; that accordingly the Bruning patent does not teach "optic fiber glass" or a chlorine containing atmosphere of the type set forth in the claimed subject matter. (RX-1005, pp. 46-47).

148. In the amendment filed April 9, 1975, Corning argued that while the Examiner cited the Heraeus et al. patent as teaching that many

chlorine compounds are used to remove impurities from glass, the De Luca claimed process employs a chlorine atmosphere for removing hydroxyl ions only during consolidation of the soot preform; that Heraeus et al. teach the use of chlorine or other halogens to render harmless or eliminate impurities in grains of "rock crystals" as they are strewn upon the surface of a cylinder; that it is stated at column 4, lines 30 and following of that patent that it is not sufficient to melt and process the quartz glass in a chamber exposed to a certain chlorine gas pressure; that it is necessary to supply chlorine gas to the processed surface in such a manner that the chlorine molecules surround and envelop the quartz particles shortly before and during their melting and during build-up of the quartz glass body; that therefore, the speed with which chlorine, or gases yielding chlorine are supplied, must at least be equal to the speed of the heating flame; that the Heraeus et al. process is more closely related to the process of forming a soot preform wherein particles of glass soot from a flame are built up on a starting member; that the De Luca method in issue differs from that of the Heraeus et al. patent in that after the soot preform is formed by the flame hydrolysis process it is subjected to a stream of dry chlorine during consolidation; that as shown in the Figure 3 furnace of the De Luca specification the dry chlorine containing atmosphere is merely fed to the bottom of a consolidation furnace, and it is not necessary that the chlorine be directed with high speed into the soot preform during the formation thereof; that the manner in which the glass body is formed dictates the particular method by which hydroxyl ions can be removed therefrom; that the flame hydrolysis process of the De Luca invention is dissimilar from that of the Heraeus et al. patent whereby quartz glass powder is dropped onto a quartz glass nucleus upon which a glass body is built up; that it is stated in the De Luca specification that even though chlorine containing compounds such as $SiCl_4$ are employed in the flame hydrolysis process to form silica containing soot preforms, the chlorine present in those chlorine containing compounds does not result in the formation of water-free soot; that further evidence of the substantial dissimilarities between the claimed De Luca method and that of the Heraeus et al. patent lies in the teaching of that patent, at col. 3, ll. 5 and following and at col. 7. ll. 14 and following, that small amounts of hydrogen in the chlorine atmosphere is generally of advantage which indicates that the reactivity of chlorine gas with impurities present in the rock crystal can be increased by introduction at the same time of small amounts of hydrogen; that the De Luca specification indicates that hydrogen cannot he used as the diluent gas since it tends to increase the water content of the glass; that claim 1 has been amended to include a limitation regarding a hydrogen free atmosphere; that it appears that the vast difference between the claimed De Luca method and the Heraeus et al. method stems from the fact that very dissimilar impurities are being removed by the two methods. (RX-1005, pp. 47-48).

149. In the amendment filed April 9, 1975, Corning argued that Nordberg relied on by the Patent Examiner was one of the patents cited in the De Luca specification under the heading "Background of the Invention" as illustrating the flame hydrolysis process; that the Nordberg patent teaches that soot may be consolidated in an oxygen atmosphere; that subsequent to the Nordberg invention it was found that oxygen was unable to provide a glass body having a sufficeintly low beta value, and various techniques were therefore employed to reduce the amount of water in flame hydrolysis produced glass; that copending application Serial No. 239,742 cited in the specification (col. 2 l. 58 of '454 patent) employs a consolidation atmosphere of nitrogen, helium, neon or argon; that in copending application Serial No. 239,746, cited in the specification (col. 2, l. 66 of '454 patent) the soot preform is placed in a chamber evacuated to less than 10^{-5} Torr; that none of the references

of record teach the equivalence of chlorine and oxygen as the consolidation atmosphere; that oxygen is not equivalent to chlorine for the purpose of removing water from a soot preform during consolidation thereof. (RX-1005, p. 49).

150. In the amendment filed April 9, 1975, Corning argued that the Patent Examiner ignored most of the dependent claims; that claim 8 which is in issue in this investigation, states the soot has a high silica content and the step of heating comprises subjecting this soot preform to a maximum temperature in the range of 1200-1700°C; that none of the references of record teach the step of subjecting a porous silica body to a chlorine containing atmosphere at a temperature in this range. (RX-1005, pp. 49-50).

151. On July 1, 1975 the Examiner indicated that all of the claims in the '454 application were allowable in view of the amendment filed on April 9, 1975. (RX-1005, p. 51).

152. On August 5, 1975 a notice of allowance were mailed and the '454 patent in the name of Robert D. De Luca issued on January 20, 1976. (RX-1005, p. 52; C-9 (RX-1004)).

VII. The Making of the '915 Invention

153. Inventor Robert D. Maurer received a Bachelor of Science in Physics in 1948 and a Ph. D. in Physics in 1951. In 1952 he joined Corning a as Physicist and has been employed by Corning since 1952. He was appointed Manager of Applied Physics Research in 1963 and Manager, Special Projects in 1976. Dr. Maurer was appointed to the position he now holds, Research Fellow, in 1978. (Maurer CX-1, paras 6, 7).

154. In 1966, Corning was contacted by the British Post Office for help in its search for a useful long distance light guiding structure. The

goal was the achievement of a structure capable of transmitting 1% of the light input over a distance of one kilometer -- the aproximate energy transmitted by copper wire, commonly used in telephone communications. As expressed in the terms of the art, this goal was a structure having a light attenuation of twenty decibles per kilometer (20 dB/km). At that time one typical form of fiber optics consisted of a core of Schott F-2 glass (a lead-silicate glass, containing approximately 50% silica, together with lead and several other components) and a cladding of Corning 7056 glass (an alkali-borosilicate glass,also containing about 50% silica). The attenuation of this typical fiber was approximately 1000 dB/km. Hence, the advance to 20 dB/km required a 50-fold improvement. Over a distance of kilometer, a 1000 dB/km conventional fiber could transmit only 10^{-98} percent of the input light, 98 orders of magnitude below the desired 1% transmission level. Corning, along with reseachers from around the world, accepted the challenge posed by the British Post Office, and Dr. Maurer undertook the task of attempting to come up with a practical optical waveguide fiber. (Maurer CX-1, paras. 22-23).

155. In pursuing this research, Dr. Maurer decided to investigate the properties of and to evaluate various Corning glasses for such use. At that time, Corning manufactured, among many other glasses, a pure fused silica glass. This glass had good ultraviolet transparency and was used for applications where such transparency was needed, for example, in certain optical instruments. It was made by a process such as is described in Hyde U.S. Patent 2,272,342 (CX-23). Corning also manufactured a titania-doped silica glass, the titania content of which was about 7% (Code 7971). The fact that glasses could be formed in the titania-silica system was known, for example, from R.C. DeVries et at., "The System TiO_2-SiO_2," Trans. Brit. Cer. Soc., Vol. 53, No. 9, 525-40 (1954) (CX-24), and, as noted in Nordberg

U.S. Patent 2,326,059 (CX-25), certain of these glasses were known to have very low thermal expansion coefficients. Corning sold such a low-expansion titania-doped silica glass for reflective optical applications such as telescope mirror blanks, where superior dimensional stability was required. It was not, however, sold or used for light transmission applications. (Maurer CX-1, para. 24; Macedo RPX-103A para. 34).

156. Prior to 1970, optical fibers were used to transmit an image or light for illumination, e.g., in medical probes. Such optical fibers are referred to as conventional optical fibers or fiber optics and could transmit a usuable amount of light only over a short distance, i.e., a few meters at most, because most of the input light was lost within the fiber. (RX-1035, col. 1, ll. 12-60, col. 7, ll. 36-45; Macedo, Tr. 2788-89, 2803-05).

157. Dr. Maurer was initially skeptical about the applicability of pure silica and titania-silica glasses for use in optical waveguide fibers. Pure fused silica was known to have a relatively low attenuation, but it also had the lowest index of refraction of any practical glass then known to him. Thus, he did not know whether pure fused silica glass possessed the proper optical qualities for transmission of light rays in a fiber, and it was also not apparent to him with what a pure fused silica core could be clad which would have a yet lower index of refraction. In considering glasses as potential candidates for optical waveguides fibers, he had no reason to expect that pure fused silica glass, let alone titania-doped silica glass, would have sufficiently low attenuation to be effective in a low loss optical waveguide fiber. (Maurer CX-1 para. 25).

158. In addition to these uncertainties (FF 157), pure fused silica and titania-doped silica were unattractive as candidates for optical waveguide fibers for a number of reasons, including the fact that they required a higher working temperature then conventional soda-lime-silica glasses (2000°C. v.

1000°C.). There also existed a lack of knowledge as to other optical properties of such glasses, such as light scattering and aborption. (Maurer CX-1 para. 26)

159. Despite these negative indications (FF 158) Dr. Maurer persisted in investigating the properties of pure silica and titania-silica glasses and thought of the idea of using pure fused silica for the cladding and titania-doped fused silica for the core of a fiber. This however, respresented a contradictory approach, since his prime objective was to find a core with suitable optical properties and low attenuation. Use of a doped fused silica core could be expected to increase the attenuation to an unacceptable degree. The prior literature speculated that glasses with a bulk loss of about 20 dB/km might be obtained "as the iron-impurity concentration [is] reduced to 1 part per million." Kao and Hockham, Proc. IEE, Vol. 113, NO. 7, 1151-58 (July 1966) (CX-26). It was considered that the deliberate addition of thousands of parts per million of a dopant material to pure fused silica glass could not have been expected to provide such a low level of attenuation, and, indeed, would have been expected to increase attenuation significantly. (Maurer CX-1, para. 27).

160. After giving considerable thought to the matter, Dr. Maurer first directed the making and testing of such fibers in the spring of 1967. He asked on March 1, 1967 Dr. Frank Zimar of Corning to draw for him a fiber with a pure fused silica cladding and a titania-doped fused silica core. Using a high temperature redraw, Zimar formed some microcane from Corning's silica-titania glass clad with "Spectrosil" synthetic silica. Dr. Maurer on July 18, 1967 reported that titania doped silica core-pure silica cladding fiber had been measured for optical attenuation and once again there were large losses, about 0.1 cm^{-1}, due primarily to absorption. It was said that this high absorption was not in the stating material and its origin

needed to be further traced down. (Maurer CX-1, para. 29; CX-28; CX-29; C-30; CX-31; CX-32; CX-33; Maurer Tr. 126-132).

161. The glasses used by Dr. Frank Zimar when he was first asked by Dr. Maurer to draw a fiber with a pure fused silica cladding and a titania doped fused silica core were Corning code 7971 glass and Corning code 7940 glass. These glasses were made some time prior to when Dr. Maurer made his request of Dr. Zimar. Also neither Dr. Schultz nor Dr. Maurer were the inventors of these glasses. (Maurer Tr. 132-143).

162. An internal Corning memo dated 9/11/67 by C.G. Fonstad, Jr. and approved by Dr. Maurer refers to fabrication of waveguide fibers. From the study, "losses" and mode excitation were said to deserve the most attention in the near future. Under experimental studies, measurements of total and side losses in fiber size samples of an unclad silica fiber drawn from a rod of Corning 7940 glass by Dr. Frank Zimar and a fiber with a Corning 7971 ULE-silica core and thin Spectrosil silica cladding drawn by Dr. Zimar from a core formed from two concentric cylinders were discussed (CX-34, P003923, P003934, P003935).

163. During 1967 at Corning two fibers of titania-doped fused silica were made by the rod-in-tube method -- in which a rod of titania-doped fused silica glass was placed inside a tube of pure fused silica cladding glass for drawing into a fiber -- and there was extensive evaluation of each. From November 1967 to January 1968, work by Dr. Maurer's co-workers continued. (Maurer CX-1, paras. 29-30; CX-28; CX-29; CX-30; CX-31; CX-32; CX-33; CX-34; Maurer, Tr. 126-32).

164. Inventor Peter C. Schultz received a Bachelor of Science degree in Ceramic Engineering and a minor in Nuclear Engineering in 1964. In 1968 he received a Ph.D. in Ceramic Science with a minor in X-Ray Analysis. He joined Corning as a Senior Research Ceramist in the Glass Chemistry

Research Department in August 1967. Dr. Schultz left Corning to become Vice President of Research & Development for SpecTran Corporation in July 1984 (Schultz CX-2, paras. 1, 5, 6).

165. Shortly after Dr. Schultz joined Corning in August 1967, he became involved in Corning's optical waveguide fiber research. He was prinicpally responsible for identifying different possible doped fused silica glasses, containing both titania and other dopants, and the fabrication of optical waveguide fiber preforms containing such doped silica glasses. He also co-developed a method of making such fibers by flame hydrolysis deposition of doped fused silica on the inside of a fused silica tube, which was subsequently drawn into an optical waveguide fiber. (Maurer CX-1, para. 31; Schultz CX-2, paras. 6, 8-11; CX-39; CX-40; CX-41; CX-42; CX-8A).

166. Direct vitrification or boule proces is a technique in which starting vapors are passed into a flame and react in the flame to form fine glass particles called soot with the soot from the flame being deposited directly into a furnace at a high temperture, i.e. the soot will enter directly into a solid piece of glass. (Shultz Tr. 226).

167. The term "FOG" at Corning meant fiber optic guide. The term was used for any experiment in which Corning was trying to make an optical waveguide preform. (Schultz Tr. 228).

168. Dr. Schultz's initial work at Corning involved the exploration of new glasses based upon fused silica. The work, which involved the fabrication of fused silica glasses with various additives and the analysis and characterization of the new glasses so formed, continued for a number of years thereafter -- at least until May of 1970. (Schultz CX-2. para. 8).

169. Shortly after Dr. Schultz's arrival at Corning, he learned of Dr. Maurer's prior work on the production of optical waveguide fibers with a titania-doped fused silica core and a pure fused silica cladding. The

applicability of Dr. Schultz's exploration of doped fused silica glass systems to the work of Dr. Maurer was recognized, and, by the beginning of 1968, Dr. Schultz became involved in Corning's search for a low loss guide for light waves. (Schultz CX-2 para. 9).

170. Much of Dr. Schultz's exploratory work is producing bulk glasses was performed using the flame hydrolysis technique. Based on this technique, in early 1968, he attempted to coat the inside surface of a pure fused silica tube with a titania-doped fused silica soot produced by flame hydrolysis. This soot was to form the core of the fiber to be drawn from the composite tube and soot structure. It soon became apparent that this production method could be successful. (Schultz CX-2, para. 10).

171. Dr. Schultz's laboratory notebook from 9/1/67 to 12/20/68 discloses his first entry dealing with the making of optical waveguides dated 2/28/68. This entry is directed to a flame hydrolysis technique in which there was deposited a cladding glass on a core glass rod of titania silica. The particular variation used was a direct vitrification technique where soot that was formed in the flame was deposited and directly vitrified inside of a furnace at a high temperature. Dr. Schultz's last attempt to make a direct vitrifieed waveguide blank was on April 8, 1968. (CX-39; Schultz Tr. pp. 223-226).

172. Dr. Schultz on April 8, 1968 in his notebook described another variant of the flame hydrolysis technique in which the soot was deposited on the inside surface of a tube as a powder and then separately, at a lower temperature, sintered to make a solid glass layer. It is not a direct vertification because when the soot came out of the flame, the temperature of the target that it hit was very low so there was only deposited a powder rather than "sintering together and making a solid piece of glass". That general process of depositing the soot in a tube and then subsequently

sintering it at a lower temperature was conducted for at least the next year at Corning. (CX-39; Schultz Tr. 226-28).

173. Run 10 FOG in Schultz's notebook refers to holding a fused silica glass tube in front of a flame hydrolysis burner. The doped silica soot that is formed in the flame was allowed to pass down through the center hole of the tube and deposited as a powder on the inside wall of the tube. Then the tube with the soot layer on it was heated repeately so that the soot would enter to make a solid glass layer of doped silica which was then drawn down until the hole in the middle collapsed and there was formed a fiber that had a core of doped silica (silica-titania) as the inner layer, and a cladding of fused silica which was the starting tube. (CX-39; Schultz Tr. pp. 288-230).

174. Run 10 FOG involved the blank that led to a fiber which was 250 dB per kilometer. Schultz's notebook on Run 10 FOG refers to a blank S1-AD. Dr. Zimar, who prepared the starting tube used the same code number S1-AD when he described drawing it into fiber as I-73. Dr. Keck, who measured the fiber used the same code number I-73 for the fiber to describe his measurement which was 250 dB's per kilometer. (CX-39, P. 3454; CX-44, P. 28431; CX-46, P. 007393, P. 007394; CX-50; Schultz Tr. 234-245).

175. Dr. Schultz's work in February 1968 was his first attempt to produce an optical waveguide fiber by depositiing flame hydrolysis-produced pure fused silica on the outside of a titania-doped fused silica rod of core material. Dr. Schultz's April 1968 work was his first attempt to coat the inside surface of a pure fused silica tube with a titania-doped fused silica soot produced by flame hydrolysis. This soot was to form the core of the fiber to be drawn from the composite tube and soot structure. Schultz CX-2, paras. 10-11; CX-39, pp. 79 et seq; Schultz, Tr. 223-28).

176. Additional work by Dr. Schultz continued, and, on August 1, 1968, the titania-doped fused silica fiber drawn from a preform produced by

Dr. Schultz was measured to have an attenuation of approximately 250 dB/km (FF 172). (Schultz CX-2,, paras. 10-13; CX-39, pp. 78 et seq; CX-43; CX-44; CX-45; CX-46; CX-48; CX-50; CX-51; Schultz, Tr. 228-45).

177. A report dated August 8, 1968 by Dr. Maurer under the subheading "Optical Wave Guides - D. B. Beck" stated that the first successful manufacture of a waveguide from tubing has overcome a "big uncertainly in one program" It was stated that Corning's entire future planning was based on this method of blank manufacture which was previously unproved; that performance of this guide at attenuation about 250 dB/km was very good. Some problems with large scattering centers were said to remain. (CX-50).

178. Dr. Schultz in a report dated 8/8/68 and under the subheadings "Flame Hydrolysis Research" and "Wave Guide Blanks" stated a blank produced by the flame hydrolysis deposition of SiO_2-TiO_2 soot onto the inner surface of a fused silica tube was successfully redrawn into wave guide fiber by Dr. F. Zimar; that the fiber had the proper core/cladding diameter ratio and exhibited the best single mode transmission seen to date. (CX-51).

179. Fiber I-73 produced from FOG 10 was a useful fiber; it could communicate information; it was a single mode fiber and it had a reasonable attenuation. (Schultz Tr. 245).

180. Until at least May of 1970, a portion of Dr. Schultz's research effort was continually directed to the preparation of soot-containing preforms of various doped fused silica glasses for fiber production. (Schultz CX-2, para. 11; CX-39; CX-40; CX-41; CX-42).

181. The preforms produced until at least May of 1970 were drawn into fibers under the direction of Dr. Frank Zimar. Corning's Dr. Donald B. Keck was then typically responsible for the measurement and characterization of fibers produced. (Schultz CX-2, para. 12; CX-43; CX-44; CX-45; CX-40; CX-47; CX-48; CX-49).

182. As reported in a progress report for period # 1, 1970 by January 25, 1970, the attenuation of optical waveuides has been dropped by over two orders of magnitude. It was said then that the final step came with a properly heat-treated-titania doped silica core waveguide. The best measurement, performed on a 26 meter piece, showed an attenuation of 21 dB/km with a standard deviation of about ± 5 dB/km. As to a method of obtaining the spectral response of the waveguides, extensive data had been taken on both the 3 percent and 5.25 percent titania waveguide as a function of heat treatment time. The delivery system for aluminum oxide doped waveguides was being redesigned to remove any sources of iron contaniuation. (CX-39; CX-40; CX-44; CX-46; CX-47; CX-58; CX-52; Maurer CX-1, para. 32).

183. Dr. Schultz and F.W. Voorhees in highlights period 1, dated January 26, 1970, reported that an optical waveguide having a core glass composition of 3 wt.% TiO_2-SiO_2 was successfully produced using the flame soot process; that after proper heat treatment by Dr. D.B. Keck, this fiber exhibited the lowest attenuation observed to date of 20 dB/km, which meets the project goal set up 3 years ago for a practical waveguide system; that a unique thermal expansion phenomenon has been observed in a clear 15 Wt.% TiO_2-SiO_2 glass which before annealing has a linear negative expansion from $-100^\circ C$ to $+700^\circ C$ with a coefficient of $-4 \times 10^{-7}/^\circ C$, whereas after annealing the expansion in this temperature range was both linear and positive (coefficient = $+10 \times 10^{-7}/^\circ C$). It was said that this latter glass is near the end point for homogeneous glass formation in this system (16 wt.% TiO_2) using the flame hydrolysis technique, and that the expansion reversal is probably the result of titanium ion coordination changes. (CX-53).

