In the Matter of

CERTAIN PAPERMAKING MACHINE FORMING SECTIONS FOR THE CONTINUOUS PRODUCTION OF PAPER AND COMPONENTS THEREOF

Investigation No. 337-TA-147

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United States International Trade Commission / Washington, DC 20436

UNITED STATES INTERNATIONAL TRADE COMMISSION

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

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NOTICE OF TERMINATION OF INVESTIGATION BASED ON A FINDING OF NO VIOLATION

AGENCY: U.S. International Trade Commission.

ACTION: Termination of investigation upon a finding of no violation of section 337 of the Tariff Act of 1930.

SUMMARY: Notice is given that the U.S. International Trade Commission has determined that there is no violation of section 337 of the Tariff Act of 1930 (19 U.S.C. § 1337) in the above-captioned investigation and has terminated the investigation.

FOR FURTHER INFORMATION CONTACT: Charles Nalls, Esq., Office of the General Counsel, U.S. International Trade Commission, telephone 202-523-1626.

SUPPLEMENTARY INFORMATION: On May 2, 1983, the U.S. International Trade Commission instituted an investigation under section 337 of the Tariff Act of 1930 upon the complaint of Beloit Corporation, 1 St. Lawrence Avenue, Beloit, Wisconsin 53511. (48 Fed. Reg. 21213). Complainant alleged unfair methods of competition and unfair acts in the importation of certain papermaking machine forming sections for the continuous production of paper and components thereof into the United States, or in their sale, by reason of alleged (1) direct infringement, (2) contributory infringement, and (3) induced infringement of claims 1, 2, 3, 4, 7, 8, 10, and 11 of U.S. Letters Patent 3,726,758. Complainant further alleged that the effect or tendency of the unfair methods of competition and unfair acts is to destroy or substantially injure an industry, efficiently and economically operated, in the United States.

Named as respondents were the following companies: Valmet Oy of Helsinki, Finland and TVW Paper Machines, Inc., of Atlanta, Georgia.

On February 14, 1984, the presiding Commission administrative law judge issued an initial determination (ID) that there is no violation of section 337. Complainant and respondents filed petitions for review of various parts of the ID, pursuant to section 210.54(a) of the Commission's rules. Having examined the record in this investigation, including the ID, the petitions for review, and the responses thereto, the Commission on March 15, 1984, determined not to review the ID as to the issue of noninfringement. The Commission took no position as to the other issues determined in the ID. (49 Fed. Reg. 11896).

On April 2, 1985, the U.S. Court of Appeals for the Federal Circuit issued its mandate reversing the Commission's determination of no violation of section 337 and remanding the case to the Commission for "further appropriate proceedings."

Both complainant and respondents then petitioned for review of various parts of the initial determination pursuant to section 210.54(a) of the Commission's rules. Because the Commission took no position on these matters in its earlier determination, they were again before the Commission for consideration and decision. After examining the petitions for review and the responses thereto, the Commission concluded that certain issues warranted review. (51 Fed. Reg. 8371.) Specifically, the Commission reviewed the following questions:

1. Whether U.S. Letters Patent 3,727,758 (the '758 patent) is invalid by virtue of anticipation within the meaning of 35 U.S.C. § 102. Specifically, the Commission is reviewing only those portions of the ID concerning anticipation of the '758 patent by U.S. Letters Patent 3,232,825 (Robinson).

2. Whether the '758 patent is invalid as obvious within the meaning of 35 U.S.C. § 103.

3. Whether complainant's domestic activities with respect to the '758 patent constitute an "industry, . . . in the United States" within the meaning of section 337. In reviewing this portion of the ID, the Commission is concerned only with those findings of fact and conclusions of law relating to the level of complainant's domestic activity and not with those portions of the ID which concern specific cost allocations or methods thereof. The Commission has determined not to review the findings of fact which concern complainant's representations on the question of continued commitment to overall domestic operations.

4. Whether the importation or sale of respondents' devices has the tendency to destroy or substantially injure an industry in the United States.

On January 15, 1987, the Commission determined that there is no violation of section 337 by virtue of the importation into or sale in the United States of the accused devices. Specifically, the Commission found:

1. That claims 1, 2, and 10 of the '758 patent are invalid as anticipated within the meaning of 35 U.S.C. § 102(b) and (e).

2. That claims 1-4, 7, 8, 10, and 112 of the '758 patent are invalid or obviousness within the meaning of 35 U.S.C. § 103.

3. That complainant's domestic activities with respect to the '758 patent do not constitute an "industry . . . in the United States" within the meaning of section 337.

4. That because the '758 patent is invalid and a domestic industry does not exist, the importation or sale of respondents' devices do not have the effect or tendency to destroy or substantially injure an industry in the United States.

Based upon those findings, the Commission terminated the investigation.

Copies of the Commission's action and order, the opinion issued in connection therewith, and all other nonconfidential documents filed in connection with this investigation are available for inspection during official business hours (8:45 a.m. to 5:15 p.m.) in the Office of the Secretary, U.S. International Trade Commission, 701 E Street NW., Washington, D.C. 20436, telephone 202-523-0161.