184. Corning's most consistent successes in the production of optical waveguide fibers prior to May 1970 were achieved primarily with an approximately 5% titania-doped fused silica. Prior to May of 1970, Corning

also made fibers containing alumina-doped fused silica and zirconia-doped fused silica. Maurer CX-1, para. 32, Schultz CX-2, para. 15; CX-54, p. 3).

185. A report dated March 4, 1970 by Dr. Maurer on project review meeting for fundamental physics stated under the subheading "Acomplishments" that the

> "primary work this year has been on altering the core glass composition in the waveguide in an attempt to reduce the attenuation. The waveguides have been made via the thin film technique and the core glass compositions have included TiO_2, Al_2O_3 and ZrO_2 doped silica.
> The composition 5% TiO_2-95% SiO_2 has been the most consistant performer, regularly giving attenuations of ...[about] 70 db/km, after proper heat treatment, in lengths as long as 90 meters. One of these guides exhibited ...[about] 1.6% transmission over a 200 meter pathlength. Al_2O_3 doped silica waveguides have not performed as well as expected, remaining at 400-500 db/km attenuation. They require no heat treatment, however. It is believed that the high attenuation is due to Fe^{2+} absorption and steps are being taken to remove the source of this contamination. ZrO_2 doped silica has not yet been made into a waveguide due to failure of the ZrO_2 soot to sinter during redraw. This core composition still remains an attractive prospect due to the single oxidation state of Zr. A reduction of the TiO_2 concentration to about 3% has produced an attenuation of about 20 db/km after proper heat treatment. This substantially demonstrates that our goal can be achieved. A subsequent waveguide with the same composition is presently being evaluated. Preliminary data shows an attenuation of about 45 db/km.
> The special response of these waveguides is being measured to ascertain the best operation regions and to aid in identifying reasons for high attenuations. This work will continue." (CX-54).

186. As of May of 1970, Dr. Maurer and Dr. Schultz had not yet experimented with dopant materials which decreased the index of refraction of pure fused silica. Their direct testimony was that such materials were well within their concept of the invention embodied by the '915 patent (Maurer Cx-1 para. 34; Schultz Cx-2, para. 20).

187. From the work performed as of May of 1970, Dr. Maurer and Dr. Schultz believed there were certain advantages to the use of no more than approximately 15% by weight of dopant material. Prior to that date, they had not produced a particularly useful fiber containing more than that amount of

dopant material. (Maurer CX-1, para. 35; Schultz CX-2, para. 21).

188. Prior to the May 11, 1970 filing date of the application for the '915 patent, the inventors had produced no particularly useful fiber containing more than 15% by weight of dopant material. Only one fiber with more than 15% by weight of dopant had been made -- an aluminum oxide, or alumina, doped fused silica fiber containing approximately 37% by weight of dopant. While this fiber did exhibit single mode light transmission, its loss was measured to be approximately 450 dB/km. Work performed by Dr. Schultz on bulk alumina-doped silica glasses suggested that glass containing high amounts of alumina would not be useful for optical waveguide applications. (Maurer CX-1, para. 34; Schultz CX-2, para. 21; Schultz, Tr. 256-59; CX-40, p. 43).

189. Corning announced its achievement of making a fiber with a loss of 20 dB/km, the level desired by the British Post Office in a paper Dr. Maurer gave at the Conference on Trunk Telecommunications by Guided Waves, held in London England from September 29 to October 2, 1970. The optical waveguide fiber referred to in this paper had a pure fused silica cladding and a 3 percent titania doped fused silica core. The core dimension was about 3.5-4 mirons, and the outside dimension was about 208 mirons. The fiber was made by the inside vapor deposition method. (Maurer, CX-1 para. 32; CX-35).

190. The July 5, 1971 issue of Electronics carried an article entitled "Fiber Optics Sharpens Focus on Laser Communications," which stated (at p. 47):

> "As recently as last fall, attenuation all but eliminated fiber optics from consideration as a transmission medium. Writing in the proceedings of the IEEE last October, Nilo Lindgren of Technology Communication Inc., New York, asserted: 'At the present time, the glass used in fiber optics is very lossy, amounting to a decibel per meter at the very best. In actuality, with present glasses, the losses would amount to thousands of decibels per mile, which makes the material clearly unsuitable for long-distance transmission.'

But by the next month, Robert D. Maurer, manager of the Applied Physics Research Group at Corning Glass Works, Corning, N.Y., reported two 30-meter sections of fiber optic waveguide with a total attenuation of 20 dB/km at the 6,328-angstrom wavelength. Several fibers were loaned to researchers at the British Post Office, London, and supplied to Bell Laboratories, Murray Hill, N.J. They confirmed Maurer's measurements.

This was the breakthrough many communications systems designers were waiting for. (Emphasis added)

(Cooper CX-7, para. 32; CX-82; CX-81)).

191. Another article, entitled "Communicating on a Beam of Light," published in the March 1973 issue of Fortune, summarized the situation as follows (p. 120):

A few laboratories here and abroard maintained an interest in trying to improve ... fibers, but for five years the movement was so slow and the required degree of perfection so elusive that the task seemed hopeless.

Breaching the 20-decibel barrier

Late in 1970, Corning Glass announced the laboratory development of an optical fiber in which the light loss was reduced to 20 decibels per kilometer or less. At this critical level glass fibers could begin to be considered competitive with metal wires, cables, and microwave relay.

(Cooper CX-7, para. 32; CX-85).

192. An article entitled "Optical Fibers for Communication," published in the November 1973 issue of The Radio and Television Engineer, stated (p. 655):

The last doubts about the usefulness of fibres for long-distance transmission of light were dispelled in 1970 when Corning Glass Works produced a fibre whose loss was 20 dB/km at the frequency of the helium-neon laser, 0.6328 um. Since this spectacular breakthrough fibre losses have been reduced steadily." (footnote omitted)

(Cooper CX-7 para. 32; CX-84).

193. Similarly, Miller et al. of Bell Laboratories recognized the importance of Corning's advance, in an article entitled "Research Toward

Optical-Fiber Transmission Systems, Part I: The Transmission Medium," published in the December 1973 Proceedings of the IEEE (p. 1704):

> The breakthrough came in 1970 when Kapron, Keck, and Maurer of Corning Glass Works announced the achievement of losses under 20 dB/km in single-mode fibers hundreds of meters long. Thereafter, progress in the science and technology of fiber transmission has developed along a broad front and continues vigorously now ...." (footnote omitted)

(Cooper CX-7, para. 32; CX-83).

194. Over 99% of all optical waveguide fibers which have been made and sold commercially in the world are formed with doped fused silica. At least a portion of these fibers are covered by the claims of the '915 patent. The invention of the '915 patent has led to a multimilion dollar industry where fifteen years ago there was no industry at all. (Maurer CX-1, para. 38).

195. The growth and development of the optical waveguide fiber market industry is demonstrated by the increase in Corning's sales. For example, in 1980, Corning sold kilometers of optical waveguide fiber. In 1981, Corning sold kilometers and the following year. Corning's total sales for 1983 kilometers. Corning's sales for 1984 through early September totalled kilometers. While Corning's type 1519 multimode graded index optical waveguide fiber and Corning's type 1508 multimode graded index optical waveguide fiber are not made under the '915 patent, Corning's type 1521 single mode fiber and its type 1517 multimode graded index fiber are covered by the '915 patent. Hence Corning's current sales includes fiber covered under the '915 patent. (Duke CX-322, para. 30; Wrisley CX-6, paras. 4-8).

196. Licensees under the '915 patent include AT&T, SpecTran Corporation, ITT, Northern Telecom, Les Cables de Lyon, Fibres Optiques, BICC

Limited, Fibre Ottiche and N.V. Philips. At least some of these licensees are selling optical waveguide fiber covered under the '915 patent. In addition, GK Technologies has an option for a license under the '915 patent. (CX-96; CX-97; CX-98; CX-99; RX-1146; RX-1147; RX-1149; RX-1150; RX-1136; RX-1145; CX100).

197. Corning's total royalty accruals for its optical waveguide fiber patent and know-how licenses for 1982 through September 9, 1984 were (Gould CX-326, para. 8, Appendix D).

198. The United States Government has entered into an agreement with Corning setting a rate of compensation to be paid to Corning for the Government's procurement and/or use of optical waveguide fiber covered by Corning patents, including the '915 patent. The initial compensation rate is 6.5%, declining to 5%. The Government paid $650,000 when the agreement was signed. The United States Government did not admit to validity or infringement of the '915 patent. (Duke CX-323, para. 54; CX-95).

199. After two years of litigation, Valtec, a domestic manufacturer of optical waveguide fiber and cable, consented to the entry of a judgment that the '915 patent is "valid and enforceable." The judgment further states that Valtec infringed the '915 patent by the manufacture, use and sale of optical waveguide fibers having fused silica cores doped with germania and phophorous pentoxide and doped or pure fused silia cladding. (Duke CX-323, para. 55; CX-94).

VIII. The Making of the '454 Invention

200. Inventor Robert D. De Luca received a Bachelor of Engineering in 1962, a Master of Science and a Ph.D. both in Metallurgy in 1964 and 1966, respectively. In July 1966 he joined Corning as a Senior Metallurgist with

the Technical Staffs Division. During his tenure with Corning, he also worked in the Electronic Materials Research Department, the Physical Electronics Department, the Applied Physics Department, the Product Development Department, and the Optical Waveguides Department. He was employed by Corning until August 1976 after which he became a research scientist at Johnson & Johnson Dental Products Company. (De Luca CX-3, paras. 1, 4).

201. Dr. De Luca's involvement with optical waveguide fibers began in the early 1970s at Corning, in approximately April 1971, while he was affiliated with the Physical Electronics Department. Among his initial duties were the heat treatment and straightening of already drawn optical waveguide fibers, as well as fiber strengthening. He then became involved in an effort to find a means for elimination of the heat treatment then necessary for titania-doped fibers. (De Luca Cx-3, para. 5).

202. Soon after Dr. De Luca began work with titania-doped fibers it was recognized at Corning that optical waveguide fibers produced by flame hydrolysis methods contained water, primarily in the form of hydroxyl (OH) ions. It was recognized that this residual water was deleterious because it contributed to losses at certain wavelenghts of light -- some of which were of interest for lightwave communications. The effect of the residual water was therefore to increase the attenuation of the optical waveguide fiber at these wavelenghts. The advantage to be gained from the removal of this residual water was clear. (De Luca CX-3 para. 6).

203. In or about May 1972, Dr. De Luca was assigned the task of finding a way to produce a "water free" optical waveguide preform, from which a fiber could then be drawn. His goal was to produce a fiber containing substantially less than ten parts per million of hydroxyls -- preferably much less than one part per million. Drawing upon experience he gained in hydroxyl elimination during his efforts to eliminate the heat treatment of

titania-doped fibers, his initial efforts centered on finding a means for reducing the water content during the process of consolidating optical waveguide soot preforms. (De Luca CX-3 para. 7).

204. Dr. De Luca tried a number of different approaches. One method attempted was the use of a dry, inert atmosphere during the process of consolidating the preform in a gradient furnace. While this approach achieved some drying, the overall level of water remaining was higher than tolerable for long distance communication applications. (De Luca CX-3, para. 8).

205. Another method Dr. De Luca attemptd with somewhat greater success involved consolidation of the soot preform in a vacuum (the vacuum consolidation process). In this process, the preform was placed in a furnace which was then evacuated. The furnace was next heated to a temperature below that at which the process of consolidation would begin, allowing gases entrapped within the soot preform to escape. After a residence time of about 24 hours, the temperature was increased so as to begin the process of consolidating the preform, and a clear glass preform was thereafter formed. While this method was more effective than using only a dry, inert atmosphere during the consolidation process, the 24 hour residence time required was uneconomical. (De Luca CX-3 para. 9).

206. Dr. De Luca next attempted to dry optical waveguide soot preforms through the use of a pure chlorine atmosphere at temperatures below those at which the process of consolidating would begin. This method utilized a residence time in the chlorine atmosphere of approximately one hour at a temperature of no more than about 900°C., followed by consolidaion in a helium atmosphere. While more economical than the vacuum consolidation process, this method produced little better results than the vacuum consolidation process. One significant drawback to this approach was the opportunity presented for the reintroduction of water into the still-porous

preform following the purge of the 100% chlorine atmosphere and prior to the closing of the interstices of the preform during the process of consolidating. (De Luca CX-3 para. 10).

207. Dr. De Luca described the use of a pure chlorine atmosphere to produce water free glass (FF) and the making of three TiO_2-doped waveguides in a Corning semiannual report dated 12/4/72 as follows:

> Chlorine treatment of semiconsolidated soot at 600 to 900°C, followed by consolidation in helium at 1400 to 1500°C has been shown to be effective in eliminating OH in the resulting glass. Water levels of less than one part per million have been achieved. The chlorine treatment process was used to prepare a germania doped waveguide which contained less than 10 ppm OH. The absorption bands attributable to OH in the glass were absent in the spectrum of the waveguide. However, the total attenuation of the sample was 20 - 40 dB/km, primarily due to a highly absorbing impurity which has been tentatively identified as vandium. The source of this impurity is being sought, as well as a method of eliminating it.
>
> Three more TiO_2-doped waveguides were made. Vacuum processing was used to prepare glasses with OH contents of less than 1, 10 and 300 parts per million (ppm), respectively. The glasses containing 1 and 10 ppm OH were drawn to waveguides having a very high attenuation (40,000 dB/km) which could not be lowered by heat treatment. The glass containing 300 ppm OH had an initial attenuation of 2500 dB/km which could be reduced to 30 dB/km by heat treatment. Further studies in this system were postponed in favor of the GeO_2-doped glasses which have been found not to require heat treatment.

(RX-1108).

208. The use of a pure chlorine atmosphere was equally effective in getting rid of water in the treatment of semiconsolidated soot as the vacuum consolidation process. However, there were other problems associated with the use of a pure chlorine atmosphere primarily due to a highly absorbing impurity. (De Luca Tr. 898; RX-1108).

209. Despite the apparent problem in using chlorine, in late 1972,early 1973, Dr. De Luca decided to attempt a different chlorine treatment of the soot preform -- application of a chlorine-containing atmosphere during the process of consolidating. A preform was introduced into a furnace with temperatures in the range for consolidation of the predominantly silica body. The furnace atmosphere used was approximately only 10% chlorine and 90% helium and was maintained at those levels until the blank had completely consolidated to form a clear glass. The result was said to be immediate and startling. Dr. De Luca's initial attempt with this method yielded a water level about two percent of the lowest attained previously in an optical waveguide fiber. (De Luca CX-3, para. 11; CX-57, CX-58 ann CX-59).

210. Dr. De Luca in a report dated January 23, 1973 stated that chlorine added to the helium during the sintering process yields water values about 2% of the lowest that had been attained in a waveguide heretofore. (CX-56).

211. Dr. De Luca's invention is directed to method of maing a low loss glass waveguide and involves consolidating in an atmosphere containing helium and chlorine which is effective to substantially remove the water from the glass soot preform while it is being consolidated (De Luca Tr. 907).

212. On January 30, 1973 Dr. De Luca submitted to Corning an invention disclosure which led to the filing of the '454 patent application for the '454 patent. The invention disclosure read in pertinent part:

> The initial step of the process is the deposition of a semiconsoliated soot of a suitable composition, e.g., 90% SiO_2 + 10% GeO_2, for the core of the optical waveguide. The soot is consolidated at 1400-1600°C in an atmosphere of 90% He + 10% Cl_2 to form a clear glass containing iss than 10 PPM OH. After appropriately finishing and cleaning the core glass a semiconsolidated soot layer of an apropriate cladding glass, e.g., SiO_2 is deposited on it.. This soot is also consolidated in a helium + chlorine atmosphere.

> The resulting redraw blank is then drawn to form an optical waveguide which has less than 20 dB/km attenuation over the entire wavelenght range 700-1100 nm.
>
> In an alternative proces the semiconsolidated soot could be treated in 100% chlorine at lower temperatures, e.g., 700-900°C prior to consolidation in 100% He at 1400-1600°C. This process offes no advantages over sintering in helium-chlorine mixtures, but may be necessary to prevent reaction between chlorine and the glass at higher temperatures. This low temperature process is necessary for single mode waveguide cores which are manufactured by a process in which the soot is not consolidated prior to drawing. (RX-1171).

213. By a memorandum dated March 22, 1974, Dr. De Luca was asked by the Corning patent attorney who prepared the '454 patent application whether there must be a continuous flow of chlorine and helium gas in De Luca's process and Dr. De Luca answered "Yes, until the glass is consolidated" (RX 1171). At the hearing Dr. De Luca testified that his answer meant until the pores of the presoot have closed up; until there is no open porosity; until the preform had "shrunk" so that it had no open porosity, i.e., a "shrinkage phenomenon "had taken place. Dr. De Luca testified that he realized subsequent to his work in early 1973 that it was not necessary to maintain the chlorine flow throughout the entire process of consolidating a preform. (RX-1172, p. 2; De Luca, Tr. 911, 947, 949-50; De Luca CX-3, para. 14).

214. Dr. De Luca testified at the hearing that although he maintained the chlorine - containing atmosphere throughout the entire process of consolidating preforms in his experimental work, this was not necessary; that chlorine can only be effective as a drying agent as long as it can permeate the soot preform; that in so doing, it reacts with the residual hydroxyl ions, creating a gaseous hydrochloric acid which leaves the preform -- leaving chlorine behind to take its place in the soot structure; that when chlorine is introduced during the process of consolidating, it enters the

preform, but can only do so as long as the interstices or the preform have not closed; that once this occurs during the process of consolidating, the chlorine becomes superfluous -- no more can enter the preform and, hence, no further dehydration can occur; that the interstices of the soot preform close, however, at a point in time prior to the complete consolidation of the soot into a clear glass; that as a result, there occurs a point in time during the process of consolidating the preform and before consolidation is completed when the chlorine flow can be ended with no effect on the dehydration or consolidation of the preform; that for the sake of simplicity in his experimental work, he chose not to do so end the chlorine flow. (De Luca CX-3 para. 14).

215. Dr. De Luca testified at the hearing that to the extent that his '454 patent refers to dehydration occurring "simultaneously" with the formation of a dense glass layer; he believed it can only mean that dehydration is to occur during the process of consolidating the preform; because it is, physically impossible for dehydration to continue throughout the entire time that the preform is consolidating. (De Luca CX-3, para. 16).

216. "Consolidation," as that term is used in the '454 patent, does not occur at a single temperature but occurs within a temperature range, over a period of time, and depends on composition. The time required for consolidation to be completed depends on the temperature, and is very long at low consolidation temperatures. (CX-9, col.m8, ll. 1-7, col. 13, ll. 23-25; De Luca, Tr. 939, 942, 944).

IX. The '915 Patent and the State of the Art

217. As early as the 1870s, Alexander Grahm Bell was experimenting with various methods for transmitting the human voice by light wave. By 1880, he had succeeded in doing so over a distance of over 200 meters. The device designed by Bell, called a photophone, utilized a light-sensitive selenium

detector to receive sunlight reflected from a flexible mirror. Sound waves directed at the mirror by a person speaking caused the mirror to vibrate, producing variations in the reflected light waves, which were detected by the receiver and transformed back into sound waves. On December 7, 1980 U.S. Patent No. 235,199 to an "Apparaties for Signaling and Communicating called Photophone" issued to Bell. An issue of Optics News, Vol. 6, No. 1 in a featured article "Alexander Graham Bell and the Photophone: The Centennial of the Invention of Light - Wave Communication, 1880 - 1980" by Forest M. Mims III paid homage to the photophone centennial (Cooper CX-7, para. 16; CX-69; CX-70).

218. The drawbacks of Bell's photophone were evident. Transmission could only be achieved between two points on an unobstructed line of sight. Moreover, the usefulness of such a scheme was severely limited by the tendency of light waves to be scattered, absorbed and blocked by atmospheric particles and weather conditions. It was recognized, even in the late nineteenth century, that some form of "light pipe" would be necessary to protect and guide the transmitted waves of light. (Cooper CX-7, para. 16).

219. It has long been observed that light can be guided through a transparent medium which is surrounded by another medium of lower refractive index i.e. that light will follow the path of the medium of higher refractive index. From this basic low of nature, it was early recognized that glass in a flexible fiber form in an air atmosphere serves as a conduit for light waves. Examples are found in decorative art pieces consisting of a bundle of spread glass fibers into which light is directed and follows the path or the individual curved fibers. (Cooper CX-7, para. 17).

220. In the 1950s, the idea of cladding an optical glass fiber with a different glass having a lower index of refraction emerged. Publications discussing this idea included N.S. Kapany, "Fiber Optics. VI. Image Quality

and Optical Insulation, Jour. Opt. Soc. Am., Vol. 49, No. 8, 779-87 (August 1959) and B. O'Brien U.S. Patent 2,825,260 which issued on March 4, 1958. These clad fibers (referred to as "fiber optics") avoided some of the practical problems inherent in "air clad" fibers. (Cooper CX-7, para. 18; CX-20; CX-21; Maurer CX-1, para. 19).

221. O'Brien U.S. Patent 2,825,260 was from an application filed November 19, 1954. The patent is for an optical image transporting device said to have improved light transporting efficiency and image resolution. (CX-21, col. 2, ll. 63-65).

222. Early fiber optics as disclosed in the Kapany article and O'Brien patent had a number of uses involving short distance transmission of light, for instance, in flexible diagnostic medical probes and instrumentation. In such fibers, conventional silicate optical glasses -- typically containing 50% to 70% silica, along with a variety of other oxides -- were often used. Many experimental compositions were tried, including some non-silicate glasses, such as the germanate glasses disclosed in United Kingdom Patent 1,108,509 published April 3, 1968. Most of these glasses could be worked at 1500°C. or lower and were suitable for drawing into fibers. However, their light transmission capabilities extended only to a few meters, grossly insufficient for a useful communication system. (Cooper CX-7 para. 19; CX-22; Maurer CX-1, para. 20).

223. A silicate glass is a glass containing approximately 20-65 percent silica, together with a variety of other oxides (Cooper CX-385, para. 55).

224. As expressed in terms commonly used in the art, light losses for conventional fiber optics as disclosed in Brady et al. U.S. patent 3,607,322 and U.K. patent 1,160,535 were on the order of 1000 decibels per kilometer (1000 dB/km). Over a distance of one kilometer, such a fiber could transmit only 10^{-98} % of the input light. The Brady patent states that an

embodiment of that invention transmits approximately 60% of the input light over five feet, approximately equal to 1600 dB/km. (Maurer CX-1, para. 22; Cooper CX-7, para. 24; RX-1035, col. 7, ll. 39-43; RX-1044; Macedo RPX-103A, para. 32-33; Macedo, TR. 2788-89).

225. With the invention of the laser in the early 1960s, interest in lightwave communication systems grew. The laser provided a controlled source of light upon which information could be superimposed. An article in the June 1961 edition of Scientific American, Vol. 204, No. 6, 52-61, entitled "Optical Masers" and dealing with what are now commonly called "lasers," summarized the situation (p. 61):

> A single maser beam might reasonably carry a signal with a frequency, or band-width, of 100,000 megacycles, assuming a way could be found to generate such a signal. A signal of this frequency could carry as much information as all the radio-communication channels now in existence. It must be admitted that no light beam will penetrate fog, rain or snow very well. Therefore to be useful in earthbound communication systems light beams will have to be enclosed in pipes.

(Cooper CX-7, para. 21; CX-71).

226. At about the same time, E. Snitzer and H. Osterberg of the American Optical Corporation published companion papers in the Journal of the Optical Society of America, Vol. 51, No. 5, 491-505 (May 1961), discussing the use of very small glass fibers as optical waveguides. Thereafter, S. Kawakami et al., Proc. IEEE, Vol. 53 (December 1965) presented an analysis of light signal propagation in a glass fiber with a graded-index core. (Cooper CX-7, para. 22; CX-72; CX-73; CX-74).

227. Bell Telephone Laboratories, one of the world's leading laboratories and one with a special concern with communications research, was actively involved in the development of the laser as a signal source for communication. As early as 1963, researchers at Bell directed their attention towards development of a suitable medium or pipe for transmission of laser

pulses, S.E. Miller U.S. Patent 3,434,774 based on applications filed February 25, 1964 and February 2, 1965 and which issued March 25, 1969, proposed a design for a glass optical waveguide which controlled the dielectric constant of the wavepath. Researchers at Bell Labs also investigated various systems of light-focusing gas and glass lenses arranged within metal pipes, designed to guide beams of light around corners and to counteract the tendency of light to spread, while avoiding the high attenuation of glass fibers. Such focusing lens systems worked, but were costly and nearly impossible to maintain over a reasonable period of time. U.S. Patent 3,558,891, based on an application filed January 12, 1968 and which issued on January 26, 1971 and U.S. Patent 3,558,896 based on an application filed August 29, 1968 and which also issued on January 26, 1971 show two of the more advanced of these systems. (Cooper CX-7, para. 23; CX-75; CX-76; CX-77).

228. By the mid-1960s, efforts were underway around the world to develop a long-distance lightwave transmission medium. This effort was spurred in part by the British Post Office, whose good was a structure capable of transmitting one percent of the light input over a distance of one kilometer -- the approximate energy transmitted by copper wire, commonly used in telephone communications. Such a structure would have a light loss of only 20 dB/km, as compared to the 100 dB/km loss found in conventional fiber optics. (Maurer CX-1, para. 22-23; Coo]er CX-7, paras. 23-25).

Kao-Hockham Article

229. One early article, which is not referenced in the prosecution of the '915 patent and which considered the possibility of a glass optical waveguide fiber was published by Dr. K.C. Kao and G.A. Hockham paper, Proc. IEE, Vol. 113, No. 7, 1151-58 (July 1966) and entitled "Dielectric-fibre surface waveguides for optical frequencies." The article identified some of

the problems to be overcome in attaining glass optical wavguide fiber, directing attention to absorption losses due to iron impurities in glass and alluding to scattering losses caused by core/cladding interface imperfections. Its introduction stated in part:

> A dielectric fibre with a refractive index higher than its surrounding region is a form of dielectric waveguide which represents a possible medium for the guided transmission of energy at optical frequencies. This form of structure guides the electromagnetic waves along the definable boundary between the regions of different refractive indexes.

The article discloses that the losses of the dielectric-fibre waveguide are governed by bulk losses of the materials which constitute the fibre and the surrounding medium; that the relative contribution to the total loss is determined by the proportion of energy within and outside the fibre and the relative losses of the two media; and that in general it is desirable to have low bulk losses for both media, in order to achieve a satisfactory fibre waveguide with low attenuation. (Cooper CX-7, para. 26; RX 1030, pp. 1151, 1152).

230. The Kao-Hockham article discloses that the bulk loss in dielectrics is caused by absorption and scattering phenomena and that scattering can arise as a result of particle, as dust, inclusion. Under the subheading "Present state of low-loss material", the article states:

> The present known low-loss materials in the frequency range of interest are mainly in the visible part of the spectrum. This is because transparent materials in this frequency range have been in high demand. The best transparent materials known in the visible spectrum are high-quality optical glasses, fused quartz, polymethyl methacrylate and polystyrene. The best absorption coefficient for glass is reported at 0.05% per cm, ... giving a bulk loss of about 200 dB/km. The published data on polymethyl methacrylate give 0.2% per cm,

> equivalent t_a bulk loss of about 600 dB/km ..
> 0.7 nm wavelength. This is for a commercial-grade material which is known to suffer from high particle-scattering losses.

The article concluded:

> Theoretical and experimental studies indicate that a fibre of glassy material constructed in a cladded structure with a [certain] core diameter ... and an overall diameter ... represents a possible practical optical waveguide with important potential as a new form of communication medium. The refractive index of the core needs to be about 1% higher than that of the cladding. This form of waveguide operates in a single ... mode and has an information capacity in excess of 1 Gc/s. It is completely flexible and calls for a mechanical tolerance of around 10% which can be readily met in practice. Thus, compared with existing coaxial-cable and radio systems, this form of waveguide has a larger information capacity and possible advantages in basic material cost. The realization of a successful fibre waveguide depends, at present, on the availability of suitable low-loss dielectric material. The crucial material problem appears to be one which is difficult but not impossible. Certainly, the required loss figure of around 20 dB/km is much higher than the lower limit of loss figure imposed by fundamental mechanisms. (RX-1030, pp. 1152, 1158).

231. The Kao-Hockham article discloses that in inorganic glasses, it is known that absorption can occur owing to the presence of impurity ions; that in high-quality optical glasses, the main contribution to absorption loss in the 1-3 millimicron region is the ferrous and ferric ions.

232. The Kao-Hockham Article states that it is forseeable that glasses with a bulk loss of about 20 dB's per kilimeter at around .6 microns will be obtained as the iron-impurity concentration may be reduced to 1 part per million. (RX-1030, p. 1153).

233. The Kao-Hockham article states that "The fabrication of dielectric-fiber waveguides is a process of pulling or extrusion. For inorganic glasses, the molten glass is allowed to flow through an orifice, often at the end of a core structure." This process is not a possible method of fabrication for fused silica. (Macedo Tr. 2794).

234. According to coauthor Kao in 1984, Kao considered it important at the time he coauthored the July 1966 article that the core of the optical waveguide fiber have a higher index of refraction than the cladding layer. Also in 1984 he considered that it was well-known in 1969 that the refractive index of fused quartz could be raised by the addition of certain metal oxides. (Kao RPX-107, pp. 27, 32).

235. In the Kao-Hockham article, the best transparent materials have a bulk loss of about 200 dB/km which is much less than the fiber optics existing in July 1966 which was something on the order of several thousand decibels per kilimeter. (Macedo Tr. 2768; RX-1030, p. 1152).

In the Kao-Hockham article there is nothing said about doped silica. (Macedo Tr. 27901).

236. Dr. Kao has a Ph.D. in Electrical Engineering and was with Standard Telecommunication Laboratories, Ltd. England from 1960 to 1970 in various research engineering positions. He taught at the University of Hong Kong form 1970 to 1974 and has been a scientist with ITT since 1974. (Kao RPX-107, pp.3-4).

237. Dr. Kao patented a silica fiber optic clad with ice in United Kingdom patent 1,184,028 which was applied for by Standard Telephones and Cables Ltd. on October 21, 1968 and was published on March 11, 1970. In the patent, Kao disclosed that the cladding of optical fibres with a transparent material of lower refractive index than that of the fiber material is "widely used" in fiber optics to eliminate light losses and contamination suffered at the fiber-air interface of uncoated fiber, to eliminate light leakage from one fiber into another uncoated fiber, and to provide a matrix for holding an assembly together. He disclosed that "conventional" cladding material for glass fibers is another glass of lower refractive index. By using ice as the cladding material, it was said that it was possible to clad a light transmitting fiber core of single fiber or multiple fiber construction of any suitable material and of any desired cross section. (CX-27, p. 1).

238. As recognized by Kao and Hockham, the problem of reducing attenuation, or light loss, in a glass optical waveguide fiber was a complex one. There are various causes of attenuation, including absorption (which can be intrinsic or related to impurities), bulk scattering (which can be intrinic or due to inclusions) and surface scattering (which can be due to imperfections and irregularities of the core-cladding interface). The mere presence of impurities is itself an important source of attenuation in glass. All of these effects offered formidable obstacles to researchers attempting to find a glass core, glass clad fiber waveguide exhibiting the desired 20 dB/km attenuation. (CX-26; Maurer CX-1, paras. 27-28; Cooper CX-7, paras 26-29; CX-78; CX-79; CX-80).

U.K. Patent 1,113,101

239. U.K. Patent 1,113,101 for a "Glass" (the U.K. '101 patent) was published May 8, 1968 from an application filed March 29, 1965. It was based on several applications filed in the United States on March 27, 1964. The invention in the U.K. '101 patent relates to cathodoluminescence and photoluminescence devices in which the target material is vitreous silica containing an oxide of a rare earth element having a maximum valance of 3. Luminescent materials are said to be used commercially in cathode ray tubes, particularly television picture tubes, X-ray and radar screens, oscillscopes, electric microscopes, fluorescent lights, radiation detection devices, and luminous markers, signs and dials. (RX-1012, p. 1). The luminescent glass compositions of the invention of the U.K. '101 patent are disclosed as useful as light sources in illuminating devices, signs, markers, etc. The luminescence devices of the invention are disclosed as useful as display means, oscilloscopes, etc. (RX-1012, p. 5). The term "luminescence device"

is defined as any apparatus or contrivance in which energizing radiation is converted to luminescence emission. (RX-1012, p. 1).

240. In the U.K. '101 patent a cathodoluminescence device is defined as a device in which the energizing agent is cathode rays; photoluminescence device is defined as one in which the energizing device is photo emission.

241. The U.K. '101 patent stated that the luminescence devices of the disclosed invention overcome many of the disadvantages in the older luminescence devices by employing a target of silica-rare-earth element oxide glass. Such rare earth elements are said to be lanthanum, cerium, praseodymium, neodymium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, lutetium and promethium. Broadly, the glasses used in the invention are said to be vitreous silica with small amounts of the aforesaid rare earth oxide where the number of rare earth atoms per million silicon atoms is from 5 to 5000. It is stated that these compositions possess the unique and advantageous properties of vitreous silica, including high chemical durability and low thermal expansion with consequent resistance to thermal shock. The transparency of silica is said to allow transmission of a greater range of exciting radiations than other glasses and most crystals. Its optical transparency in particular is said to allow excellent resolution, definition, and contrast ratio, so that images remain visible at luminosity levels lower than those which are adequate with commercial opaque phosphors; conversely, it is said that the vitreous silica host can withstand extremely high current density without damage, allowing cathodoluminescence to achieve high luminocity. The silica-rare each oxide glasses of the invention are said to posseses unique and unexpectedly bright cathodoluminescence and photoluminescence when excited with the rare earth oxides. (RX-1012, p. 2).

242. The objects of the invention in the U.K. '101 patent are to provide "new and improved" luminescence devices, or " new and useful "luminescent glasses or "luminescent glass fibres containing silica and a rare earth oxide". (RX-1012, p. 3).

243. An aspect of the invention of the U.K. '101 patent provides vitreous luminescent fibres of silica containing a rare earth oxide. In a further aspect of the invention, there are provided luminenscent glass fibres wherein the central core is of silica containing a rare earth oxide but wherein there is an outer sheath of vitreous silica containing no rare earth oxide, or at least containing several orders of magnitude less rare earth oxide than in the core. (RX-1012, p. 4). It is said that the silica glass fibres containing rare earth oxides are responsive to the same energizing radiations as the bulk glasses, and can thus be used in various luminescence devices; that the fibers containing the outer covering of vitieous silica cannot be used as cathodoluminescent fibers by bumbardment through the silica sheath, since the electrons will not sufficiently penetrate although they can be employed by bombardment on the end where the luminescent glass is exposed. (RX-1012, p. 4).

244. In the compositions of the U.K. '101 patent, the number of rare earth atoms per million silicon atmos is from 5 to 5000. (RX-1012, p. 3).

245. The U.K. '101 patent discloses that the pure vitreous silica outer sheath can be readily removed by grinding from the silica-rare earth oxide component. (RX-1012, p. 6. Ex 1. p. 8, Ex. 6).

> 22. A substantially transparent, luminescent glass of silica containing at least one rare earth oxide, the glass being prepared from a composition of finely divided anhydrous particulate non-crystalline silica substantially devoid of crystalline material having a maximum linear dimension of 5000 millimicrons, and the number of rare earth atoms per million silicon atoms being from 5 to 5000.

26. A substantially transparent, luminescent glass which is in the form of a fiber and which comprises a core of a glass of silica containing a rare earth oxide as claimed in claim 22 and a sheath of silica. (RX-1012, p. 11)

246. Photoluminescent fibers made in accordance with the U.K. '101 patent may have central elements which absorb radiation, such absorption being required for luminescence to occur. However, light absorption by the core is precisely what must be avoided in an optical waveguide fiber. (Cooper CX-385, para. 57).

247. When the luminescent materials of the U.K. '101 patent are in the form of fibers with an outer sheath of vitreous silica and radiation is by electrons, only the end will luminescene because the glass is essentially opaque to electrons. (Cooper CX-385, para. 57).

248. The silica used in the examples of the U.K.'101 patent has a particle size 10 to 20 millimicrons and can be obtained from Godfrey L. Cabot, Inc. Boston. They have the following composition:

Al_2O_3	0.010%
Fe_2O_3	0.0001%
TiO_2	0.0001%
CuO-MgO	0.0000%
Na_2O	0.020%
SiO_2 by difference	99.968%

This composition indicates extremely low levels of impurities and would make a material which is very, very clear. (RX-1012, p. 4; Macedo Tr. 2782).

249. For some of the intended purposes in the U.K. '101 patent for the composition of the invention, the device would work without the cladding. (Macedo Tr. 27840).

250. There is no ference to optical waveguide f: rs in the U.K. '101 patent. (Macedo Tr. 2784).

251. The U.K. '101 patent is referenced in the Corning U.K. Patent Specification 1,322,992 (the U.K. '992 patent) which is the British counterpart to the '915 patent. The U.K. '992 patent states in part:

> In Specification No. 1,113,101 there is described and claimed a substantially transparent, luminescent glass of silica containing at least one rare earth oxide, the glass being prepared from a composition of finely divided anhydrous particulate non-crystalline material having a maximum linear dimension of 5000 milimicrons, and the number of rare earth atoms per million silicon atoms being from 5 to 5000.
>
> There is also described and claimed (in claim 26) a substantially transparent luminescent glass which is in the form of a fiber and which comprises a core of a glass of silica containing a rare earth oxide, said glass being as defined above, and a sheath of silica.
>
> We make no claim herein to a glass in the sheath of silica as claimed in the said claim 26.

(RX-1012; RX-1240, p. 6; Schultz Tr. 3305, Maurer Tr. 3314).

252. There is no discussion in the U.K. '101 patent of the effect of dopants on the index of refraction. (Macedo Tr. 2781).

U.K. Patent 1,160,535

253. U.K. Patent Specification 1,160,535 for "Dielectric Fibres" (the U.K. '535 patent) was published August 6, 1969. The U.K. '535 patent discloses a composite dielectric fiber said to be suitable for the transmission of light and which comprises an alkaline earth aluminate or alumino-silicate glass fiber core covered respectively by an alkaline earth aluminate or alumuno-siliate glass cladding, the glass constituting the core having a refractive index higher than that of the glass constituting the cladding (RX-1044, p. 1).

J.F. Hyde U.S. Patent No. 2,272,342

254. The Hyde patent for "Method of Making a Transparent Article of Silica" issued on February 10, 1942 on an application filed August 27, 1934. The invention in the Hyde patent relates to the production of articles containing vitreous silica at relatively low temperatures and of a high degree of purity. The invention is based on the "discovery" that silica, which is deposited when the vapor of a hydrolyzable compound of silicon is decomposed in the presence of heat and water vapor, is of such nature that it is highly vitrified at comparatively low temperatures. (RX-1031, p. 1).

255. The Hyde patent discloses a "flame hydrolysis "method for producing fused silica. (RX-1031; Cooper CX-385, para. 54).

256. The Hyde patent was disclosed to the U.S. Patent Office by Corning in connection with the prosecution of the '915 patent. The '915 patent at col. 4, ll. 4-12, specifically incorporates by reference copending U.S. patent application Serial No. 36,267 which later issued as U.S. 3,711,262. The Hyde patent was referred to at col. 5, ll. 60-64 of U.S. 3,711,262. (CX-8; CX-8A).

M.F. Nordberg U.S. Patent No. 2,326,059

257. The Nordberg patent for "Glass Having an Expansion Coefficient Lower Than That of Silica" and assigned on its face to Corning issued on Augugst 3, 1943 on application filed April 22, 1939 (RX-1028). The '915 patent at column 4, lines 4-12 incorporates by reference then co pending U.S. patent application Serial No. 36,267 which later issued as U.S. 3,711,262 (CX-8A) The Nordberg patent was referenced to at col. 5, ll. 60-65 of U.S. Patent No. 3,711,762 (CX-8).

258. The Nordberg patent relates to a combination of titania and silica in a certain range of proportions to form a series of glasses which are transparent or opal, as desired, and which have very low expansion coefficients. Glasses are disclosed containing form 89 to 95% of silica and over 5% but not more than 11% of titania. Small amounts of titania or silica may be replaced by aluminium oxide or zirconium oxide in an amount not exceeding 5 %. (RX-1028, p. 1).

259. Nordberg discloses that the claimed glass can be reworked in a high temperature flame and molded and formed into desired articles "in the manner known to those who are skilled in such manipulations". (RX-1028, p. 3).