By order of the Commission.

Kenneth R. Mason
Secretary

Issued: January 20, 1987

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

In the Matter of CERTAIN PAPERMAKING MACHINE FORMING SECTIONS FOR THE CONTINUOUS PRODUCTION OF PAPER AND COMPONENTS THEREOF	Investigation No. 337-TA-147

COMMISSION ACTION AND ORDER

Introduction

The United States International Trade Commission has concluded its investigation under section 337 of the Tariff Act of 1930 (19 U.S.C. § 1337) of alleged unfair methods of competition and unfair acts in the importation of certain papermaking machine forming sections and components thereof into the United States, or in their sale, the alleged effect or tendency of which is to destroy or substantially injure an industry, efficiently and economically operated, in the United States.

Complainant Beloit Corporation is incorporated in the state of Delaware and has its principal place of business in Beloit, Wisconsin. Through its Paper Machinery Division, Beloit manufactures and sells papermaking machinery in the United States. The respondents named in the notice of investigation are Valmet Oy, the Finnish manufacturer of the accused papermaking machines, and TVW Paper Machines, Inc., a Valmet subsidiary engaged in the promotion, marketing, and sale of Valmet's products in the United States.

Action

Upon review of certain portions of the administrative law judge's initial determination of February 14, 1984, the Commission has considered: (1) the submissions filed by the parties; (2) the transcript of the evidentiary hearing before the ALJ and the exhibits accepted into evidence; and (3) the ALJ's initial determination. The Commission has determined that there is no violation of section 337 of the Tariff Act of 1930 in the importation into and sale in the United States of certain papermaking machine forming sections and components thereof. Specifically, the commission has found that:

1. Claims 1, 2, and 10 of the '758 patent are invalid by virtue of anticipation within the meaning of 35 U.S.C. § 102(b) and (e).

2. Claims 1-4, 7, 8, 10, and 12 of the '758 patent are invalid for obviousness within the meaning of 35 U.S.C. § 103.

3. Complainant's domestic activities with respect to the '758 patent do not constitute an "industry . . . in the United States" within the meaning of section 337.

4. Because the '758 patent is invalid and a domestic industry does not exist, the importation or sale of respondents' devices do not have the tendency to destroy or substantially injure an industry in the United States.

Order

Accordingly, it is hereby ORDERED THAT—

1. Investigation No. 337-TA-147 is terminated as to all issues and all respondents;

2. The Secretary shall serve this Action and Order and the opinion issued in connection therewith upon each party of record to this investigation and upon the U.S. Department of Health and Human Services, the U.S. Department of Justice, the Federal Trade Commission, and the U.S. Customs Service; and

3. The Secretary shall publish notice thereof in the Federal Register.

By order of the Commission.

Kenneth R. Mason
Secretary

Issued: January 20, 1987

VIEWS OF THE COMMISSION 1/

This investigation is before us on remand of our March 19, 1984, determination that there was no violation of section 337 of the Tariff Act of 1930 2/ in the importation and sale of certain papermaking machine forming sections for the continuous production of paper and components thereof. 3/ In that determination, the Commission specifically adopted its ALJ's initial determination that complainant Beloit Corporation had failed to prove that the accused devices manufactured, imported, and sold by respondents infringe U.S. Letters Patent 3,726,758 (the '758 patent). However, the Commission took no position with respect to the other issues considered by the ALJ, including patent validity, enforceability, and the tendency of the accused devices to substantially injure an efficiently and economically operated industry in the United States. 4/ On January 4, 1985, the United States Court of Appeals for the Federal Circuit (CAFC) reversed the Commission's finding of noninfringement and formally remanded the investigation to the Commission for further proceedings in April, 1985. 5/

On March 4, 1986, the Commission determined to review certain issues from the ID upon which it had previously taken no position. 6/ Based upon the evidentiary hearing, the written submissions of the parties, and the entire record in this investigation, the Commission determined on January 16, 1987,

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1/ The following abbreviations are used in this opinion: ALJ--Administrative Law Judge; ID--ALJ's Initial Determination; FF--Finding of Fact; TR--transcript of evidentiary hearing before ALJ; RX--respondents' exhibit; CX--complainant's exhibit.

2/ 19 U.S.C. § 1337.

3/ 49 Fed. Reg. 11896 (1984).

4/ Id.

5/ Beloit v. Valmet Oy, TVW Papermachines, Inc., and United States International Trade Commission, Appeal No. 84-1296 (Fed. Cir. January 4, 1985).