260. While the Nordberg patent teaches that titania-doped fused silica glass may be "transparent" as well as opaque, there is no disclosure that such glass possessed the transparency of the "best" transparent materials identified in the Kao article (RX-1030) because there is no way of knowing from the clarity of a small piece of glass whether that glass has sufficient transparency. There are different degrees of transparency and while window glass may be characterized as "transparent," it is not a material one would select to make an optical waveguide, because it is much too highly absorbing. (RX-1028, p. 3, col. 1, lines 49-52; Cooper, Tr. 3131, 3156-57).

261. The Nordberg patent is not directed to optical waveguides. (Macedo Tr. 2785).

262. The purpose of including titania in the compositions of the Nordberg patent was not to increase the index of refraction of the composition. (Macedo Tr. 785).

<u>R. Mattmuller U.S. Patent No. 3,334,982</u>

263. The Mattmuller patent for "Manufacture of Silica Glass" issued on August 8, 1967 on an application filed January 30, 1962. The objects of

the claimed invention . . to improve the manufacture of .lica glass by vapor phase reactions utilizing a blowpipe process. A major feature of the invention is the use of a halogen gas to entrain the silicon halide vapors. Glasses of pure fused silica containing up to 5 percent aluminum oxide are produced. Silica glass containing germania can be produced. Amounts of 0.4 - 0.5 percent germania is exemplified. (RX-1059, col. 1, col. 2).

264. The Mattmuller patent does not suggest that any novelty resided in the doped fused silica materials which were produced using the claimed process. (RX-1029).

265. The glasses of the Mattmuller patent are highly refractory, requiring extremely high temperatures for "working". (Cooper CX-385, para. 52).

266. The Mattmuller patent does not disclose any measure of the transparency or any precautions to be taken to achieve high transparency. (Cooper, Tr. 3135-36, 3156-57).

267. The Mattmuller patent is not directed to optical waveguides. (Macedo Tr. 2786).

268. The Mattmuller patent does not disclose including a dopant in a glass to increase the index of refraction of the glass. The patent does not specifically say what the disclosed glasses are used for. (Macedo Tr. 2786, 2787).

Koester U.S. Patent No. 3,445,785

269. The Koester patent for "Laser Systems and the Like Employing Solid Laser Components and Light - Absorbing Claddings" issued on May 20, 1909 on an application filed August 5, 1963. The invention in the patent is to elongated laser components of solid materials having side walls clad with selectively absorbing light transmitting solid materials of substantially the same refractive indices as the laser components. (RX-1033, cols. 1,2).

270. The Koester patent discloses the use of highly absorbing dopants. Cooper CX-385, #54; RX-1033, col. 5).

271. The Koester patent was cited by the Patent Office Examiner during the prosecution of the '915 patent. (RX-1001, pp. 18-19).

R. Seitz U.S. Patent No. 3,533,013

272. The Seitz patent for "Optical Maser Having Means for Concentrating the Pumping Light Energy in the Central Portion Thereof" issued on October 6, 1970 on an application filed March 23, 1967. The disclosed invention includes an exteriorly silvered generator having disposed therein a plurality of flash tubes arranged within the outer layer of a host material, such as a ruby (Al_2O_3) crystal. The crystal includes doping medium such as chromium ions. It is said that the invention in particular relates to optical masers or lasers, wherein more efficient utilization of "pumping" energy, is provided. (RX-1032, cols. 1, 2).

273. The Seitz patent was cited by the Patent Office Examiner during the prosecution of the '915 patent. (RX-1001, pp. 17-19).

274. The Seitz patent discloses that a variation of doping concentration produces a variable index of refraction. (RX--1032, col. 3).

R.P. Flam et al. U.S. Patent No. 3,542,536

275. The Flam et al. patent for "Method of Forming Optical Waveguide by Irradiation of Dielectric Material" issued on November 24, 1970 on an application filed September 1, 1967. In accordance with the Flam et al. invention, the method of fabricating an optical waveguide comprises the step of providing a single continuous quantity of solid optical dielectric material and the step of changing the refractive index in an interior localized region

of the quantity of sol' optical dielectric material by radiating the dielectric material so as to produce atomic displacements in the localized region. The irradiation dose is sufficient to produce a difference in refractive index between the interior localized region and the remainder of the material which is said to permit the guiding of optical energy. (RX-10334, col. 2).

276. The Flam et al. patent was cited by the Patent Office Examiner during the prosecution of the '915 patent.

277. The Flam et al. patent does not suggest adding a material to a fused silica. The method of the Flam et al. patent cannot be extended to kilometer long optical waveguides. (Cooper CX-385, para. 49).

278. The Flam et al. patent has basically no dopants other than through radioactivity and through irradiation. Thus Flam et al. would not normally require a restriction on 85 weight percent silicon.

W.C. Brady U.S. Patent No. 3,607,322

279. The Brady patent for "Light Transmitting Glass Fibers, Core and Cladding Compositions" issued on September 21, 1971 on an application filed May 22, 1969.. (RX-1035).

280. The Brady invention involves core and cladding glass compositions for optical glass fibers. The patent discloses that glass core composition can have an index of refraction of from 1.56 to 1.64 capable of transmitting light when in fiber form with the core. (RX-1035, col. 2, ll. 3-5; col. 7, ll. 70-75).

281. In optical fibers formed of a preferred combination of core and cladding glasses of the Brady invention, more than 60 percent of light entering 5 foot lenghts of there fibers will be internally reflected and transmitted out the opposite end which corresponds to something on the order of several thousand decibels per kilometer. (RX-1035, col. 7, lines 39-43; Macedo Tr. 2788-89; RX-1030, p. 1152).

282. As disclosed in the Brady patent, in the fiber optics field, a number of individual fibers or filaments are bundled together to form what the art refers to as a light pipe or fiber optic array. In light pipes, individual fibers are composed of two essential components, namely a central core having an index of refraction higher than an outer cladding or sheath which surrounds the core. Due to different indices of refraction of the core and cladding materials the principles of total internal reflection operates to reflect light entering one end of the fiber along the internal length of the fiber to its opposite end. (RX-1035, col. 1, ll. 12-45).

Corning's Code 7940 and Corning's Code 7971 Glasses

283. In 1966 Corning manufactured, among many other glasses, the pure fused silica glass (Code 7940). This glass was made by a process such as is described in Hyde U.S. patent 2,272,342. Corning also manufactured a titania-doped silica glass (Code 7971), the titania content of which was about 7%. This glass, disclosed in Nordberg U.S. patent 2,326,059, was known to have a very low thermal expansion coefficient and was used for structural (non-optical) applications such as telescope mirror blanks, where superior dimensional stability was required. It was not sold or used for light transmission application. (Maurer CX-1, para. 24; CX-23; CX-24; Cooper CX-385, paras, 51, 56; Day, Tr. 2682-83; Macedo, Tr. 2785; CPX-3; CPFF 45).

X. The '454 Patent and the State of the Art

T.H. Elmer et al. U.S. Patent No. 3,459,522

284. The Elmer et al. patent for a "Method of Treating a Porous High Silica Content Glass" issued on August 5, 1969 on an application filed

August 1, 1967 which was a continuation of an application filed July 8, 1963. The disclosed invention is to a method of making a substantially water-free article of high silica content comprising the steps of forming a shaped body from a borosiliate glass; thermally treating the glass body at a temperature and for a period of time sufficient to separate the glass into a silica-rich phase and a silica-poor phase; leaching the silica-poor phase to produce a high silica glass body having a porous structure; treating the porous body in a flowing stream of a substantially dry, chlorine containing atmosphere at a temperature of 600°-1000°C. for a sufficient time, said atmosphere having such a low moisture content as to replace hydroxy ions by chlorine ions; and consolidating the treated porous body in a dry nonoxidizing atmosphere or vacuum to produce a nonporous, transparent, substantially water-free glass article having a maximum beta OH value of 0.02 $mm.^{-1}$. (RX-1057, col. 8, ll. 5-24).

285. Chlorine containing atmosphere as used in the Elmer et al. patent means an atmosphere containing in the order of 10% or more of either chlorine gas or a chloride vapor and the chlorine gas or chloride vapor can be used as such. (RX-1027, col. 3, ll. 34-38).

286. The Elmer et al. patent discloses that the chlorine treatment removes water extremely slowly if at all, at temperatures below 600°C and that such lower temperatures are essentially impractical; that the rate of water removal increases with temperature with the limit being imposed by incipient pore closure, that is initiation of consolidation which occurs at 950°C or higher depending on the residual flux content of the porous glass. It is said that preferably the chlorine treatment is carried out about 700 to 900°C. (RX-1027-col. 3 ll. 45-54).

287. The Elmer et al. patent discloses that the time of chlorine treatment will depend on the degree of dewatering desired, glass thickness, and temperature of the glass during treatment; that for example, it has been found that essentially complete removal of water from tubing having a 1

millimeter thick wall is accomplished in several minutes at temperature pf 800°C and above, whereas hours are required at 600-650°C. The patent discloses that subsequent to the treatment in a chlorine containing atmosphere, the porous glass may be maintained in such atmosphere while the temperature is increased to a consolidation temperature, normally 1250-1300° C; that this may be undersirable from an economic standpoint because it may result in retention of an excess amount of chlorine within the glass and may cause splitting of the glass at high Cl_2 concentration. Alternatively, the chlorine treated porous glass is removed from the chlorine atmosphere and transferred to an inert atmosphere, such as nutrogen for further heat treatment. (RX-1027, col. 3, ll. 45-73).

288. Example 9 of the Elmer et al. patent dicloses a sample of one mm. wall, porous tubing treated at 800°C. for 30 minutes in a stream of chlorine gas flowing at the rate of 100 cc./minute; that at the conclusion of this treatment, the furnace temperature was raised to 1250°C. at a rate of 100 degrees per hour with the flow of chlorine gas being maintained; that the furnace was then held for a half hour at 1250°C. to completely consolidate the porous glass and then cooled; and that the calculated beta value of this treated tubing was 0.002. (RX-1027, col. 6).

289. The Elmer et al. patent was cited and discussed at length in the specification of the '454 patent. (RX-1027; CX-9 (RX-1004) col. 3, col. 4). The Elmer et al. patent discloses that the rate of water removal increases with temperature with the limit being imposed by incipient pore closure, that is initiation of consolidation. (RX-1027, col. 3, ll. 47-50).

Macedo et al U.S. Patent No. 3,938,974

290. The Macedo et al U.S. Patent No. 3,938,974 for a "Method of Producing Optical Waveguide Fibers" issued on February 17, 1976 on an application filed April 22, 1974 which was a continuation-in-part of an application filed April 27, 1973. The invention in the Macedo et al patent is in a method for the production of an optical wave guide comprising a cladding

layer and a glass core with an index of refraction larger than the index of refraction of said cladding layer, the improvement comprising forming said core by heat treating a base glass, which is separable into at least a soluble phase and an insoluble phase to cause phase separation, leaching out the soluble phase and impurities to obtain a porous glass, thermally consolidating the glass to seal said pores, drawing the resultant glass into a fiber, and applying a cladding layer to produce said wave guide. (RX-1052, col. 11, ll. 35-46).

291. The Macedo et al patent teaches that the consolidation step of the process of the invention consists of heating a sample to a range from 700°C. to 950°C. depending on the glass composition so that the pores of the glass close by viscous flow, leaving a homogeneous glass of the hard phase; that if the glass is kept at 500°-700°C. for 15-50 hours before heating to the 700°-950°C range most of the inhomogeneities in the glass, caused by the presence of water can be removed . This drying process is carried out preferably in a reactive atmosphere (such as CCl_4, Cl_2 gas or $SiCl_4$). It is stated that during the 500-700°C heat treatment the unconsolidated glass can be efficiently controlled. (RX-1052, col. 7, ll. 33-48).

Japanese Patent 45-37311

292. Japanese patent 45-37311 was published on November 25, 1970. It discloses heating a porous glass within a range of 750-950°C to drive off the free and the superficially adsorbed water. The glass is subsequently treated in an anhydrous atmosphere that does not react with silicon tetrachloride. Thereafter, a silicon tetrachloride vapor is passed through the furnace for a fixed period of time. Next the glass is heated at an appropriate speed up to 1250-1300°C. After sintering the glass is cooled to produce a dewatered high silica acid glass. (RX-1229A).

XI. Early Work

293. By mid-1965 respondents were involved in developing gas lenses for optical communications. (Nakahara Tr. 2153).

294. Respondents in June 1966 published an article on "Rays and Ray Envelopes within Stable Optical Resonators Containing Focusing Media" in Applied Optics, p. 1023. (CX-243).

295. In 1970 respondents were involved in work and research using liquid cores in optical waveguide fibers. There is no documentary evidence that respondents conducted experimental work on glass clad-glass core fibers during the 1960's (Nakahara Tr. 2153, 2154).

296. Optical fiber was first produced by SEI in 1972. SEI began production of commercial quantities of optical waveguide fiber in 1976 (Nakahara RPX-100, Para. 2).

297. Corning production of optical waveguide fiber began around October 1971. Its commercial production commenced in 1972. It first sale occurred around March 1972. (RX-1098, pp. P036485-86, P036500; RX-1104; SX-4, No. 5, p. 7).

298. Maurer did not originate the idea of an optical fiber having a refractive index higher in the core than in the cladding. (Maurer Tr. 116).

XII.

299. is not listed as a dopant in the '915 patent specification. (CX-8, RX-1001).

300. was not used by inventors Maurer and Schultz as a dopant when the application was filed on May 11, 1970 for the '915 patent. A Corning "Optical Waveguide Technical Request Review" dated March 20, 1972 listing inventor Maurer in connection with research stated that several

composition fields have been explored and the system well characterized. (RX-1098, p. P036463, -64, -71).

301. Prior to the May 11, 1970 filing of the '915 application inventor Schultz had produced a -doped fused silica in bulk form, but because of the process he used, only a small amount of was actually added to the silica. As of May 11, 1970, insufficient work had been preformed at Corning to name it in the '915 application. (Schultz, CX-2, para. 17)

302. Corning's U.S. Patent No. 3,884,550 (the '550 patent) issued May 20, 1975 on an application filed January 4, 1973 by Robert D. Maurer and Peter C. Schultz, the inventors of the invention claimed in the '915 patent. The '550 patent is to a germania containing optical waveguide with germania in the core of the waveguide and with the cladding layer formed of high purity glass. The germania content is in excess 15 percent by weight. The '550 patent is based on a patent disclosure dated June 19, 1972. The '550 patent references the '915 patent. (RX-1002; RX-1130).

303. Inventor Maurer in a technical report dated March 21, 1972 stated that fibers of doped glass show low attenuations and will be pursued as "our major alternative composition." (RX-1099, pp. P052971-72).

304. A portion of a Corning report dated March 24, 1972 stated:

"3. AURORA Project (P.C. Schultz, D.L. Bachman)
A 10 wt% glass blank was successfully produced and redrawn into a multimode optical waveguide for the first time; some outgassing problems were encountered, but, for the first time, as-drawn fibers (no heat treatment) had very low optical losses (one measurement gave losses of only 25 dB/km)." (RX-1127, p. P010753).

305. By mid-1972 Corning had produced a doped fused silica optical waveguide fiber containing approximately 9 percent by weight in the core which had an attenuation of only 4 dB/km. (Schultz CX-2, para. 18).

306. In late 1971, inventor Schultz turned his attention to work in the glass system, and in early 1972 began work on the preparation of silica fibers doped with Such fibers almost

immediately exhibited their usefulness as optical waveguides, and, by mid-1972 a doped fused silica optical waveguide fiber was produced at Corning which contained approximately 9 percent by weight in the core, and which had an attenuation of only 4 dB/km. (Schultz CX-2, para. 18; Maurer CX-1, para. 36).

307. As of May 1970, inventors Maurer and Schultz had not yet experimented with dopant materials which decreased the index of refraction of pure fused silica. (Maurer CX-1, para. 35; Schultz CX-2 para. 20).

308. Corning's most consistant successe in the production of optical waveguide fibers piror to May 1970 were achieved primarily with an approximately 5 percent titania-doped fused silica. Prior to May 1970, Corning also made fibers containing alumina-doped fused silica and zirconia-doped fused silica. (Maurer CX-1 para. 32; Schultz CX-2, para. 15; CX-54, p. 3).

309. On December 10, 1972, Corning reported that the doped materials have led to a low loss waveguide fiber that has demonstrated a degree of reproducibility never possible with the titania system. The level in the core was said to have an appreciable effect in fiber performance and a major effort was concentrated on defining the optimum gradient and establishing a process to produce it. (RX-1109).

310. Although it was not known to the inventors when the '915 application was filed in 1970, it has been known at least since 1954 that the introduction of significantly decreases the index of refraction of certain glasses. (Cooper CX-385, para. 61).

311. Had the inventors Maurer and Schultz experimented with dopant materials, which negatively altered the refractive index of fused silica, prior to the filing of the '915 application on May 11, 1970, specific reference to such materials would have been made in the '915 patent. There is no difference in either function or effect between negatively doping the cladding of a fused silica fiber to reduce its refractive index or positively

doping the core of a fused silica fiber to increase its refractive index. (Maurer CX-1, para. 35; Schultz CX-2, para. 20; Cooper CX-7, para. 37; Hoshikawa, Tr. 2086-93).

312. Inventor Maurer has testified that when the '915 patent application was filed on May 11, 1970, he clearly had in mind using dopants which may decrease the refractive index, especially if there was a dopant which raised it; that he did not know at the time that would decrease the refractive index of glass. (Maurer Tr. 84).

313. Prior to the filing date of the application for the '915 patent, inventors Maurer and Schultz had only experimented with dopant materials which increased the refractive index of fused silica. Thus, the specification of the '915 patent only specifically mentions such dopant materials. (Maurer paras. 32, 35; Schultz CX-2, paras. 16, 20; CX-8, col. 4, ll. 14-33).

314. is a material which, when added to fused silica, positively changes its refractive index, but which does not absorb or scatter light to any appreciable extent. (Maurer CX-1, paras. 33, 36; Schultz CX-2, paras. 18-19; Cooper CX-7, para. 35; CX-361; CX-362; Cay RPX-102A, para. 3; RX-1053, col. 7, ll. 23-30, col. 9, ll. 9-18; CX-8, col. 4, ll. 23-26).

315. There is nothing in the specification of the '915 patent expressly excluding the use of as a dopant material or suggesting that would not perform in the same manner as the exemplary dopant materials specifically listed in column 4 of the '915 patent. (CX-8; Maurer CX-1, para. 33; Schultz CX-2, paras. 17-19; Cooper CX-7, para. 34-35).

316. Although fused silica containing more than trace amounts of may not have been known to have been produced prior to 1970, this is because of the use of direct vitrification methods of deposition, wherein the soot was desposited into a highly heated furnace, causing the to volatilize. The '915 patent and incorporated U.S. patent 3,711,262 teach the deposition of doped fused silica

into an unheated tube at room temperature, followed by a sintering step at temperature below those at which will volatilize. The '915 patent and incorporated U.S. patent 3,711,262 therefore teach a method by which fused silica can be produced containing useful amounts of (Schultz CX-2, para. 17; Schultz, Tr. 204-07, 222, 250-55, 308-11; CX-8, col. 4, l. 60 to col. 5, l. 7, CX-8A, col. 7, ll. 16-54; Day, Tr. 2657-58, 2661-64).

317. If the specific example of the '915 '915 patent, at column 4, l. 60 through column 5, l. 7, or the specific example of the incorporated U.S. patent 3,711,262, at column 7, ll. 16 through 54, were followed, substituting for the titania used in each, each would produce a usable optical waveguide fiber. (CX-8; CX-8A; Schultz, Tr. 250-55; Day Tr. 2661-64).

318. is a dopant material within the scope of the '915 patent. (Maurer CX-1, para. 9; CX-1App., Glossary, p. 2; Schultz CX-2, para. 7; CX-2App., Glossary, p. 2; Cooper CX-7, para. 9; CX-7App., Glossary, p. 2; CX-94; CX-362).

XIII. British Patent 1,322,992

319. British Patent 1,322,992 is the British counterpart of the '915 patent. It states that doping material or dopant is a material which may be added to unfused silica, and which causes the index of refraction of the "doped fused silica" article produced therefrom, to be increased above that of pure fused silica. (RX-1240, p. 2, ll. 114-120).

320. Inventors Maurer and Schultz could not recall ever having seen the definition of dopant material in British Patent 1,322,992. Neither at any time ratified or approved such definition. Both inventors belived that the definition of dopant material in the British patent to be more restrictive then their concept of the invention of the '915 patent. (Maurer Tr. 3309-11; Schultz Tr. 3302-05).