6/ 51 Fed. Reg. 8571 (1986). The Commission reviewed the ID pursuant to rule 210.54(a). 19 C.F.R. § 210.54(a).

that there is no violation of section 337 in the importation and sale of the accused devices in the United States. The following opinion discusses the reasons for the Commission's determination reversing the ID in this matter. 7/

PROCEDURAL HISTORY

On May 11, 1983, the Commission instituted an investigation to determine whether the importation and sale of certain papermaking forming sections for the continuous production of paper and components thereof constituted a violation of section 337 of the Tariff Act of 1930. 8/ The investigation was based upon the complaint of Beloit Corporation (Beloit). Named as respondents were Valmet Oy (Valmet), the Finnish manufacturer of the accused papermaking machines, and TVW Paper Machines, Inc. (TVW), a Valmet subsidiary engaged in the promotion, marketing, and sale of Valmet's products in the United States. The unfair acts and unfair methods of competition alleged were the direct, contributory, and induced infringement of claims 1-4, 7, 8, 11 and 12 of the '758 patent. 9/

On February 13, 1984, the ALJ issued an ID finding that, while the '758 patent was valid and enforceable, complainant Beloit had failed to prove that the accused devices literally infringe the '758 patent. The ALJ further found that in the absence of literal infringement, there could be no contributory or induced infringement. In addition to these findings, the ALJ determined that the accused machinery did not infringe complainant's patent under the doctrine of equivalents. As a result, the ALJ concluded that respondents Valmet and

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7/ The Commission specifically adopts those of the ALJ's findings of fact which are not inconsistent with this opinion.

8/ 48 Fed. Reg. 21213 (1983).

9/ Beloit subsequently withdrew its allegations with respect to claim 12.

TVW had not violated section 337 by the importation and sale of the accused papermaking forming sections and components.

The ALJ defined the relevant domestic industry as the portions of complainant's Paper Machinery Division dedicated to the manufacture, sale, and service of the twin-wire forming sections covered by the '758 patent. In addition, the ALJ found that this industry was efficiently and economically operated. Finally, the ALJ found that, if respondents had committed unfair acts as alleged, such acts did not have the effect of substantially injuring the domestic industry, but did have a tendency to substantially injure it.

On February 27, 1984, complainant Beloit filed a petition for review of the ID alleging that the ALJ had erred in finding no infringement of the '758 patent. Beloit also alleged error in virtually every aspect of the ID related to the question of domestic industry and requested review of that portion of the ALJ's determination. Valmet and TVW opposed review of the findings and conclusions relating to the question of infringement and the definition of the domestic industry, insofar as that definition excludes certain of complainant's paperforming machines.

However, Valmet and TVW requested review of those portions of the ID which found a domestic industry to exist in the manufacture by Beloit of its "Bel Baie" forming sections. Further, respondents contended that the ALJ's findings and conclusions relating to the patent validity questions of anticipation and obviousness were in error. Finally, Valmet and TVW challenged the portions of the ID relating to tendency to injure as overly conjectural or speculative.

The Commission investigative attorney (IA) filed a submission in which she took no position on review of the patent issues and opposed review of the

ID on the economic issues. Beloit then petitioned the Commission on March 9, 1984, to reopen the record for the submission of additional documents. The Commission denied that request.

After examining the record in the investigation, the ID, and the submissions of the parties, the Commission determined not to review the ID on March 19, 1984. 10/ The Commission specifically adopted that portion of the ID relating to noninfringement of the '758 patent, but stated that it took no position on the other issues considered in the ID. 11/ The effect of the Commission's action was to terminate the investigation based on a finding of no violation of section 337.

Complainant appealed the Commission's finding of no violation to the CAFC solely on the issue of noninfringement. Respondents Valmet and TVW moved for dismissal on the ground that all issues relating to the finding of no violation had not been appealed from. In respondents' view, the appeal had to include all of the issues covered by the ID, particularly in light of respondents' belief that those portions of the ID not addressed by the Commission had become binding on the Commission by virtue of Commission rule 210.53(h). 12/

In an order dated June 21, 1984, the CAFC rejected respondents' arguments concerning which issues were properly before it. 13/ The CAFC held that the Commission is free to reach a determination of "no violation" on a single

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10/ 49 Fed. Reg. 11896 (1984).
11/ Id.
12/ Under rule 210.53(h), an ID on violation of section 337 becomes the final determination of the Commission within 45 days of service upon the parties, unless the Commission orders review of the ID.
13/ Beloit Corp. v. Valmet Oy, TVW Papermachines, Inc., and United States International Trade Commission, 742 F.2d 1421 (Fed. Cir. 1984) (Order denying appellee's motion to dismiss).

dispositive issue. 14/ Specifically, the CAFC found that the Commission had not made findings on the issues (patent validity, domestic industry, and injury) as to which it stated it had taken no position, Commission rule 210.53(h) notwithstanding. 15/ The CAFC pointed out that respondents could argue the validity and injury issues before the Commission in the event of a remand. 16/

After the submission of briefs and the presentation of oral argument, the CAFC issued its opinion reversing the Commission's determination of noninfringement. 17/ The CAFC determined that the imported devices infringe the '758 patent. 18/ The apparent basis for the decision is that the ALJ (and hence the Commission) improperly narrowed the scope of the claim language, particularly with respect to the claim terms "entrance nip" and "adjacent", thereby excluding respondents' devices from coverage under the '758 patent. 19/ Having found infringement, the CAFC reversed and remanded the investigation to the Commission for "further appropriate proceedings." 20/ On April 2, 1985, the CAFC issued its mandate formally returning the investigation to the Commission. 21/

Subsequent to the remand order, complainant and respondents filed several motions with the Commission. On April 4, 1985, complainant filed a Motion for

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14/ Id. at 1423.
15/ Id. at 1422-23.
16/ Id. at 1424.
17/ Beloit v. Valmet Oy, TVW Papermachines, Inc., and United States International Trade Commission, Appeal No. 84-1296 (Fed. Cir. January 4, 1985).
18/ Id., slip op. at 4.
19/ Id., slip op. at 3.
20/ Id., slip op. at 4.
21/ The delay in return of the mandate was occasioned by a stay issued by the CAFC in response to a motion by respondents to prevent issuance of the CAFC's mandate pending disposition of a petition for a writ of certiorari filed with the U.S. Supreme Court, which petition was denied.

Expedited Hearing on Remedy Or, In the Alternative, For Temporary Relief Pending Completion of Investigation. 22/ Complainant modified this motion by withdrawing its request for temporary relief on April 29, 1985. Respondents filed a Motion to Schedule Briefing and Argument Before the Commission. 23/

On March 4, 1986, the Commission determined to review the following issues presented by the ID:

1. Whether U.S. Letters Patent 3,726,758 [the '758 patent] is invalid by virtue of anticipation within the meaning of 35 U.S.C. 102. Specifically, the Commission is reviewing only those portions of the ID concerning anticipation of the '758 patent by U.S. Letter 3,232,825 [Robinson].

2. Whether the '758 patent is invalid for obviousness within the meaning of 35 U.S.C. 103.

3. Whether complainant's domestic activities with respect to the '758 patent constitute an "industry . . . in the United States" within the meaning of section 337. In reviewing this portion of the ID, the Commission is concerned only with those findings of fact and conclusions of law relating to the level of complainant's domestic activity and not with those portions of the ID which concern specific cost allocations or methods thereof. Specifically, the Commission will not review the findings of fact concerning dollar amounts and percentages attributed to complainant's various activities. Further, the Commission has determined not to review the findings of fact which concern complainant's representations on the question of continued commitment to overall domestic operations.

4. Whether the importation or sale of respondents' devices has the tendency to destroy or substantially injure an industry in the United States. 24/

In addition, the Commission denied complainant's motion for Expedited Hearing on Remedy and respondents' Motion for Argument Before the Commission, but granted respondents' Motion for Briefing.

22/ Motion No. 147-16C.
23/ Motion No. 147-17C.
24/ 51 Fed. Reg. 8571 (1986).

THE PARTIES

Complainant Beloit is incorporated in the state of Delaware and has its principal place of business in Beloit, Wisconsin. Through its Paper Machinery Division, Beloit manufactures and sells papermaking machinery in the United States. In addition, it is engaged in research and development of such machinery. Beloit owns U.S. Letters Patent 3,726,758 (the '758 patent) which describes and claims a twin-wire web forming system with dewatering by centrifugal force. It is this patent for paper forming machinery that Beloit alleged was infringed by respondents Valmet and TVW.

Respondent Valmet, a Finnish concern, is likewise engaged in the manufacture of papermaking machinery. It produces and sells the Sym-Former R, one of the devices accused by Beloit of infringing the '758 patent. It also offers for sale another accused device designated as the New Sym-Former. 25/ Respondent TVW, a New York corporation with its principal place of business in Atlanta, Georgia, imports and sells in the United States the papermaking products of Valmet.

THE PRODUCT AND TECHNOLOGY

The product at issue is the so-called "forming section" of papermaking machinery and components of the forming section. In a typical papermaking machine, a suspension or slurry of fibers in water called "stock" is introduced into the forming section where a substantial part of the water is removed ("dewatering"). 26/ The remaining "web" of fibers or forming sheet

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25/ None of these had been manufactured at the close of the evidentiary record in December 1983.

26/ ID at 4-5 (FFs 3, 4).

then passes through a press section, where more water is squeezed out, and, finally, through a dryer section in which any remaining water is thermally removed. 27/

The forming section of the papermaking machine begins at the headbox slice where stock is introduced into the machine for dewatering and ends at the press section, the point where the web exits. 28/ Upon entering the forming section, the stock consists of a mixture that contains 98.5 to 99.5 percent water and 0.5 to 1.5 percent wood pulp fibers and fine particles of pulp and fillers randomly arranged in suspension. 29/ As the stock is dewatered in the forming section, the random mixture of fibers gradually forms a two-dimensional sheet or "web," which is transferred to the press section. 30/

For more than 100 years, the standard forming section was the Fourdrinier machine, a substantially horizontal moving belt or wire or screen upon which the stock is deposited. 31/ As the wire moves along the machine or "table," the stock is dewatered by gravity, sometimes with the assistance of vacuum or suction devices. 32/ The Fourdrinier former, despite many improvements over a number of years, suffers from a number of drawbacks including lack of fine fiber formation for higher quality paper, production speed limitations, and varying surface quality between sides of the paper ("two-sidedness"). 33/

27/ Id. at 5(FF 5).
28/ The term "headbox" refers to the device used for introducing stock into the papermaking machine, while the "slice" is an opening in the headbox through which the stock is introduced. ID at 5-6 (FF 6).
29/ ID at 6(FF 7).
30/ Id.
31/ Id. at 6-7 (FF 8).
32/ Id.
33/ Id.