321. Belgian Patent 766,972 is the Belgian counterpart of the '915 patent. The patent does not state that the only dopants usable in the disclosed waveguides are those that increase the index of refraction of fused silica. It states that the dopant materials used in the invention may be the same in the core and cladding or may be different. The only essential condition is said to be that the respective quantities of dopant assure a precise and predetermined difference between the indices of refraction of the core and cladding, the core having the higher index of refraction, and the amount of doping material calculated to give the desired difference in indices. (CX-389, CX-389A, pp. 14-15).

322. French Patent 2,088,485 is the French counterpart of the '915 patent. The patent does not state that the only dopants usable in the disclosed waveguides are those that increase the index of refraction of fused silica. The invention is said to consist of a cladding layer composed of pure fused silica or of a doped fused silica, the nature and degree of doping of the core being such that there is a precise difference in indices of refraction between the core and the cladding layer and that the index of the core is greater than that of the cladding layer. (CX-390, CX-190A, p. 7).

323. Italian Patent 924,956 is the Italian counterpart of the '915 patent. The patent does not state that the only dopants usuable in the disclosed compositions are those that increase the index of refraction of fused silica. Its disclosure is comparable to the disclosure of the French counterpart to the '915 patent (CX 391, CX-391A).

324. Japanese Patent application which is the Japanese counterpart of the '915 patent does not state that the only dopants usable are those that increase the index of refraction of fused silica. It states an absolute condition of the optical waveguide of the invention is that the dopant produce an accurate, predetermined difference in refractive indices between the fused silica sheathing and the fused silica core of the waveguide such that the core

has a higher refractive index, and that the quantity of dopant be calculated as to provide this necessary difference in refractive indices. (CX-392, CX-392A, p. 11).

325. German Patent Application No. 05 2,122,896 which, is the German counterpart of the '915 patent, does not state that the only dopants usable are those that increase the index of refraction of fused silica. It discloses that optical waveguides of the invention comprise core and cladding consisting of silica glass and that either or both can contain a doping agent in such percentage that a precise, predetermined difference in the corresponding indices of refraction of core and cladding are obtained. It is said that the addition of doping agent is preferably in an account such that the index of refraction of the core is greater than that of cladding. (CX-393, CX-393A, p. 3).

326. Canadian Patent 951,555, the Canadian counterpart of the '915 patent, does not state that the only dopants usable in the disclosed waveguides are those that increase the index of refraction of pure silica. (CX-60).

XIV. The 15 Percent Limitation

327. Inventors Maurer and Schultz on September 15, 1970 filed a continuation-in-part (cip) application of the '915 application in the United States Patent Office. At pages 6 and 7 of the cip application, it was representd:

> Because the amount of dopant material necessary to give the desired increase in the index of refraction of fused silica at any given temperature is low, the physical characteristics, such as viscosity, softening point, and coefficient of expansion of the fused silica in the core may be almost identical to those of the fused silica used for the cladding layer. This substantially eliminates many of the difficulties encountered in drawing wave guides, such as devitrification, excess internal strain, and large vicosity

differential. Accordingly, it is generally desirable that the doping mate[illegible]l not exceed 15% by weight of glass.

At page 11 of the cip application it was stated:

> In general, the amount of dopant that may be added to a fused silica is limited only by the amount that can be melted or dissolved into the glass without crystal formation during cooling and/or subsequent processing. Alumina may be present in amounts up to 40% but other oxides are generally limited to no more than 25% at most, while no more than 5% ZrO_2 or Nb_2O_5 may be added and no more than 20% TiO_2. As indicated earlier, where it is desired that other physical properties match rather closely, the amount of dopant may be limited to less than 15%. (RX-1221, pp. P121286, P. 121287, P121291)

328. From the work which inventors Maurer and Schultz performed as of May 11, 1970, it was believed that there were certain advantages to the use of no more than 15% by weight dopant material in preparing the claimed waveguides. Prior to May 11, 1970, Maurer and Schultz had not produced a particularly useful fiber containing more than that amount of dopant material. (Maurer CX-1, para. 34). An invention disclosure dated October 16, 1969 by inventor Schultz directed to doped vitreous silic for Letters and waveguides did read in part:

An invention disclosure dated October 16, 1969 by inventor Schultz directed to doped vitreous silicas for filters and waveguides read in part:

> The present disclosure is concerned with a series of new high temperature silicate glasses which have been produced by the flam hydrolysis of these vapors in mixture with $SiCl_4$ vapors. In particular, the glasses are binary silicates containing Al_2O_3, ZrO_2, Ta_2O_5, and Nb_2O_5 in amounts between 1 and 25 wt.% (depending upon additive used), and are all of excellent quality. Earlier hydrolysis techniques ... could not successfully produce these glasses containing these additives in amounts greater than approximately 0.1 wt.% due to the inefficient vapor generators employed for solid chlorides. In addition, production of these glasses having the quality obtained here would be extremely difficult, if not impossible, using classical melting techniques.

The disclosure stated that glasses are highly desirable as ultraviolet filters and are "attractive core glasses" for use in optical waveguide. However no attenuation values are presented. (RX-1125).

329. A report dated June 16, 1969 coauthored by inventor Schultz read:

An optical \ e guide has been successfully , .duced having a core glass composition of 37 wt. % Al_2O_3-63% SiO_2 and a cladding of 100% SiO_2. The fiber exhibits excellent single-mode transmission and eliminates the necessity of secondary heat-treatment which plagued the SiO_2-TiO_2 wave guides. (RX-1124)

XV. Incorporating Dopants Into Glass

330. U.S. Patent 3,711,262 to "Method of Producing Optical Waveguide Fibers" issued January 16, 1973 to D.B. Keck et al on an application filed May 11, 1970. The application is referred to at col. 4, line 6 of the '915 patent. The Keck et al. patent describes a process in which a film of soot from the flame hydrolysis burners is first deposited as a powder on the inside wall of a glass tube, and then the soot is sintered into a solid glass layer at a sintering temperature of about 1450°C. Other methods are disclosed for depositing glass. Dr. Schultz did not specifically deposit soot of fused silica doped with inside of a tube but did deposit the soot outside of a rod, which was very similar, and then sintered it into a glass incorporating into the glass. (Schultz Tr. 250-251, 253; CX-8A, col. 5, ll. 55-60).

331. Dr. Schultz testified that if in fact one had attempted to doposit as a dopant material, utlizing the process described in U.S. Patent 3,711,262 one would be able to obtain a core doped in excess of .1 percent (Schultz, Tr. 251,252,255).

332. The amount of dopant used with fused silica could be affected by the method used to make the doped silica. (Maurer Tr. 167).

333. Either a direct melting processes in which highly purified starting materials could be melted at high temperatures, an inside vapor deposition method involving depositing soot on the interior of the tube, an outside vapor deposition method involving the deposition of preform on the surface of a mandrell, a boule process with further processing or a "VAD process" could be used to prepare a core glass that is usable in the '915 invention. Each of these processes could cause a variation in the amount of

dopant used to make a core glass but differences that would occur in a bulk piece of glass could be eliminated in the fiber drawing step. There still would be some necessity for experimentation in determining which process would best apply to a given doped core glass. (Schultz, Tr. 321-323).

334. Dr. Maurer was questioned in deposition about a two page document dated August 16, 1968 which he prepared. The document referred to "the difficulties of working with titania-doped silica for the core" and Dr. Maurer testified that there were a great number of difficulties in working with any doped silica "in our early work". When asked whether it would be extremely difficult to predict whether any particular dopant could be used to form an optical fiber, his testimony was:

> A. It would be
> Q. It would require experimental work?
> A. It might, depending on what you were trying to predict."
> (Maurer RPX 104, pp. 136-141, Sept. 14, 1984)

335. Maurer testified that copper and vanadium would be limited in optical waveguide fiber if one were concerned with certain attenuation levels and certain frequency regions because they induced absorptions. (Maurer RPX 104, p. 146 October 8, 1984).

336. The immisibility of ytterbium silicate was published in 1961; the immisibility of lanthanum silicate was published in 1962. (Macedo Tr. 2736).

337. In about 1970 it was known that transition element multi-valent oxides such as iron, copper, cobalt, chromium, vanadium, nickel and uranium typically produce light absorption that is unacceptable in glass. (Macedo Tr. 2730).

338. There are broad guidelines that one could follow as to which dopants to try with fused silica. For example would the dopants produce color in glass and would they form immisciable liquids. If so, such dopants would be unacceptable. Also one would know about the points where immisibility would occur. (Day Tr. 2685-86, 2707).

339. In 197ʋ it was known that oxides as titanuim oxide would produce excessive color at a high concentration so that light absorption levels would be increased to an unacceptable level. (Macedo Tr. 2734).

340. It was known in about 1970 that chemical compounds as calcuim and barium oxide, if added to at least 85 weight percent silica glass in amounts exceeding 10 weight percent would result in the formation of immissible liquids and attendant light scattering. (Macedo Tr. 2733; Maurer Tr. 33).

341. It would be a trail and error process in determining what dopants can be used in making glasses. There is no way one could predict whether a particular dopant would be satisfactory for an optical waveguide. There are some general principles to start with to actually establish the suitability but experimental work would be needed. One would have to melt the glass, pull a fiber from it and measure the optical transmission and with that experimental evidence decide whether the glass fiber was acceptable for a waveguide. With respect to how long it would take, that depends on the number of people working on the matter and what would be in the laboratory. In a well-established laboratory as Corning's lab, it could be all done in a week, probably a faster time. (Day Tr. 2701-09).

342. In an established laboratory with sufficient facilities and with a description of the invention in the '915 patent, experimentation would be routine for someone working in the optical waveguide field in 1970 to select a workable optical waveguide fiber. It would not involve under undue experimentation. (Cooper CX-385, para. 65).

343. With regard to dopant materials of the '915 patent, those skilled in the art in 1970 would have known of the concentrations of such materials at which immiscibility would occur. In fact, such information was available in published literature. (Day, Tr. 2707; Macedo, Tr. 2733, 2736-38).

344. To establish the suitability of any particular dopant material for optical waveguides -- after elimination of those dopants whose concentrations were known to be unsuitable -- one would make a fiber and measure its properties. In a well-equipped laboratory, this could be done in a week at most, probably faster. In fact, to establish the suitability of any dopant material throughout its composition range would take no more than a few weeks of testing, which could be preformed by a laboratory technician. (Day, Tr. 2685-86, 2707-09; Schultz, Tr. 260-61; Cooper CX-385, para. 65).

345. In glass technology generally, it is not unusual to try a number of different compositions before arriving at a desirable composition. (Macedo, Tr. 2762).

> "The percentage of doping material that should be added to fused silica to produce a small, yet precise, change in the index of refraction can readily be determined by one skilled in the art."

(CX-8A, col. 5, ll. 38-41; CX-8, col. 4, ll. 1-10).

XVI. Commercial Production of Optical Waveguide Fiber

346. At present, included in commercial production at Corning, is one single mode optical waveguide fiber (type 1521) and one multimode graded index fibers (type 1517). (Wrisley, CX-6, para. 4).

347. Corning's single mode optical waveguide fiver, type 1521, has an overall diameter of 125 microns and a core diameter of approximately 10 microns. Its core is comprised of approximately

with the remainder its cladding is

(Wrisley CX-6, paras. 4-5).

348. Corning's type 1517 multimode graded index optical waveguide fiber has a specified numerical aperture of .20, an overall diameter of 125 microns and a 50 micron core. Its core is comprised of approximately

on average, and with the remainder its cladding is (Wrisley CX-6, para. 6).

349. Each of Corning's type 1521 and 1517 optical waveguide fibers has a cladding of and a core formed of to which dopant material on at least an elemental basis has been added, said dopant material having been added in an effective amount (Cooper CX-7, para. 46).

350. Other commercial multimode graded index optical waveguide fibers previously manufactured at Corning's Wilmington facility with core dopant levels, on average, of no more than approximately include types 1515, 1516 and 1518. (Wrisley CX-6, para. 9).

351. Corning's type 1515, 1516 and 1518 optical waveguide fibers each has a cladding of to which dopant material on at least an elemental basis has been added. Each also has a core of to which dopant material on at least an elemental basis has been added, said dopant material having been added in an effective amount (Cooper, CX-7, para. 46).

352. The manufacturers of optical waveguide fiber who are supplying optical waveguide fibers to the United States market today are AT&T Technologies ("AT&T"), formerly Western Electric, Corning, International Telephone and Telegraph Corporation ("ITT"), Northern Telecom Limited ("NTL"), SpecTran Corporation ("SpecTran") and Sumitomo. Valtec, Inc., a former manufacturer of optical waveguide fiber in the United States has been acquired by ITT. (CX-103, 274322, 274323; Charlton, Tr. 1225-26; Duke Tr. 1430).

353. SEUSA is engaged in the sale and marketing of optical waveguide fiber and cable among other products, and provides customer support related to those products. (Nomura, RX-466, para. 1).

354. All single mode fiber sold today has a core containing less than 15% dopant material by weight. Certain multimode fiber has a numerical aperture of 0.25 or less. (Cooper CX-7, para. 15).

355. Corning has licensed two domestic manufacturers of optical waveguide fiber -- AT&T and ITT -- under the '915 patent and has licenses SpecTran Corporation ("SpecTran") under the '915 patent. (Duke CX-323, para. 45; CX-96; CX-97; CX-98).

356. Approximately of the optical waveguide fiber manufactured by AT&T in 1983 and 1984 had a numerical aperture of 0.25 or less. (CX-302; SX-90).

357. Approximately of the optical waveguide fiver manufactured by ITT has a numerical aperture of 0.25 or less. Dopant materials added by ITT to the core of its optical fiber designated as T-1232, T-1231, T-1228, T-1221 are

ITT employes for the manufacture of its optical fiber. The process consists of the deposition of thin layers of

The process involves many layers performed inside the tube followed by a process that that contains the to a The is then

optical fiber. (CX-319, Freiburger Dep. Tr. 23-24, 27-28, 29, 56).

358. of the fiber manufactured by SpecTran in 1984 was single mode fiber. Of the multimode fiber manfactured by SpecTran in 1984, was a numerical aperature of 0.25 or less. (CX-354, Jaeger Dep. Tr. 64-65).

359. Corning has licensed NTL, a Canadian corporation, to use and sell in the United States optical waveguide fiber under the '915 patent which

NTL has a

United States subsidia-, Northern Telecom, Inc. ("NTI", which sells in the United States optical waveguide fiber manufactured by

(Duke CX-323, para. 45; CX-99; CX-303; Belboul Dep. Tr. 15).

360. of the optical waveguide fiber sold by NTI in the United States in 1984 was manufactured was manufactured of the fiber manufactured by NTL had a numerical aperture of 0.25 or less. (CX-304, Jamroz Dep. Tr. 18-22).

361. Corning currently utilizes the outside vapor deposition ("OVD") method in the manufacture of its commercial optical waveguide fiber. For the production of fiber, a stream of reactant gas -- determined so as to yield the desired final composition in the particular fiber being made -- is fed into generating a stream of particulate glass material, commonly referred to as soot, which is directed toward a bait.

a preform is built after completion of this soot despoition, The resulting soot preform is then passed into in a chlorine-containing atmosphere. Therein, the preform is dehydrated during the process of consolidation, and, finally, a clear, bubble-free, consolidated glass preform is formed. This glass preform is then and an optical waveguide fiber is drawn from the preform. (Wrisley, CX-6, para. 10).

362. For the production of fiber, Corning utilizes the steps in

Instead of fiber, is then used as or

the is not removed. The resulting and

an optical waveguide fiber (Wrisely, CX-6, para. 10).

363. Exhibit CX-67 contains excerpts from Corning's Standard Operating Procedures, which describe in detail the dehydration and consolidation process utilized by Corning. Pages of Exhibit CX-67 referencing document 42007 pertain to dehydration and consolidation of

Pages referencing document 42009 pertain to dehydration and consolidation of Pages referencing documents 42010 and 42011 pertain to the dehydration and consolidation of

These Standard Operating Procedures show that the chlorine flow in Corning's dehydration/consolidation furnaces does not continue throughout the entire period during which Corning's preforms undergo consolidation. The

have, however,

prior to the halting of the chlorine flow. As a general rule at the time of the lower

of the furnace -- in the range of --

while the with a temperature no lower than

(Wrisley, CX-6, paras. 12, 13; Wrisley, Tr. 334).

XV. <u>Validity of '454 Patent</u>

364. Corning's expert Professor Alfred R. Cooper joined the faculty of Case Western in 1965 as an Associate Professor of Ceramics and became a full Professor in 1968. He is currently Director of the Materials Research Laboratory at Case Western. He received a Bachelor of Science degree in Glass Technology in 1948, and thereafter worked in the glass industry. Professor Cooper received a Doctor of Science degree in Ceramics in 1960 and taught in cermanics from 1960 to 1965. (Cooper, CX-7, paras. 1, 2).

365. The '454 patent speaks of the removal of water from porous preform as occuring "simultaneously" with the formation of a dense glass layer. This means, and would have been taken to mean by those skilled in the art in or prior to April of 1974, that the removal of water occurs during the process of consolidating the preform. It does not mean that removal of water occurs during the entire consolidation process; this would be physically impossible. The interstices of the preform close prior to completion of the consolidation to a clear glass. Once the interstices have closed, the preform becomes impervious to the chlorine-containing atmosphere. Thus, removal of water cannot occur throughout the entire consolidation process. (Cooper, CX-7, para. 41).

366. The Elmer et al. patent is not directed at the removal of water from optical waveguide preforms but rather to a technique for removing residual water from "96% silica glass," which is not produced by the flame hydrolysis deposition of glass soot. Instead, "96% silica glass" is made by first preparing alkali borosilicate glasses by melting and shaping into glass articles by conventional glass-forming methods, thereafter heat treating the articles to cause a phase separation into a silica rich phase and a second phase rich in alkali oxide and boric oxide, and finally removing the second phase by an acid leaching process. (Cooper, CX-385, para. 59).

367. Respondents' expert Dr. Pedro B. Macedo received his Bachelor in Physics in 1959 and his Ph.D. in 1963. Since 1969 he has been codirector of the Vitreous State Laboratory at The Catholic University of America. In 1967, when at Catholic University, one of the major tasks Dr.Macedo worked on was the determination of the uttimate transmission of glasses for laser windows. (RPX-103A; Macedo, Tr. 2711-2713).

368. Dr. Macedo testified that it is not desirable when consolidating a glass preform to a dense glass state for use in optical waveguide fiber construction to do so in a chlorine-containing atmosphere

because one runs the r.sk of entrapping chlorine gas bubbles which would increase the scattering and absorption. He further testified that if germania is the dopant, there is a higher risk of forming volatile compounds that would adversely affect the optical properties. (Macedo RPX-103A, para. 22).

369. Inventor De Luca characterized his '454 claimed method as a process of consolidating in a chlorine-containing atmosphere so that a dehydration process takes place. This simutlaneous purification is a process which is a "continum", to a point where the soot preform longer contains open porosity, at that point there has been consolidation and dehydration ends but the soot preform is not "perhaps" completely consolidated. The rest of the process goes on to make the blank solid dense and clear glass. Dehydration and consolidation are simultaneous because they both occur in the same process but only in that part of the process where chlorine can get in and water can get out. (De Luca, Tr. 923-924).

370. The size of the preform becomes smaller as a whole during the dehydration step of the accused process for making optical waveguide fiber. (Hoshikawa, Tr. 2204).

371. During a dehydration step of the accused processes, the preform becomes more dense. (Hoshikawa, Tr. 2233).

372. After a dehydration step in the accused processes, Mr. Hoshikawa testified that the preform is in a porous state with particle boundaries and therefore that there is a "possibility" that water might be introduced into the pores. (Hoshikawa, Tr. 2204).

373. Consolidation occurs during the so-called dehydration step of the accused process. The substantial shrinkage of the preform during this step establishes by definition that consolidation has occured. (Cooper, CX-385, para. 62).

374. The fact that respondents transfer the dehydration preform from the "dehydration furnace to the consolidation furnace" with the

precaution against the rewetting of the preform being only to transfer "as quickly as possible" is evidence that the consolidation in the accused processes has progressed sufficiently during the so-called "dehydration" step to form a dense glass layer which protects the preform from introduction of water during the transfer. (Cooper, CX-7, para. 44; Hoshikawa, Tr. 2218-19).

XVIII. Infringement of '454 Patent

375. Respondents on July 24 1984 in responding to Corning's Interrogatory No. 2 which asked, for each type of optical waveguide fiber identified by respondents, the process steps waveguide identified as step 2:

> "(2) is next placed in an electric furnace having a sometimes if necessary, thereby forming a The atmosphere is

(CX-87).

376. Respondents on September 26, 1984 in a second supplemental answer to Interrogatory No. 2 identified a process step of an additional category of optical fiber as:

> (2) is next placed in an electric furnace having a thereby forming a The atmosphere is

(CX-88).

377. Deposition testimony of respondents' Mr. Hoshikawa by Corning on September 13-14, 1984 read in part:

Q (By Mr. Kulleseid) Mr. Hoshikawa, are you aware that your counsel has provided us with samples of five different kinds of optical fibers that Sumitomo has exported to the United States?

A Yes, sir.

Q I will describe each of those, as I understand it. And then I want to ask you whether each is made by the process that we have been discussing over the course of the last day or so.
The first is a fiber principally for [M-2 fiber]
Any my understanding is that that contains approximately at the peak of the gradient curve.
Is is your understanding that one of the fibers is generally of that type?

A Yes.

Q And was that made generally by the process that we have been discussing?

A Basically, yes. [in M-2 process]

Q is used at all for that fiber?

A Yes, you are correct.

Q What are the reasons that you do not need the

A Because the specification for this fiber calls for

Mr. Hoshikawa thereafter in his deposition did identify a in the M-1 process. (CX-91, pp. 37-38). (Emphasis added).

378. In direct testimony at the hearing Mr. Hoshikawa testified that the M-2 process involved Such step was omitted from the M-2 process. The described process omits any step using a as that term is used (Hoshikawa, Rx-103A, para. 3a; CX-9 (RX-1004).

379. Dr. Cooper, Corning's expert, in his direct testimony identified CX-91 as the "transcript of the deposition of Masao Hoshikawa, further describing respondents' dehydration and consolidation process." (Cooper, CX-7, para. 42).

380. Respondents produced a collection of run sheets after the close of the discovery period to Corning in support of Mr. Hoshikawa's direct testimony that the M-2 process (RX-1238).

381. An electron microprobe analysis of a sample of M-2 fiber shows the presence of from about (Tong, CX-5, paras. 1, 5-7; CX-65, p.6).

382. Mr. Hoshikawa testified that the in the M-2 fiber is because respondents use as a raw material and therefore the in

such a raw material remains after processing. He testified that the is not from any (Hoshikawa, Tr. 2015-2016).

383. Mr. Hoshikawa at the hearing was not able to explain why in the S-2 fiber, which S-2 process utilizes a in a the level is than what it appeared to be in the M-2 fiber. (Hoshikawa, Tr. 2017-2022).

384. When asked why there's in fiber M-2 as fiber S-2 when both utilize the Mr. Hoshikawa testified that "[s]ince the amounts used of for M-2 and S-2 so that might be the reason. But, I am not exactly sure about this". (Hoshikawa, Tr. 2020).

XIX. Importation and Sale

385. Respondents' optical waveguide fibers are manufactured by SEI in Yokohama, Japan. (Nakahara, RX-467, para. 18).

386. SEUSA made its first sale of optical waveguide fiber or cable in the United States in 1980. Since that time it has had calendar year sales
C of approximately (Corsello, RX-468, para. 7).

XX. Domestic Industry

A. Corning

387. Corning began research and development in the fiber optic field in approximately 1966 (Duke, RPX-21C, p. 10) and commenced production of optical waveguide fiber allegedly covered by the '915 patent in approximately October 1971 at Corning's Product Development Facility in Sullivan Park, New York. (SX-4, No. 5, p. 7).

388. Corning's first sale of fiber produced under the '915 patent
C occurred in March 1972, pursuant to a contract with
C (SX-4, No. 5, p. 7).

389. The process covered by the '454 patent was allegedly utilized by Corning during the first half of 1973. (SX-4, No. 5, p. 7).

390. In 1977, Corning established a pilot plant in Erwin, New York, at a cost in excess of $1,000,000.00. By 1977, this facility was on line, and producing fiber. (Duke, CX-323, p. 13).

391. Since January 1, 1980, Corning has produced fiber through the Telecommunications Products Department at its production facility in Wilmington, North Carolina. (SX-4, No. 3). In 1983, Corning employed over
C at the Wilmington plant and an additional at the division level. (SX-63; Balcerek, RPX-17, Exh. 3).

392. Corning reported the following figures of optical kilometer sales and revenue from 1980-1984.

	1980	1981	1982	1983	(Projected) 1984
C Km					
C $(000)					

393. Since January 1, 1980, Corning has conducted fiber research at its research laboratory in Sullivan Park, New York, which is primarily engaged in optical waveguide fiber research. (SX-4, No. 3, p. 5).

394. Since January 1980, the sale and marketing of optical fiber has taken place in Corning's offices in Corning, New York. (SX-4, No. 3, p. 5).

395. As originally designed and built, Corning's Wilmington, North
C Carolina optical facility provided a manufacturing capacity of
C kilometers of fiber with space for an eventual capacity of
kilometers per year. (SX-60).

396. Since completion of the Wilmington, North Carolina facility in
C 1979, Corning has invested approximately
C (SX-60).

397. Capacity is difficult to gauge in the optical fiber industry because it is sensitive to product mix as well as changes in rates and
C selections. A shift in product mix from single-mode to multi-mode fiber
C will (RX-164, p. 274316).

C 398. Corning is currently engaged in expansion
C program:
C
C
C
C
C (RX-164, p. 274335).

C 399.

C

C (RX-164, p. 274329).

C 400. for optical waveguide fiber in the
C United States is (RX-164, p. 274328).

401. Siecor is a joint venture in Hickory, North Carolina formed by Corning and Siemens A.G. of Munich, West Germany in 1977. (SX-48, p. 458).

C 402. Siecor

(RPX-21, Duke Dep., Exh. 10).

C 403. During 1984, Corning anticipates employing an average of
C employees at the plant level and an average of at the division level. (Balcerek, RPX-17, Exh. 3, pp. 5-1).

404. Corning develops, manufactures, markets and distributes in the United States optical waveguide fiber some of which is covered by the '915 patent and which is manufactured under the '454 patent. Most of Corning's commercial optical waveguide fiber is covered by the '915 patent and all of Corning's commercial optical waveguide fiber production is covered by the '454 patent. (Cooper, CX-7, para. 46; Complainant's Findings of Fact 261).

405. Corning commercially produces a type 1519 optical waveguide
C fiber, which comprises and a type
C 1508 optical waveguide fiber, which comprises
C Corning admits that both of these fibers are not covered by the '915 patent. (Wrisely, CX-6, paras. 7-8; CPH pp. 26-27).

406. Corning has licensed two domestic manufacturers of optical waveguide fiber -- AT&T and ITT -- under the '915 and '454 patents, and has licensed SpecTran Corporation ("SpecTran") under the '915 patent. (Duke, CX-323, para. 45, CX-96; CX-97; CX-98).

C 407. AT&T, ITT, and "SpecTran"

C

C

according to Corning. (Complainant's Reply to Proposed Findings of Fact by Respondent, RFF 56).

B. Corning's Licensees:

1. AT&T

408. AT&T is a vertically integrated producer of fiber, cable and fiber optic systems. (SX-88, para. 2(e); SX-92, p. 36) AT&T currently

C employs approximately in the manufacture of optical waveguide fiber. (SX-87, p. 11).

C 409. AT&T has a

C

C At&T's license allows it to manufacture optical waveguide fiber in the United States. (CX-97).

C 410. AT&T manufactures fiber:

C An increasing share of its production is

C attributable to (SX-87, p. 1).

C 411. AT&T sells cabled optical fiber

C

C (SX-87, pp. 1, 7)

412. AT&T's fiber and cable operations are managed by its subsidiary, AT&T Technologies (formerly Western Electric Co.) (SX-87).

C 413. AT&T has invested over

C in its fiber and cable operation. (SX-87, p. 11) Since 1981, AT&T

C has expended approximately in research and development related to fiber and cable. (SX-87, p. 10).

C 414. In 1983, AT&T made commercial sales of approximately
C fiber kilometers for a total sales revenue of approximately
(SX-87, p. 8).

C 415. AT&T anticipates that it will sell
C worth approximately in 1984, and that of the unit volume of
C cabled fiber for 1984 will be (SX-87, pp. 8-9).

416. AT&T's installed capacity for production of cabled optical
C fiber was in 1983 and in 1984. AT&T is
C producing and selling at (SX-87; SX-88;
Exh. A).

C 417. In 1985, AT&T plans
C (SX-88, Exh. A).

C 418. According to Corning, the licensor, approximately
of the optical waveguide fiber manufactured by AT&T in 1983 and 1984 had a numerical aperture of 0.25 or less and is, therefore, within the scope of the '915 patent. (CX-302; SX-90; Complainant's Findings of Fact, 263).

2. <u>ITT</u>

419. ITT is a vertically integrated producer of fiber, cable and cable systems. (SX-92 p. 36).

420. ITT received a license from Corning under the patents in issue as part of a settlement of litigation occurring in the United States District Court for the Western District of Virginia in Civil Action No. 76-0111.
C (CX-96) Under the settlement,
C
C
(CX-96).

C 421. Under its license from Corning, ITT
C
C (CX-96).

422. ITT reported the following sales figures for the last two
C years: 1982,
C (Stafford, RPX-32, Exhs. 6, p. 1619 (1982); 5,
p. 1616 (1983); RX-407. p. 1 (1984)).

C 423. ITT currently has
C
C (Moore, RPX-34, p. 90).

424. ITT purchased Valtec Corp. of West Boyleston, Massachusetts, a
C fiber-cable producer, in September 1984,
C the Electro Optical Products Division of ITT located in
Roanoke, Virginia. (Kanely, RPX-13, pp. 164-166).

425. Prior to its acquisition by ITT in September, 1984, Valtec was a producer and seller of optical waveguide fiber and cable in the United States. (Kanely, RPX-13, pp. 163-166, 171-172).

426. Before its purchase by ITT, Corning had sued Valtec in the United States District Court for the District of Massachusetts for infringement of the '915 patent, and other Corning patents. Valtec agreed on August 29, 1984 to the entry of a Final Judgment On Consent that provided that the '915 patent is valid and infringed by Valtec. The parties "compromised and settled the matter of damages." (RX-1154).

C 427. Approximately of the optical waveguide fiber
manufactured by ITT has a numerical aperture of 0.25 or less and is, therefore, within the scope of the '915 patent. (Freiburger, CX-319, pp. Tr. 27-28, 29, 56).

3. <u>SpecTran</u>

428. Corning has granted SpecTran a limited license to make, use and sell optical waveguide, fiber under the '915 patent. Under the terms of
C the license,
C (CX-98).

429. SpecTran began commercial production of fiber under its

C license from Corning in SpecTran now employs approximately

in its fiber operation. (CX-354, pp. 53, 58, 76).

C 430. SpecTran estimates that of it sales in 1984 will be of

C optical waveguide fiber. The remaining of its operations involves the

manufacture of glass capillaries. (CX-354, pp. 7-8).

C 431. Corning's license to SpecTran

C

C (Jaeger, RPX-12,

Exh. 13).

C 432. SpecTran has approached Corning about

C

C (Jaeger, RPX-12, pp. 12-17).

C 433. SpecTran but on

C occasion work for its customers. (CX-354, pp. 12-13).

C 434. SpecTran's principal customers are

C

C (CX-354, p. 90).

C 435. SpecTran manufactured approximately of fiber in

C 1983, resulting in a sales revenue of approximately (CX-354, pp.

69-70).

C 436. SpecTran's fiber sales

C (CX-354, pp. 69-70, 93).

C 437. As stated by Corning, approximately of the fiber

manufactured by SpecTran in 1984 will be single mode fiber, and thus within

the scope of the '915 patent. Of the multi-mode fiber manufactured by

C SpecTran in 1984, approximately will have a numerical aperture of

0.25 or less, and thus, will be within the scope of the '915 patent. (Jaeger,

CX-354, Tr. pp. 64-65; Complainant's Finding of Fact, 265).

4. NTL

438. Corning has licensed Northern Telecom, Ltd. ("NTL"), a Canadian corporation, to use and sell in the United States optical waveguide

C fiber under the '915 patent which

C NTL has a United States subsidiary, Northern Telecom, Inc. ("NTI") which sells in the United States optical waveguide fiber

C manufactured (Duke, CX-323, para. 45; CX-99; Belboul, CX-303, p. 15).

439. Northern Telecom, Inc., engages in marketing, distribution, and sales activities, in the United States for the U.S. market with respect to a number of products produced in Canada by Northern Telecom, Ltd., including optical waveguide fiber cable. (Belboul, RPX 15, pp. 9, 15, 17, 18).

440. Northern Telecom, Inc., does not produce optical waveguide fiber or cable in the United States. (Belboul, RPX 15 p. 17).

441. American Fiberoptics Corp. and Lightwave Technology are companies producing and selling optical waveguide fiber in the U.S. market, and are not licensed by Corning under the patents in issue nor authorized by Corning to produce or sell optical waveguide fiber in the United States. (Jaeger, RPX-12, pp. 56-62).

XXI. Efficient and Economic Operation

A. Corning

442. From 1972 to the projected end of 1984 Corning will have spent

C on research and development of optical waveguide fiber. This figure includes all expenditures for labor and amortized capital expenditure for research and development. By year, Corning's expenditure and projected expenditures are as follows:

Year	Expenditures

C

C

C

C

C

C

C

C

C

C

C

C

(Gunderson, CX-325, para. 4, Appendix A).

443. Corning devotes a substantial portion of its optical waveguide fiber manufacturing capacity to development activities. In 1983,
C approximately of that capacity was dedicated to development work,
C and Corning plans, over the next five years, to dedicate annually between
C of its commercial manufacturing capacity to such development activities. (Duke, CX-323, paras. 10, 11).

444. Corning manufactures optical waveguide fiber in a building
C constructed in the 1960's at a cost of approximately including land. Starting in 1978, that facility was converted to the manufacture of
C optical waveguide fiber at a cost of Since that
C time, Corning has invested an additional in its facilities for the research, development and manufacture of optical waveguide fiber. (Duke, CX-323, paras. 14, 15; Gould, CX-326, para. 4, Appendix A).

445. Corning employs skilled personnel who are paid competitively
and who receive extensive employee incentive benefits. Corning employs over
C in connection with the research, development, manufacture, sale and
distribution of optical waveguide fiber. The average annual compensation for
C these personnel in 1983 was approximately (Duke, CX-323, paras.
33-37; Gould, CX-326, para. 5, Appendix B).

446. Corning has a substantial and comprehensive quality assurance program to ensure the quality of its optical waveguide fiber. (CX-101; CX-102).

447. Corning's optical waveguide operations have steadily moved
C towards profitability.
C
C (Duke, CX-323, para. 31; Duke, RPX-21B,
pp. 41-42).

B. <u>ITT</u>

448. ITT manufactures optical waveguide fiber covered by the '915
C patent in facilities acquired in Since 1978, ITT has invested
C in machinery and equipment for the research, development
C and manufacture of optical waveguide fiber. ITT uses
C
(Freiburger, CX-319, pp. 25-26, 42-43; Stafford, CX-317, pp. 7-8, 10-20,
23-24; CX-356).

C 449. IT employs more than in the research, development
and manufacture of optical waveguide fiber. Many of these employees are
highly skilled. (Freiburger, CX-319, pp. 45-47; CX-253, 003444; CX-254,
003266; CX-255, 003300; CX-256, 003375).

450. ITT has a quality assurance program to ensure the quality of its products. (Freiburger, CX-319, pp. 47-48).

451. ITT has made and continues to make investments in research and development to improve its optical waveguide fiber and the method by which that fiber is manufactured. Since 1978, ITT has spent, without including

C capital investment, on such research and development activities. (CX-356).

C 452. Currently ITT has production capacity to produce

C of fiber per year. (Moore, RPX-34, pp. 45-46).

C 453. ITT plans

C

C

C (Moore, RPX-34, pp. 41-42).

C 454. ITT expended

C

(Moore, RPX-34, pp. 41-42).

C. AT&T

C 455. AT&T has invested exclusive of land and buildings, in facilities and equipment used to manufacture optical

C waveguide fiber, AT&T's fiber

C manufacturing facilities are (SX-87, p. 10; FF 413, 418).

C 456. AT&T employs approximately in the manufacture of optical waveguide fiber. (SX-87, p. 11).

457. AT&T has an extensive quality assurance program to ensure the quality of its optical waveguide fiber. (SX-87, p. 11).

C 458. AT&T has invested over in research and development activities with respect to optical waveguide fiber. (SX-87, p. 10).

D. SpecTran

C 459. SpecTran employs approximately in research and development, manufacturing operations, marketing, administrative, management

C and support services. This represents

C (Jaeger, CX-354, pp. 50, 57-62, 91).

460. SpecTran has an extensive quality assurance program to ensure the quality of its products. (Jaeger, CX-354, pp. 62-64).

C 461. SpecTran has

C

C (Jaeger, CX-354, p. 93).

C 462. SpecTran has invested in fiber manufacturing equipment for its Sturbridge, Massachusetts plant (CX-354 pp. 53, 58, 76) and will spend

C in 1984 on research and development for its fiber products. (CX-354, pp. 53, 58, 76).

C 463. Currently, SpecTran

C

C (Jaeger, RPX-12, pp. 12-29).

XXII. INJURY

A. Substantial Injury

464. Optical waveguide fiber is used in the United States primarily in telecommunications applications. Other common uses include data and computer communication, cable television and secure government and military applications. (Charleton, CX-324, para. 5; CX-133; Markham, Tr. 1580-81).

465. The largest single market for cabled optical waveguide fiber in the United States is the telecommunications market. This market accounts for approximately   percent of all cabled optical waveguide fiber sold in the United States. (Corsello, Tr. 2619-20).

466. Corning markets three types of optical waveguide fiber. They are single mode fiber (SMF), multi-mode fiber (MMF) and short distance fiber (SDF). Corning's SMF is used primarily for long distance telecommunications. MMF is available to meet a wide variety of physical specifications and satisfies a similarly wide variety of applications, including, for example, long distance telecommunications, computer interconnects, interbuilding communications and cable television. SDF is a specific type of multi-mode fiber, and is used primarily as computer interconnects. It is designed to be used over relatively short spans and can operate with less costly light sources. (Duke, CX-323, para. 7).

467. The United States fiber market is dominated by several large producers, the largest being Corning, Western Electric Co. (now AT&T Techologies), ITT (including the former Valtec facilities), and Northern Telecom, Inc. (which imports cable into the United States from Canada). (SX-92, pp. 36-37).

468. Before : is used in the above applicat__ıs, optical waveguide fiber must be made into cables. Corning sells fiber to companies who make that fiber into cable suitable for use in these applications. Corning itself does not cable fiber. (Duke, CX-323, para. 26; CX-103, pp. 274327-28).

469. The major cablers of optical waveguide fiber in the United States are AT&T, Siecor Corporation (Siecor), General Cable Company (General Cable), Ericsson, Inc. (Ericcson), formerly Anaconda Ericsson, Inc. and ITT. These cablers, together with NTL, supply most of the cable containing optical waveguide fiber sold in this country. (Duke, CX-323, para. 46).

470. AT&T and ITT, Corning licensees, are vertically integrated companies which manufacture optical waveguide fiber and cable. AT&T also cables optical waveguide fiber X-302; Jamroz, CX-304, pp. 18-22; Freiburger, CX-319, pp. 71-72).

471. SpecTran, also a Corning licensee, manufactures optical waveguide fiber which it sells to cablers. SpecTran

(Jaeger, CX-354, pp. 12-13, 90).

472. The three major cable manufacturers -- other than AT&T and ITT -- in the United States are Siecor, General Cable and Ericsson.

They do not themselves manufacture fiber. (Duke, CX-323, para. 46; CX-347; CX-103, pp. 274327-28; Day, CX-315, p. 6; CX-223, p. 521337; Corsello, CX-363, pp. 104, 118-19).

473. Respondents compete with Corning for the sale of optical waveguide fiber to customers who cable that fiber. (Duke, 1357-58; RX-365; CX-307, 795-96; CX-193; CX-194; CX-195).

474. The telecommunications cable market is divided into three market segments: the former Bell operating companies (BOC); the independent telephone companies; and the specialized common carriers. (Bhatia, RPX-1, Exh. 60).

475. In 198 was the largest supplie f the BOC market, followed by

(Bhatia, RPX-1, Exh. 60, p. 11195).

476. The independent telephone market consists of firms such as Continental Telephone, United Telephone, and other smaller independents. (Bhatia, RPX-1, Exh. 60, p. 11193).

477. In 1984, was the largest supplier to the independent telephone market, followed by

(Bhatia, RPX-1, Exh. 60, p. 11193).

478. The specialized common carrier market consists of firms such as MCI, GTE Sprint, Microtell, and Western Union. (Bhatia, RPX-1, Exh. 60, p. 11195).