As a solution to the shortcomings of the Fourdrinier former, twin-wire machines were developed. 34/ In twin-wire formers, stock is introduced between two wire-mesh belts for dewatering from both sides of the forming sheet. 35/ The twin-wire method tended to eliminate two-sidedness and led to the development of a number of different twin-wire machines as demand for higher production speed and better quality paper formation increased. 36/

In a true twin-wire former the stock is deposited directly into the area of convergence between the two wire-mesh belts. 37/ Other twin-wire machines known as top-wire or hybrid formers include a forming section situated about half-way down the Fourdrinier table. Stock is dewatered in one direction until it reaches the top-wire unit, where twin-wire formation begins. Dewatering then takes place in two directions along the latter half of the Fourdrinier section. 38/

As the various types of twin-wire formers developed, the papermaking industry recognized that centrifugal forces could be employed in dewatering by passing the stock, between the twin wires, over a curved surface such as a rotary cylinder or arcuate shoe. The portion of the curved surface over which the wires and stock pass is sometimes referred to as the "wrap." 39/

1. The Patent

The subject matter of the patent in controversy is described in the "Summary of the Invention" as:

34/ Id. at 7-8 (FF 9)
35/ Id.
36/ Id.
37/ Id. at 8 (FF 10).
38/ Id. at 8 (FF 11).
39/ Id. at 8 (FF 12).

> [A] forming machine and system including a head box means for providing a ribbon-thin jet stream of web stock in a given direction (horizontal or vertical); two endless loop forming wires arranged to travel in a given direction so as to define a forming zone; a breast roll positioned within each of the looped wires to define a nip therebetween for receiving the stock and curved guide elements positioned downstream of the breast rolls and within the loop of one of the wires to dewater the stock sandwiched between the wires. 40/

This apparatus and its embodiments constitute a true twin-wire former, which incorporates an "entrance" nip or convergence between the two wires which receives the paper forming stock. Complainant's patented formers typically do not include a Fourdrinier table preceding the twin-wire former or upon which a top wire is imposed. 41/

All of the claims in controversy, in addition to describing an entrance nip, include a curved stationary surface which is adjacent to the entrance nip. 42/ Further, in each of the various embodiments envisioned in the '758 patent, the stationary curved surface has a relatively large radius of curvature and is followed by a cylindrical roll of substantially smaller radius of curvature. 43/ This arrangement in the '758 devices provides a gradual nip between wires which, as the patent claims, prevents rejection or spewing of the stock, eliminates formulation problems, and provides centrifugal dewatering of the stock. 44/

2. The Accused Devices

Complainant asserted, and the CAFC found, that two of Valmet's paper

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40/ The claims of the '758 patent at issue are fully set forth in the Appendix to this opinion. In addition, the interpretation of these claims are discussed infra at 22-30.
41/ ID at 12-13(FF 24).
42/ Id. at 12(FF 22).
43/ Id. at 12 (FF 26).
44/ Id. at 13-14 (FF 28).

forming machines, the Sym-Former R and the New Sym-Former, infringe the '758 patent, assuming that the patent is valid. 45/ These two forming machines are top wire formers which are positioned atop Fourdrinier tables. 46/ The Fourdrinier sections begin at the headbox and extend approximately 20 to 30 feet to either the Sym-Former R or the New Sym-Former, where the top-wire section begins. 47/

In the Fourdrinier section of the accused devices, the bottom wire is supported by a number of dewatering elements which, by means of suction, remove water from the stock downward through the bottom wire. Between 35 and 50 percent of the water in stock is removed as it passes over this section of the Sym-Former R. Typically, 43 percent of the water is removed between the headbox and the top wire section of the accused devices. 48/

As the stock passes from the Fourdrinier section to the forming roll where the top-wire section begins, a so-called nip is formed between the bottom wire and the top wire which wraps the forming roll. 49/ This nip has been characterized as "abrupt," beginning where the top and the bottom wires approach each other at a sharp angle and ending at the six o'clock position on the forming roll. The two wires with stock therebetween then pass around a portion of the periphery of the forming roll, a perforated cylinder or drum, at an arc of 30 to 40 degrees whereby an additional 30 percent of the water is removed from the stock. 50/

45/ Although Valmet and TVW offered the New Sym-Former for sale, no such former had been manufactured prior to the close of the record by the ALJ. ID at 4(FF 3).

46/ ID at 14 (FF 30).

47/ Id. at 14 (FF 31).

48/ Id. at 14-15 (FF 31).

49/ Id. at 15 (FF 32).

50/ Id. at 15-16 (FF 33, 35).