479. The largest supplier of optical cable to the specialized common carrier market is

(Bhatia, RPX-1, Exh. 60, p. 11195).

480. In Seicor's it is estimated that the largest competitors in the United States telecommunications market are

(Bhatia, RPX-1, Exh. 60, pp. 00011189, 11192).

481. Corning's

(RX-414, p. P400005).

482. The fo wing figures show the quantity and price realized for U.S. sales by Corning of optical waveguide fibers for the years 1980-1983:

	1980	1981	1982	1983
Km				
$(mil)				

(RX-414, p. 400005, RX-469, p. 33, Tables 2 and 4; RX-164, p. 274345).

483. Corning estimates its 1984 sales of fiber to be kilometers at a (RX-175, p. 6).

484. Corning estimates its market share at in 1980, in 1981, in 1982, in 1983 and for 1984. (RX-414, p. 400005; RX-469, Table 2).

485. In 1983, AT&T sold approximately kilometers worth IN 1984, AT&T estimates it will sell approximately fiber valued at (SX-87, para. 2K).

486. In 1983, ITT had sales of In 1984, ITT estimates it will have sales of (Stafford, RPX-32, Exh. 5, p. 001616; RX-407, p. 1).

487. SpecTran manufactured kilometers of fiber in 1983, resulting in a sales revenue of (Jaeger, CX-354, p. 69-70).

488. In 1984, SpecTran estimates that it will manufacture kilometers of fiber resulting in total sales worth percent of SpecTran's fiber production in 1984 will be (Jaeger, CX-354, p. 70).

489. SEI/SEUSA made its first optical fiber and/or cable sale in the United States in Since that time, it has had calendar year sales of approximately:

YEAR	_.ber-km's	$ (000)

(Corsello, RX-468, p. 5).

490. Since 1980, respondents share of the U.S. market for optical waveguide fiber has been less than (Corsello, RX-468, p. 6; Bhatia, RPX-1, Exh. 60, pp. 00011192 - 00011195; Corsello, Tr. 2376; Nomura, RX-466, para. 6).

491. Based on Corning's market model of the total U.S. market for optical waveguide fiber of kilometers, respondents in 1981 had a market share of approximately of the total U.S. market, with its sales of approximately of optical waveguide fiber and cable in the U.S. market. In 1982, based on Corning's market model of the total U.S. market for optical waveguide fiber of kilometers, and respondents' sales in that market of approximately respondents had a market share of approximately In 1983, based on Corning's market model of the U.S. market of kilometers and respondents' approximation of its total sales in the U.S. market of respondents had a market share in the U.S. market of approximately In 1984, based on Corning's estimate of a total U.S. market for optical waveguide fiber of and respondents' estimate of its total sales in the U.S. market of approximately

SEI/SEUSA would have a market share of approximately of the U.S. market. (RX-414, p. P400005; Corsello, RX-468, p. 5).

492. The to _. U.S. market between 1980 and _,4 has been estimated by Corning at fiber kilometers of optical waveguide fiber. During the same period, respondents' total sales of imported optical waveguide fiber in the U.S. market (including estimated 1984 sales) has been estimated at

or approximately of the total U.S. market. (RX-414, p. 400005; Corsello, RX-468, p. 5).

493. Between 1979 and 1983, the total U.S. market for optical waveguide fiber increased from

according to estimates by Corning. (RX-414, p. 400005; Martin, RX-469, p. 13 and Table 2). During that same period, respondents sales of optical waveguide fiber in the United States rose from in 1979 to sales of fiber kilometers in 1983. (Corsello, RX-468, p. 5). Thus, the increase in the total U.S, market was more than the increase in the amount of sales of imported optical waveguide fiber by respondents during that period.

494. From 1982 to 1983, the total market is estimated to have risen by some 226,000 fiber kilometers, a gain that was about larger than the increase in respondents' imports from Japan in the same period. At the same time, Corning's sales were

(RX-414, p. P400005; RX-469, p. 13; Corsello, RX-468, p. 5) From 1983 to 1984, the total U.S. market for optical waveguide fiber is expected to increase by 349,000 fiber kilometers (from 583,000 fiber kilometers to 932,000 fiber kilometers). During this period, respondents' sales of imported optical waveguide fiber is expected to increase by fiber kilometers. Thus, the U.S. market increase will be times the amount of respondents' sales increase. (RX-469, pp. 16, 17 and Table 2; Corello, RX-468, p. 5).

495. On Aug c 21, 1984, Siecor estimated re ondents' U.S. market share for optical waveguide fiber cable at approximately of the market. This compared with Siecor's estimation of U.S. market shares for Siecor itself of AT&T Technologies of Valtec of Northern Telecom of Ericsson of General Cable of ITT of and Pirelli of (Bhatia, RPX-1, pp. 534-536 and Exh. #60 to RPX-1, p. 11192.)

496. Corning has indicated that due to America's penchant to communicate, the economic prove-in of optical waveguide technology, and the AT&T divestiture of March, 1982 the manufacturers of optical waveguide systems, cables and fiber have been faced with an exploding market and a "... tremendous appetite for optical waveguides has been fostered and

(RX-164, p. 274319; RX-469, p. 25; RX-190, p. 261482).

497. The major market and the major factor in demand for optical waveguide fiber and cable has been the domestic telephone and telegraph service industry. This industry has enjoyed a growth rate of per annum in costs and dollars and it is expected that revenues will continue to rise at per year over the next 5 years. Since 1982, the U.S. market for optical waveguide fiber has grown in the area of annually. (RPX-469, pp. 8-9; Charlton, RPX-20, p. 35).

498. Corning has indicated that by 1990, it expects the value of products for optical communications systems in the United States to reach the level. It also stated that most of today's sales are long distance and local telephone exchange systems but markets are emerging for data transmission, private telephone exchanges and cable television systems. It also indicated that another growing market is in local area networks which link users at different facilities and which offer combinations of services over the same transmission lines. (RX-469, p. 14; RX-290, p. 2).

499. From 1 4 to 1985, the U.S. market for ber is expected to increase by almost Though longer range forecasts depend upon a number of variables for their accuracy, it is projected that the market will in size from 1985 to 1988 with a forecasted total sales of fiber kilometers. (RX-469, pp. 13-14).

500. In the telecommunications, cable television, data processing, industrial electronics, and government/military segments of the optical waveguide fiber and cable market, Gnostic Concepts is anticipating increasing demand over the next several years. (RX-469, p. 12).

501. Many information and service providers such as financial institutions, publishers, retailers, news institutions and many others are actively engaged in the development of systems for data and information transmissions which may further augment demand for high speed transmission, high performance equipment and apparatus, including optical waveguide fibers. Today's expansion of light waveguide systems plus the introduction of new package switching of local route carriers and video conference networks may also contribute to the demand for telecommunications services involving optical waveguide fibers in the future. (RX-469, p. 9, 10).

502. Corning has invested in expansion of its waveguide facility as follows:

YEARS	INVESTMENT

(SX-60; SX-4, p. 20).

503. On July 24,1984, Corning announced that it would commit $87 million to a major expansion of manufacturing capacity for optical waveguide fibers. Corning indicated that the company will construct a manufacturing facility

adjacent to the Wilmir__on plant, increasing employment y 300 persons. Fiber from the expansion would be available in the first half of 1985, and bring Corning's total waveguide capacity to over 1 million fiber kilometers per year in 1986. (RX-290, pp. 1, 2).

504. Corning's 1984 capacity is kilometers and in 1985 Corning will have capacity of kilometers. (Duke, Tr. 1398).

505. AT&T

(SX-88, paras. 2(d),2(e); SX-90, para. 2(e)).

506. ITT intends

(Frieburger, CX-319, p. 69-70, see Moore, RPX-34B, pp. 51-52).

507. Northern Telecom has a capacity

(Belboul, RPX-15, pp. 45-46).

508. The demand for fiber by cablers does not always represent an accurate reflection of need. For example, where a number of different cable companies may bid for a particular optical waveguide fiber cable job, the cable companies bidding on the job may attempt to secure a commitment for fiber from more than one fiber supplier for that job. However, once a job is awarded, the companies that bid unsuccessfully will no longer need the fiber which they requested for that specific installation. Also, it is a common practice for customers to order optical waveguide fiber, and then cancel their orders. This has happened to Corning numerous times over the last four or five years. (Duke, CX-323, para. 27; Duke, Tr. 1351-1354, 1373-74, 1377-78, 1403, 1431-32).

509. Peter ding of Corning testified tha every year for the last four years",

(Radding, CX-394, p. 361).

510. Optical Fibers is a joint venture in England, owned by Corning and BICC limited.

Corning wants to be certain that it can serve the market and get some upside potential. (Duke, Tr. 1424; Duke, RPX-21c, p. 97, 98).

511. Corning

(Duke, RPX-21c, p. 100; Radding, RPX-29A, p. 97).

512. Corning will be able to

.

(Duke, RPX-21C, p. 99).

513. Corning has in order to meet short term needs of customers. (Radding, RPX-29A, p. 94).

514. In 1981 Corning

(RX-36, p. P259222; RX-147, p. P259580).

515. In 1982, Corning

(RX-23, p. P262558; Balcerek, RPX-17C, p. 15).

516. On August 19, 1982,

(RX-323, pp. 2, 7-8).

Date	Amount (Meters)	Cite
		RX 323, p. 14
		RX 324, p. 3
		RX 325, p. 3
		RX 330, p. 2
		RX 329, p. 2

517.

(Balcerek, RPX-17C, pp. 15-16, 24, Exh. 16 pp. 2-3; Radding, RPX-29A, p. 97).

518. In Period 5, 1980, Corning was producing

(RX-65).

519. In 1981,

(RX-78) During 1981, there was a period of time where Corning

(Charlton, RPX-20C, p. 23).

520. In Period 9, 1982, Corning reported

(RX-27 p. 262475) In 1982, Corning

(R. 77, p. 6) From

Period 13, 1982 to Period 3, 1983, Corning reported

(RPX 20, 21, 22 and 24). As of August 1983, Corning's

(RX 212, p. P257857).

521.

(Balcerek,

RPX-17B, pp. 206-207).

522. In order to meet customer specifications when some types of fiber are in short supply, Corning has a policy to ship fiber of higher specifications. (RX-199, p. P256691).

523. Around the time period of May 1984,

(Dulude, RPX-22B, p. 23).

524.

(Duke, RPX-12, pp. 180-181).

525.

(Kanely, RPX-12, pp. 55-57).

(Kanely, RPX-13, pp. 59-60).

526. SpecTran

(Jaeger, RPX-12, pp. 179-180).

527. ITT

(Nakahara, 2413-2414).

528. Corning's open order balance (the amount of orders actually placed on the books but not yet shipped)

	1980	1981	1982	1983	Through period 8, 1984
KM					
$					

(RX-49; RX-23, p. P262558; RX-2; RX-10, p. P262009; RX-36, pp. P259227-8).

529. Corning is presently

(Duke, 1333; Duke, RPX-21A, p. 90).

530.

(RX-4, p. 4).

(RX-2; Duke, RPX--1C, p. 131; Balcerek, RPX-17B pp. 228-229; Gould, RPX-24A, p. 101-103).

(I.; Gould, RPX-24B, p. 42).

531. Cornir___3 head of delivery scheduling, ___. Balcerek, estimated that if an order had been placed in September 1984, for the purchase of 5,000 kilometers of multi-mode fiber, it could

(Balcerek, RPX-17A, pp. 124-126).

532. Corning expected, in Period 9, 1984,

(Gould, RPX 24B, p.

42)

(RX-1, p. 3).

533. In Period 8, 1984,

(Gould, RPX-24A, pp. 117-118).

534. As of May 1984,

.

(RX-164, p. P274313).

(Duke, RPX-21A, pp. 19-21).

(Duke, 1380-1381).

535.

(Balcerek, RPX-17A,

pp. 166-168).

(Balcerek, RPX-17B, p. 232).

536. Cornir_ prepares

(RX-179, p. P255400; RX-181, p. 5; RX-182, p. 6; RPX-183, p. 4; RX-184, p. 7; RX-185, p. 5).

537.

(RX-184, p. 7).

538.

(RX- 183, p. 4).

539. In December of 1983 Siecor in 1984 and possibly as much as (RX-271). As of March 28, 1984, Siecor was projecting that its total in 1984 would total kilometers of single mode fiber. (RX-247).

540. In a memorandum dated June 1, 1984, Mr. Dennis J. Shea, Siecor's manager of purchasing and planning, indicated that Siecor had been

(Shirley, RPX-3, pp. 90-91; Exh. #6 to RPX-3, p. 11709).

Siecor Corp. was expe ncing They were also faced with the possibility of (Shirley, RPX-3, pp. 97-104; Exh. #4 to RPX-3).

541. In July of 1984, (Wakeman, RPX-7, pp. 19-23). (Wakeman, RX-258; pp. 19-23). (Wakeman, RPX-7, pp. 19-23, 59-60).

542. Siecor (Wakeman, RPX-7, p. 24).

543. Charles Wakeman is the Vice President and General Manager of Siecor. He understands that Siecor's demand for (Wakeman, RPX-7, pp. 11-13).

544. Siecor (Wakeman, RPX- 7, pp. 60-61).

545. SpecTr believes

(Jaeger, RPX-12, pp. 94, 95). SpecTran believes

(Jaeger, RPX -2, pp. 40-41 and Exh. 5).

546. SpecTran Corporation is predicting in the second half of 1984 that its total sales will equal fiber kilometers of optical waveguide fiber. However, it is projecting that through use of its

(Jaeger, RPX-12, pp. 18-23; Exh. 3 to RPX-12 at p. 000358).

547. ITT's director of purchasing indicated

(Morris, RPX-31, pp. 25-26, 38). ITT expects

(Morris, RPX-31, p. 27). ITT, as of August 1984,

(Morris, RPX-31, p. 24).

(Morris, RPX-31, pp. 24-25).

548. Northe Telecom

(Belboul, RPX-15, pp. 98-99). Northern Telecom estimates the U.S. market from mid-1984 to mid-1985 to be

kilometers of optical waveguide cable. Further, Northern Telecom is estimating that there will be approximately

kilometers of optical waveguide fiber available to service the U.S. market in mid-1984 to mid-1985. (Belboul, RPX-15, pp. 141-144). Northern Telecom believes that demand in the U.S. market for optical waveguide fiber at present is (Belboul, RPX-15, pp. 39-41).

549. Northern Telecom Inc. has indicated that

(Belboul, RPX-15, pp. 138-139).

550. Valtec anticipates it would be able to sell

(Kanely, RPX-13, p. 54). Valtec Corporation believes that U.S. producers of optical waveguide fiber cable

(Kanely, RPX-13, p. 107).

551.

(RX-164; Radding, RPX-29A, pp. 143-149).

552.

(Balcerek, RPX-17A, pp. 166-168; Balcerek, 17B, p. 232).

553. In a memo dated June 1, 1984 to Corning from D. J. Shea, Supervisor of Production Planning, Seicor Optical Cable (Seicor) the following comment is made:

(Shirley, RPX 3, Exh. 6).

554. In a memo dated June 19, 1984 from Charles Shirley, Supervisor of Purchasing, Seicor, it is stated:

(Shirley, RPX 3, Exh. 8).

555. David Day, Manager of Cable Manufacturing and Development for Optical Cable, Seicor, indicated that

(Day, CX-315, pp. 46-48).

556. Cablers have told SEUSA that they have been

by Corning for 1984 and 1985. In addition, end-users are coming to SEUSA,

(Corsello, Tr. 2412-2415, 2418-2420; RX-468, pp. 2-3).

557. Genera :able and Phalo Corporation hav said

Times Fiber has also stated

(Corsello, Tr. 2420).

558. Recently, Northern Telecom Inc. ("NTI") determined that

(Belboul, RPX-15, pp. 39-41, 137-40).

559. NTI believes that

(Belboul, RPX-15, pp. 40-41).

560. ITT

(Morris, RPX-31, pp. 12, 13, 22, 23).

561. SpecTran claims that

(Jaeger, RPX-12, pp. 15, 171).

562. SpecTran's license from Corning

(CX-98).

563. Respondents made a sale of optical waveguide fiber cable on

(CX-163; CX-290).

564.

(CX-290; CX-353).

565.

(CX-290; CX-353, p. 2).

566.

(CX-171; CX-291; Shindo, CX-307, pp. 257-259).

567.

(CX-291).

568.

(CX-173; CX-291, pp. 506245-46; Shindo, CX-307, pp. 268-75,286-89; CX-174; CX-292; Brouhard, CX-313, pp. 37-38).

569.

(CX-296; CX-176; Shindo, CX-307, p. 293).

570.

(CX-296 p. 00003974).

571.

(CX-289; CX-162; Shindo, CX-307, pp. 218-19; CX-347).

572.

(Corsello, RX-468, para. 5).

573.

(Corsello, RX-468, para. 5).

574. Prior to September, 1984, when Valtec was acquired by ITT, it

(Kanely, RPX-13, pp. 165-166; Complaint, pp. 16, 26, 27).

575. Unlice ed U.S. manufacturers of optica waveguide fiber selling in the United States, include

(Jaeger, RPX-12, pp. 56-61).

576.

(Jaeger, RPX-12, pp. 56-61).

577. Northern Telecom, Inc.,

sells and markets in the United States the fiber optic products that are manufactured in Canada (Belboul, RPX-15, p. 18).

578. In 1983, Northern Telecom sold approximately fiber kilometers of optical waveguide fiber cables in the U.S. market, and estimates that such sales will total approximately fiber kilometers in 1984. Northern Telecom sold

(Corsello, RX-468 para. 7).

579. Complainant's own domestic licensees and some of the cablers who sell Corning fiber indicate that t

(SX-87, paras. 14, 15; SX-2 pp. 40-48; Jaeger SX-89 pp. 88-90; RX-435, p. 3, RX-437 p. 3).

580. At present, SEI/SEUSA

(corsello, Tr. 2418, 2633-2634).

581. SX-35 is

(Charlton, Tr. 1204-1207, 1213)

(SX-35; Charlton, Tr. 1216)

(Charlton, Tr. 1213; SX-35).

582. For advertising and promotion in the United States, SEI/SEUSA spent

.

(Corsello, CX-363, pp. 65-68, 84, 130-31).

583. SEUSA's expenses incurred with respect to of its optical waveguide fiber activities

(Nomura, Tr. 2939-41, 2970; CX-242; CX-249).

584.

(Nomura, CX-306, pp. 122-123, 140-142; CX-155).

585. SOCA is a consortium trading company with nine sales offices across the United States. (Nomura CX-306, pp. 122-123, 140-142; CX-155).

586.

(Nomura, CX-306, pp. 142-144; CX-158).

587. Respondents' sales and marketing efforts are directed from SEUSA's New York and Los Angeles offices. (Nomura, CX-306, pp. 122-123, 140-142; CX-155).

588. Currently, SEUSA has employees selling fiber and cable from its New York and Los Angeles offices. Also,

(Corsello, Tr. 2399-2404; Corsello, RX-468, ,p. 11).

589. In an effort to obtain customers, respondents have provided demonstrations and presentations of fiber to potential customers and lent fiber to potential customers. (Shindo, CX-307, pp. 603-05).

590. Although respondents do not provide a complete "turnkey" sales service, they do make and sell their splicing equipment and provide installation services and training in connection with fiber and cable sales. (Corsello, Tr. 2395).

591. A memorandum from Beverly McClave of Siecor to C.B. Wakeman, date May 4, 1983, discusses the activity of Japanese fiber optic manufacturers in the U.S. market. The memo states that:

The memo also states that, to date:

(Bhatia, RPX-1, Exh. 6).

592. Respo.. nts' Bhatia Exh. 26 sets forth ..

(Bhatia, RPX-1, Exh. 26).

593. With respect to the calendar years 1983 and 1984, Siecor made over quotations in response to requests for quotations (RFQ's), about

(Bhatia, RPX-1, pp. 59-60, 66-68, Exhs. 3, 4). For calendar year 1982, Seicor made

(Bhatia, RPX-1, pp. 317-321, Exh. 37).

594. Valtec has made quotations a year for 1983 and 1984 with respect to optical waveguide fiber cable in response to RQF's in the U.S. market. (Hutton, RPX-14, pp. 15-18).

595. Northern Telecom has made quotations with respect to optical waveguide fiber cable in the U.S. market on occasions in the years 1982, 1983 and 1984. (Belboul, RPX-15, pp. 111-117, Exh. 1).

596. SESUA has responded to approximately RFQs involving in whole, or in part, optical waveguide fiber or cable in 1982, such requests in 1983, and in 1984 through mid-October.

597. The U.S. customs duty applied to respondents' optical waveguide fibers is a factor in making respondents' sale prices for its optical waveguide fiber and cable in the U.S. market prices of U.S. producers and sellers of such products. (Nomura, RX-466, 25; CX-381, p. APP. III A-68; Martin Tr. 3014).

598. In add ion to import duties, there are ded costs to importing optical waveguide fiber or cable into the U.S. market not experienced by U.S. producers, such as international freight and shipping charges, insurance on such freight and shipping, brokerage fees, export packing expenses and other costs associated with importation and exportation. These costs, other than duties, have added to the costs of respondents' imported fiber and cable and are a factor in respondents' prices of such products in the U.S. market. (Nakahara RX-467, para. 25).

599. Some end-users of optical waveguide fiber or cable in the U.S. market

(Nomura, RX-466, para. 6, sub-para. B; RX-337; RX-334, para. 1, p. 523671).

600. In 1982, after the Western Electric Co. almost lost the Northeast Corridor Project to Fujitsu, AT&T's Long Lines and most of its Bell Operating Companies, included in all of their optical transmission system RFQs a clause stating that components such as optical fibers, light sources and the connectors must be manufactured in the United States, and that final assembly of the optical cable must take place in the United States. (Corsello, RX-468, para. 11; RX-419; RX-422; RX-423.)

(Corsello, RX-468, para. 11).

601. One of .e reasons SEI/SESUA

(Corsello, Tr. 2414-2415).

602. Some of respondents' sales in the U.S. market of optical waveguide fiber or cable are of unique application products which are not available in the U.S. market. (Corsello, RX-468, paras. 5, 8.) Respondents supply OPGW cable to the U.S. market, which currently has no domestically manufactured competition.

(Corsello, Tr. 2594).

603. Respondents have also supplied to

(Corsello, RX-468, para. 8).

604. The total U.S. market between 1980 and 1984 has been estimated by Corning at kilometers of optical waveguide fiber. During this same period, respondents' total sales of imported optical waveguide fiber in the U.S. market, rounded off to the next highest thousand, totalled Thus, for this entire 5-year period, Respondents total sales have represented a U.S. market share of approximately (RX 414, p. P400005; Martin, RX-469, Table 2; Corsello, RX-468, para. 7).

605. If expressed as a percentage change in sales volume since 1982, SEI/ SEUSA's sales of fiber and cable in the United States have

(Martin, Tr. 2987-2988, 3058-3059; RX-469, pp. 12-13).

606. SEI/SEUSA's

(Nomura, RX-466, para. 6).

607. Respondents' prices have played a part in forcing down prices for all Corning's optical waveguide fiber. (Charlton, CX-324, para. 11; Duke RPX-21B, pp. 64-75; Duke Tr., 1363-64).

SEUSA's Corsello stated:

> It is difficult to know with certainty what the prices of other bidders have been because they are usually not made public. However, it is often possible to get some sense of relative price based on industry publications and discussions with purchasers and with other members of the trade. (Cosello, RX-468, para. 12).

608. In 1982, bid on a project for Pacific Northwest Bell for a route between Portland and Vancouver. Seicor

(Charlton, Tr. 657; Charlton, CX-324, para. 12; CX-137; CX-138).

609. Mr. Charlton of Corning changed Corning's prices for second window fiber in February, 1983. (Charlton, Tr. 696) The pricing process which culminated in Corning's 1983 second window fiber price reduction lasted for several months. There was no one day when the decision was made to change the prices of second window fiber. (Charlton, Tr. 696) At the time of the second window fiber price change, Mr. Charlton considered all of the factors which he normally looks at in making pricing recommendations. (Charlton, RPX-20A, p. 75).

610. The w ings which Mr. Charlton had be' e him when he prepared his recommendations regarding second window fiber pricing for 1983 did not discuss the Pacific Northwest Bell project. (Charlton, Tr. 722-723, 1247; RX-276).

611. Mr. Charlton stated that he knew of no SEI/SEUSA bids and had no knowledge of SEI/SEUSA's pricing prior to the bid. (Charlton, Tr. 676, 697).

612. It is unlikely that an isolated bid in one market or for one project by respondents would result in massive across-the-board price reductions by domestic producers for fiber and cable products nationwide. (Martin, Tr. 3061-3062).

613. With respect to the request for quotation

(RX-536, pp. 1, 2).

614. With respect to request for quotation

(RPX-536, p. 3, paras. 10, 11 and 12).

615. General Telephone Co., of the Northwest issued a request for quotation for the purchase of optical waveguide fiber cable for the Northern Area fiber optical system.

Bidding Company	Total Price

(RX-529).

616. GT of t Northwest also issued quotatic number 560 for the purchase of 57.9 kilometers of cable. In response to the quotation, GT of the Northwest received the following bids:

(RX-529).

617. Respondents, in late 1983, quoted single mode fiber at a price

(RX-359; RX-360).

618. With respect to an offer to supply

(Corsello, CX-363, pp. 44, 45.)

(RX 416).

619. Corning has taken

into consideration when setting its prices.

(Charlton, RPX-20A, pp. 47-48, 52, 55; Radding, RPX-29B, pp. 101-25, 203-207, Charlton, Tr. 584).

620. Corning has lowered its prices in the past

(Charlton, RPX-20C, p. 178).

621. Corning has pursued a policy of

(RX-469 p. 30).

622. Valtec's pricing policy was

(Kanely, RPX-13, p. 92).

623. In setting its prices,

(Kanely, RPX-13, pp. 94-95).

624. Valtec s

(Bhatia, RPX-1, pp. 437-38, 499).

625. During the 20-month period from October 1981 to June 1983, and in particular during the period coinciding with the shift from multimode to single mode fiber,

(Bhatia RPX-1, pp. 487, 490).

626. In 1980, 1981, and parts of 1982, Valtec had a consistent policy of

(Charlton, Tr. 1231-32).

627. At present,

(Radding, RPX-29B, pp. 184-185; Belboul, RPX-15 p. 103).

628. AT&T has been

(Charlton, RPX-20A, p. 48).

629. Various cable customers of Corning

(Charlton, RPX-20A, p. 48).

630. AT&T was

(Charlton, RPX-20A, p. 49).

631. Mr. Belboul of NTI testified that

(Belboul, RPX-15, p. 103).

632.

(Bhatia, RPX-1, pp. 488, 490).

633. Cornin as been asked by several custo...s including (Radding, RPX-29A, pp. 102-04; Charlton, RPX-20A, p. 40).

634. The Eastern Corridor was the first large scale long distance telecommunications application for fiber optics. The request for bids for this project in 1982

(Charlton, RPX-20A, pp. 40, 96).

635. Mr. Charlton recalled an instance which occurred after the Eartern Corridor project in which

(Charlton, RPX-20A, p. 47).

636. Northern Telecom Inc. ("NTI") is a United States subsidiary of Northern Telecom, Ltd. (Belboul, RPX-15, p. 17), a Canadian corporation licensed by Corning under a Canadian counterpart of the '915 patent. (Belboul, RPX-15, pp. 15-17) Norther Telecom, Ltd. ("NTL") manufacturers fiber in Canada, under a license from Corning (CX-323, p. 45), which

(Duke, Tr. 1411).

637. Mr. Radding of Corning testified that there have been instances where

(Radding, RPX-29B, p. 211).

638. Corning has received complaints from various customers regarding the (Radding, RPX-29B, p. 212).

639. Mr. Kanely of Valtec characterized

(Kanely, RPX-13, p. 180).

640. Mr. Bh .a of Siecor is certain that

(Bhatia, RPX-1, p. 461).

641. Competition from NTI has caused

(Bhatia, RPX-1, p. 438).

642. Respondents have underbid domestic suppliers in a number of instances and as a result have caused domestic suppliers to reduce their prices in order to meet the competition posed by respondents. In July, 1982, Siecor submitted a quotation to

After submitting the quotation Siecor was informed by that Sumitomo had submitted a lower price, and was given the opportunity to match that price. In response, Siecor revised its bid to a reductin of $23,000, to match respondents' bid. After reducing its price, Siecor was awarded the contract. (CX-288, p. 00011081; Ryan CX-314, pp. 25-28, 31).

643.

(Bhatia, RPX-1, p. 489).

644. Siecor considers its largest competitors to be

(Bhatia, RPX-1, p. 419).

645. Siecor has, on occasion,

(Bhatia, RPX-1, pp. 500-501)

646. Mr. Kanely of Valtec characterized

(Kanely, RPX-13, p. 181).

647. Mr. Kanely of Valtec testified that Valtec considered

(Kanely, RPX-13, p. 178-179).

648. There are also unlicensed and allegedly infringing producers of fiber including

who may be affecting prices. (Jaeger, RPX-12, pp. 56-61).

649. AT&T i. .ot aware of any instance where

(SX-87, para. 15.)

(SX-2, p. 74).

650. General Cable stated that it

(RX-435, para. b, p. 3).

651. When considering competition, Valtec

(Hutton, RPX-14, p. 87).

652. Northern Telecom Inc. has stated that it has

(Belboul, RPX-15, p. 209).

653. ITT is aware of no instances in which

(Moore, CX-311, vol. 1, p. 32.)

(Moore, CX-311, vol. 1, pp. 26, 31-32.)

(Moore, CX-311, vol. 1, p. 29).

654. Corning's 1982 second window fiber price list was effective from March 1982 to February 1983. (Charlton, RPX-20B, p. 172.) Effective March 1, 1983, Corning announced a price cut applicable to all its fibers, including second window multimode. (RX-21, p. P262241).

655. In dec: ng on the price changes in 198 or the 1983 period, Corning took into consideration

(Radding, RPX-29B, p. 209; Charlton, RPX-20A, pp. 75, 78; Duke, RPX-21C, pp. 122-123; Duke, Tr. 1362-3; Charlton, Tr. 783).

656. Mr. Charlton testified that he considers in making pricing recommendations:

(Charlton, RPX-20A, p. 31).

657. Corning has invested heavily in research and development and this has helped to bring down costs. (Radding, RPX-29A, pp. 92-93).

658. Corning has

(Radding, RPX-29A, pp. 92-93) Corning has been able to pass on its increased savings to its customers. (Radding, RPX-29A, pp. 92-93).

659. In 1981, Corning produced of fiber with an actual manufacturing cost of (CX 148, pp. P259588, P259591) yielding an actual manufacturing cost of per meter of fiber. In 1983, Corning produced a total of of fiber (CX 150, p. P261703) with an actual manufacturing cost of (CX 105, p. P261706) yielding an actual manufacturing cost of per meter. Corning's total manufacturing cost per kilometer

(RX-279, p. 6).

660. Corning's sales volume has risen without interruption from kilometers in 1979 to an kilometers in 1984. Notwithstanding a decrease in the average selling price per meter during the same period, Corning's sales revenues rose

(RX-469, p. 33; RX-164, p. 274345).

661. Studi by Gnostic Concepts, Inc. indi e

3. (RX-469 p. 32).

662. According to AT&T Technologies, the sale price of optical cable and optical waveguide fibers

(RX 436, p. 4, para. 10).

663. Costs of many of the raw materials for producing fiber have

(Kanely, RPX-13, p. 176).

664. Prices of optical fiber have been decreasing because of economies of manufacturing. This has occurred, for example, because the standard length of single-mode fiber has increased from two to six kilometers. (Charlton, Tr. 1218, 1219).

665. Technological improvements have contributed to the reduction in fiber prices. (Charlton, Tr. 1221).

666. The increase in yield rates has contributed to the reduction in production costs. The yields of single-mode fiber over the last 12 months

(Kanely, RRX-13, p. 176).

B. <u>Tendency to Substantially Injure</u>

667. In each of the four major market segments, respondents compete against all the major companies in the fiber optics market, including AT&T Technologies, Siecor, Corning, Northern Telecom, Inc., Anaconda-Ericsson, and ITT. (CX-223, p. 521326). Respondents also compete in the sale of uncabled fiber. (Corsello, RX-468, pp. 4-8).

668. SEUSA' distribution of sales to the va ous market segments

(Corsello, Tr. 2620).

669. SEUSA

(Corsello, Tr. 2648).

670. Corsello further testified that

(Corsello, Tr. 2417, 2418).

671.

(Corsello, Tr. 2418) For 1985 requirements of GTE telephone companies,

(RX-536)

(Corsello, CX-363, p. 144).

672. All the major independent telephone holding companies have requirements where standards are set and approved vendors are established.

(RX-355, para. 6).

673. Respondents have recently provided quotations to

(Corsello, CX-363, pp. 39-40).

674. Although some of SEUSA's fiber sales in the United States have

been of

(Corsello, Tr. 2378-2381; RX-468 pp. 6-7; Moore, RPX-34, V.2, p. 9; RX-436, para. 11; RX-435, para. f.; Belboul, RPX-15, pp. 34-35).

675. In November 1983, SEUSA projected that its telecommunications fiber/cable sales in the U.S. would

(Corsello, CX-363, pp. 107-114).

676. Since 1980, approximately of SEI's production of optical waveguide fiber has been committed to sales in the Japanese market. In 1983, specifically, approximately of SEI's production went to Japanese sales. It is expected that this level of production for the Japanese market will

(Nakahara, Tr. 2541, 2542).

677. At the present time, SEI's Yokohama facility has a production capacity of

(Nakahara, RX-467, para. 18).

678. (Yoshida, CX-309, pp. 27-30).

679. The number of employees at the Yokohama plant has (Yoshida, CX-309, pp. 29-30).

680. Dr. Nakahara of SEI testified that he believes that Japanese capacity to manufacture optical waveguide fiber in Japan (Nakahara, Tr. 2540, 2541).

681. Since 1980, sales to third country markets other than the United States have accounted for approximately of SEI's actual production of optical waveguide fiber. In 1984, SEI estimates that this percentage will of optical waveguide fiber and cable will be sold in third country markets. SEI views third country sales SEI estimates that SEI expects (Nakahara, RX-467, para. 20).

682. The establishment of Sumitomo Electric Research Triangle, Inc. (SERT), a new domestic facility in Raleigh, North Carolina, as a wholly-owned subsidiary of SEI, was (RX-433).

683. SERT was (Nakahara, Tr. 2437-2439; CX-467 pp. 3-5; CX-306 p. 309).

684. Construction of SERT began in 1983, and orders for research and development and production equipment and other machinery for

production of cable ar. :iber, were initially placed ii SERT is to be a (Nakahara, RX-467, para. 23).

685. When production fully comes on stream, SERT will produce all types of fiber and cable which SEI has imported, (Nakahara, RX-467, para. 23).

686. Actual production for commercial sale by SERT is scheduled to begin in 1984 and it is expected that SERT will reach a production capacity of approximately kilometers of fiber per year and that it will reach this level by (Nakahara, RX-467, para. 23).

687. Because production at SERT will be less than fiber kilometers per month at the beginning of 1985, overall production at SERT in 1985 will be less than fiber kilometers. (Nakahara, Tr. 2441).

688. Initial investment by SEI

(RX-432; RX-433; Nomura RX-466, para. 12).

689. SERT is expected to employ approximately when it becomes fully-operational. As of November 1984, SERT

(Nakahara, RX-467, para. 24).

690. Under current planning for SERT, respondents anticipate that

(Nakahara, Tr. 2558-2559; Nakahara, RX-467, pp. 8-9).

691. If den 3 increases to a reasonable le\ for

(Nakahara, Tr. 2558-2559).

692. Once production of optical waveguide fiber and cable begins, respondents' SERT facilities in North Carolina will serve as the principal source of fiber and cable for respondents' sales in the United States market. (Nomura, RX-466, para. 12; Nakahara, RX-467, para. 18).

693. SEI and SEUSA have been attempting to conform their cable and fiber products to standard specifications and standard customer requirements in the United States.

(Corsello, TR. 2621-2622; Corsello, CX-363, pp. 126-129).

694. Corsello has testified that

(Corsello, RX-468, para. 20).

695. Dr. Nakahara, the managing director of SEI, has indicated that

(Nakahara, Tr. 2453)

(Nakahara, CX-344, p. 252)

(Nakahara, CX-344, pp. 252, 267).

696. SEI e: mates that no more than

(Nakahara, RX-467, para. 31; Nomura, RX-466, para. 12; Normura, Tr. 2958-2959).

697.

(Nakahara, RX-467, para. 31; RX-436, p. 2, para. c; RX-435 p. 2).

698.

(Nakahara, Tr. 2503-2504)

(Nakahara, Tr. 2561-2562).

699. SEUSA and SEI

(Nakahara, Tr. 2426).

700. Respondents have had their cabled fiber evaluated by

(Corsello, Tr. 2381-2383).

701. Respondents plan to market fiber and cable produced at SERT

(Corsello, Tr. 2384-2385).

702. Respo nts intend to

(Nakahara, Tr. 2558-2559; Nomura, Tr. 2943-2944, 2958-2959; Corsello, Tr. 2204, 2423, 2605)

703. SEUSA's management is currently considering

(CX-363 p. 132; SX-72)

(Corsello, Tr. 2624-2627; SX-72).

704. SEUSA is planning to

(RX-468, p. 15; Nomura, Tr. 2947-2949).

705. No final decision has been made on

(Nomura, Tr. 2943-2944).

706. Mr. Corsello expects that

(Corsello, Tr. 2404, 2423).

707. In connection with the start-up of SERT, respondents in 1985 will have

(Nakahara, Tr. 2357-2358, 2555; Corsello, Tr. 2603).

708.

(Corsello, Tr. 2605).

709. Mr. Corsello's proposal for

(Corsello, Tr. 2607-2608; RX-346; Nakahara, Tr. 2440-2441).

710. Respondents are planning to

(Corsello, Tr. 2614-2615; SX-79, p. 521768).

711. Mr. Corsello believes that Attachment A of SX-79, which sets forth figures on marketplace potential as of April 1984, is reasonably accurate in aggregate. (Corsello, Tr. 2616).

712. As optical waveguide fiber finds greater use in local loop and local area network applications, this development will give rise to a new boost in demand in the United States. (RX-466 pp. 3-4).

713. SEI currently manufactures fiber and cable types

(Nomura, Tr. 2936).

714. The optical waveguide fiber market in the United States is considered to be in an early growth stage, one which is rapidly accelerating, and is expected to maintain an explosive annual growth rate throughout the decade. (Corsello, RX-468, para. 2; Corsello, Tr., 2409).

715. Valtec believes that

(Kanely, RPX-13, pp. 194-195).

716. Mr. Cc ello testified that respondent nticipate

all participants'

absolute business in dollar terms will continue to grow phenomenally. (Corsello, Tr. 2377).

717. In 1985, based on Corning's estimate of a total U.S. market for optical waveguide fiber of kilometers, and respondents' estimate of its maximum sales in the U.S. market of imported fiber and cable respondents would have a market share in the U.S. market of approximately (RX-414, p. P400005).

718. In 1984 through 1988, Corning's U.S. market share

(RX-414, p. P400005; Martin RX-469, Table 2.) Corning's projected sales are

(RX-414, p. P400005; Martin, RX-469, p. 13, and Table 2).

XXIII. CONCLUSIONS OF LAW

1. U.S. Letters Patent 3,659,915 ('915 patent) is valid.

2. U.S. Letters Patent 3,933,454 ('454 patent) is valid.

3. Respondents' M-1 Fiber infringes claims 1 and 2 of the '915 patent.

4. Respondents' S-1 Fiber infringes claims 1 and 2 of the '915 patent.

5. Respondents' S-2 Fiber infringes claim 1 of the '915 patent.

6. Respondents' S-3 Fiber infringes claim 1 of the '915 patent.

7. Respondents' processes for producing M-1, S-1, S-2 and S-3 fibers infringe claims 1 and 8 of the '454 patent.

8. Corning has not proven by a preponderance of evidence that respondents' process for producing M-2 fiber infringes claim 1 or claim 8 of the '454 patent.

9. There are two relevant domestic industries, consisting of the operations of Corning and its domestic licensees engaged in the exploitation of the '915 patent and the operations of Corning devoted to the exploitation of the '454 patent.

10. The relevant domestic industries are economically and efficiently operated.

11. Importation and sale of the accused optical waveguide fibers does not have the effect or tendency to substantially injure the domestic industries.

12. There is no violation of Section 337 of the Tariff Act of 1930, as amended. 19 U.S.C. § 1337.

XXIV. INITIAL DETERMINATION AND ORDER

Based on the foregoing findings of fact, conclusions of law, the opinion and the record as a whole, and having considered all 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 DETERMINATION that there is no violation of Section 337 in the unauthorized importation and sale in the United States of America of the accused optical waveguide 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;

2. The Exhibits accepted 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 <u>in camera</u> 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. 210.54(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: January 22, 1985