Upon leaving the forming roll, the twin wires pass over a large stationary curved shoe having a relatively large radius. A number of slightly curved, 2-inch wide blades form the top surface of the shoe and effect dewatering of the stock by another 16 percent. The blades also deliver a series of pressure pulses to the stock which serve to redistribute the fibers and fine particles to improve sheet formation. 51/

Following the curved shoe, the twin wires traverse a solid roll, which is positioned on the same side of the wires as the shoe, and reverse their upward direction. The twin wires wrap this solid roll in a 20 to 40 degree arc during direction reversal in the Sym-Former R, although this wrap is not as great in the New Sym-Former. 52/ Some minor additional dewatering occurs during this stage of the process with 3 percent or less of the initial water content being removed through the two wires. 53/

From the solid roll in the Sym-Former R, the twin wires, with the stock between them, return to the horizontal path of the Fourdrinier table by means of a reversing roll. As the wires and stock pass around the reversing roll, a small amount of water is removed from the stock. 54/ This reversing roll is unnecessary in the New Sym-Former, because that device has a different configuration which does not require the return of the wire and stock combination to the path of the Fourdrinier section. 55/

51/ This differs from the uniform, continuous pressure that would result from the shoe being a solid curved surface. Id. at 17 (FF 38).

52/ Id. at 17 (FF 39).

53/ Id. Because the roll is solid, there is no dewatering through the bottom wire which faces the roll.

54/ Id. at 17-18 (FF 40).

55/ Id. at 18 (FF 40).

At this stage of the process in both versions of respondent Valmet's formers, the upper wire is separated from the bottom wire by another elevated roll positioned slightly above the path of the twin wires and aided by suction devices under the bottom wire. Some additional dewatering occurs at this point before the formed web passes into the drying section of the paper making machine. 56/

PATENT VALIDITY

A. Introduction

As noted, the Commission is reviewing two issues with respect to patent validity: (1) whether the Robinson patent anticipates the '758 patent within the meaning of 35 U.S.C. § 102, and (2) whether the '758 patent is invalid for obviousness. In connection with these two issues, we note that the '758 patent is entitled to a statutory presumption of validity. 57/ Accordingly, the burden of proving invalidity by clear and convincing evidence falls upon respondents. 58/

However, prior to considering whether respondents have demonstrated that the '758 patent is invalid, the Commission must undertake a construction of the claims at issue in this investigation. Such analysis is necessary in this instance because the CAFC determined that the ALJ's findings of fact with respect to certain claim terminology were incorrect as a matter of law. 59/

56/ Id. (FF 41).
57/ 35 U.S.C. § 282.
58/ See, e.g., Lannom Mfg. Co., Inc. v. United States International Trade Commission, Appeal No. 85-2558 (Fed. Cir. Aug. 27, 1986); Raytheon Co. v. Roper Corp., 724 F. 2d 951, 960 (Fed. Cir. 1983); Certain Limited-Charge Cell Culture Microcarriers, Inv. No. 337-TA-129, USITC Pub. 1486 (1984), Views of the Commission at 11.
59/ Beloit v. Valmet Oy., slip op. at 3.

As a result of that decision, at least a part of the factual predicate for the ALJ's determination with respect to the validity questions is no longer operative. Thus, the Commission must reevaluate the meaning of the claims of the '758 patent prior to assessing their validity.

B. The claims at issue.

The ALJ entered findings with respect to the pertinent claims of the '758 patent. Repeating the language of the claims themselves, the ALJ determined that: Claim 1 covers an apparatus for forming fibrous webs comprising:

(a) First and second continuous looped foraminous forming wires which are arranged to converge and provide an entrance nip for the reception of web-forming stock;

(b) A curved stationary surface positioned adjacent to said entrance nip;

(c) Means for supporting said wires within their respective loops and moving said wires into said entrance nip;

(d) Said forming wires being arranged to travel over said stationary curved surface downstream of said entrance nip while having stock therebetween;

(e) A rotary cylinder;

(f) Said wires traveling around a part of the periphery of said rotary cylinder immediately following the stationary forming surface, with said surface and said cylinder being on the same side of said wires;

(g) Said stationary curved surface having a relatively large radius of curvature;

(h) The first wire being free of restraining means on its outer surface opposite said rotating cylinder;

(i) Said wires arranged for traveling at a speed so that the stock is dewatered centrifugally through the first wire.

Claim 2 covers an apparatus as defined in claim 1 wherein the first wire passes over a roll for guiding it into said entrance nip.

Claim 3 covers an apparatus as defined in claim 2 including means for adjusting said roll relative to the entrance nip.

Claim 4 covers an apparatus for forming a fibrous web as defined in claim 1 wherein said wires wrap a guide roll after leaving the rotary cylinder with the first wire engaging said guide roll.

Claim 7 covers an apparatus for forming fibrous webs as defined in claim 1 including means for separating the first wire from the second wire following the rotary cylinder with the web being carried on the second wire.

Claim 8 covers an apparatus for forming fibrous webs as defined in Claim 7 including a web transfer means positioned downstream of the rotary cylinder and in working relation with the second wire for transferring the web away from the second wire.

Claim 10 covers an apparatus for forming a fibrous web comprising:

(a) Those features described in sub-paragraphs (a) through (d), (f), (h) and (i), above, in connection with claim 1; and

(b) A rotary cylinder positioned downstream in close-working relation with said curved stationary surface to define a continuous bi-radii curved path of wire travel having a first radius of curvature substantially larger than a second radius of curvature.

Claim 11 covers an apparatus for forming fibrous webs as defined in claim 10 wherein the curved stationary surface is a substantially water permeable surface defined by a plurality of longitudinally spaced generally transverse wire-contacting edges defining the curve of said surface. 60/

The ALJ then noted that the language of all of the claims at issue requires that:

(a) The first and second wires must be arranged "to converge and provide an entrance nip for the reception of web-forming stock"; and

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60/ ID at 9-11 (FFs 13-20).

(b) The device must include "a curved stationary surface positioned adjacent said entrance nip." 61/

Next, the ALJ turned to the specification of the '758 patent to construe the terms "entrance nip" and "adjacent" as used in the claim language. First, the ALJ found that in all of the embodiments described in the specification of the '758 patent, the entrance nip was a nip (i.e., convergence of the top and bottom wires) into which a jet stream of stock is directly discharged. 62/ Further, the ALJ noted that the entrance nip of the '758 devices was a gradual convergence between the top and bottom wires. 63/ This gradual entrance nip in the '758 embodiments prevents the stock from being rejected or spewed, in addition to eliminating problems involving formation and providing for free centrifugal dewatering. 64/ Finally, the ALJ pointed out that the '758 patent does not encompass a Fourdrinier section preceding the twin wire former or upon which the top wire is imposed. 65/

As to the term "adjacent," the ALJ found that a curved stationary surface could be adjacent the entrance nip if at least some portion of the entrance nip lies directly upon the curved surface. 66/ The ALJ based this interpretation upon the fact that the specification was replete with references showing a portion of the entrance nip resting on and being shaped by the curved stationary surface. 67/ In fact, testimony by one of the

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61/ ID at 12 (FF 22) (emphasis supplied).
62/ ID at 12 (FF 24).
63/ Id. at 13-14 (FF 28).
64/ Id.
65/ Id. at 13 (FF 24).
66/ Id. (FF 25).
67/ Id. at 13 (FF 25); 18-19 (FF 43); 21-25 (FF 549-53).

inventors of the '758 patent, Mr. Gustafson, supported the ALJ's construction of the term adjacent as used in the claim language. Based upon these constructions of the claim language, the ALJ and the Commission found that the claims of the '758 patent did not read on the accused devices.

On January 4, 1985, the CAFC reversed the Commission's finding of non-infringement. The per curiam opinion of the court is predicated upon the determination that the ALJ and the Commission erred as a matter of law in their construction of the claims. 68/ In the court's view, the Commission improperly limited the terms "entrance nip" and "adjacent" to "preferred embodiments and specific examples in the specification where the specification does not require these limitations." 69/

The CAFC then stated that the specific findings of fact relating to the interpretation of the two terms in question were premised upon an improper interpretation and application of the governing law and were also unsupported by substantial evidence. 70/ However, the CAFC provided no guidance concerning the proper interpretation of the claims to supplant the Commission's construction. Only by implication in the disapproval of the Commission's approach and references to several other cases does the CAFC seem to indicate that the claim language is entitled to broad or literal construction in this instance. 71/

Respondents take an essentially two-tiered approach in arguing the effect of the CAFC's decision upon the interpretation of the claim language of the '758 patent. On the first level, respondents maintain that the opinion

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68/ Beloit v. Valmet Oy, slip op. at 3.
69/ Id.
70/ Id. at 4-5.
71/ Id.

explicitly reversed all findings of fact in relating to the terms "entrance nip" and "adjacent." 72/ Respondents point out that the CAFC's basis for setting aside these findings was the Commission's legal error in limiting the claim language to preferred embodiments and specific examples in the specification, when the specification does not require such limitations. 73/ Consequently, respondents maintain that the two specific claim terms in question now must be given a broad reading. 74/

On the second level of their analysis, respondents point out that the CAFC's determination of legal error in claim interpretation by the Commission is a general proposition that applies to all aspects of the language of the claims. Specifically, respondents "refer the Commission's attention to the expression 'curved stationary surface' which appears in all of the claims in issue." 75/ Respondents note that the ALJ relied on the interpretation of the term as requiring a curve of constant or decreasing radius to distinguish the '758 patent from the prior art. 76/ Respondents argue that this limitation was improperly based upon preferred embodiments, rather than specific structural limitations, in contravention of the legal principle enunciated by the CAFC. 77/

In support of their position, respondents point out that nothing in the specification requires a given shape of the curved surface. To the contrary, complainant argued before the patent examiner that it intended to cover "any

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72/ Respondents' Reply Brief at 1. The specific findings voided by the decision, according to respondents, include FFs 44-55 and 58-61.
73/ Respondent's Reply Brief at 2.
74/ See id.
75/ Id. at 3.
76/ Id.
77/ Id. at 3-7.

type of curved surface." 78/ Indeed, respondents maintain that the specification to the '758 patent itself describes the curved surface as "essentially flat." 79/ Thus, respondents contend that the only interpretation of the language of the '758 patent claims consistent with the CAFC's decision gives a broad reading to those claims, particularly with respect to the terms "entrance nip", "adjacent," and "curved stationary surface."

Complainant contends that the CAFC "did not disturb any of the findings of fact entered by the [ALJ] and adopted by the Commission with respect to the terms 'entrance nip' and 'adjacent'." 80/ In complainant's view, the CAFC reversed on the basis that the Commission's decision was not supported by substantial evidence, not as a factual matter but because the findings with respect to the two terms in question were based upon improper interpretation and application of governing law. 81/ However, complainant maintains that this determination does not disturb the Commission findings of fact concerning the definition of entrance nip and adjacency. 82/

The claims of a patent provide the concise, formal definition of the invention. 83/ However, a patentee's choice of terms may cause some difficulty in understanding the language used in the claims. 84/ Thus, the words of the claims must be construed in connection with other parts of the

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78/ Id. at 6, citing RX-377, amendment A at 7.
79/ Id. at 6-7; CX-1, col. 17, lines 51-54.
80/ Brief of Complainant on Review at 6.
81/ Id. at 7.
82/ Id.
83/ W.L. Gore & Associates, Inc. v. Garlock, Inc., 721 F.2d 1540, 1548 (Fed. Cir. 1983); Environmental Designs v. Union Oil Co. of Cal., 713 F.2d 693, 699 (Fed. Cir. 1983).
84/ Autogiro Co. of America v. United States, 384 F.2d 391, 397 (Ct. Cl. 1967); see also Fromson v. Advance Offset Plate, Inc., 720 F.2d 1564, 1569 (Fed. Cir. 1983).

patent instrument, i.e., the specification which serves as a concordance to the claims. 85/ In addition to the specification, significant evidence of the scope of a claim may be gleaned from other claims as well as from other patent documents such as the prosecution history and patent drawings. 86/

There are several important caveats to interpretation or construction of claim language. First, the fact that claims are interpreted in light of the specification does not mean that everything expressed in the specification is to be read into the claims, nor must the specification embrace all possible forms in which the claimed invention is to be reduced to practice. 87/ Similarly, where some claims are broad and others are narrow, the limitations of the narrower claims may not be read into the broad claims either to avoid invalidity or to escape infringement. 88/ Essentially, one cannot broaden or narrow the claims to give the patentee something different from what he has set forth. 89/ Rather, claim interpretation in light of the specification and relevant patent documents is a process whereby the meaning of claim terminology may be ascertained and the boundaries of the claims' meaning established. 90/

In this instance, the CAFC found that the Commission had gone beyond the proper bounds of claim interpretation by limiting the claims of the '758 patent to preferred embodiments and specific examples in the specification where the specification does not require such limitations. Contrary to

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85/ Autogiro, 384 F.2d at 397-98.
86/ Autogiro, 384 F.2d at 397-99; Fromson, 720 F.2d at 1570.
87/ Smith v. Snow, 294 U.S. 1, 11 (1934); Raytheon Co. v. Roper Corp., 724 F.2d 951, 957 (Fed. Cir. 1983).
88/ Kalman v. Kimberly-Clark Corp., 713 F.2d 760, 770 (Fed. Cir. 1983) cited in Fromson, 720 F.2d at 1570.
89/ Autogiro, 384 F.2d at 396.
90/ Autogiro, 384 F.2d at 399.

complainant's contentions' we believe that this determination led the CAFC to explicitly reject all of the findings of fact concerning the terms "entrance nip" and "adjacent". Moreover, the CAFC's ruling requires the Commission to give a broad reading to these terms in light of the admonition that the specification of the '758 patent places no particular restriction upon the manner in which the terms are to be read.

Concomitantly, the CAFC's ruling implies risk of reversal should the Commission attempt to interpret other claim language in an impermissibly restrictive fashion. In this context, respondents' argument that the Commission reexamine the ALJ's construction of the claim term "curved stationary surface" is well taken. This particular terminology was not essential to the Commission's finding of non-infringement and, thus, was not scrutinized by the CACF. However, the CAFC's decision indicates that this language should be reinterpreted if the ALJ based his construction upon preferred embodiments or specific examples described in the specification. 91/

Turning first to the term "entrance nip," the broad definition of the term as the convergence between the two foraminous wires or belts remains intact as an overall description. 92/ The issue before the CAFC and, now, before the Commission is the precise nature and shape of the entrance nip

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91/ We note that complainant's contention that the CAFC's decision with respect to claim interpretation for determining infringement has no effect on validity is without legal basis. As the CAFC has noted:

> the invention patented is no more and no less than what the finally issued claims, as construed by the court, define; and they must be construed in the identical way for both infringement and validity.

Kimberly-Clark Corp. v. Johnson & Johnson, 745 F.2d 1437, 1449 (Fed. Cir. 1984). As a result, the CAFC's specific rejection of the Commission's definition of "entrance nip" and "adjacent" as well as its general proscription against restricting the claimed invention to preferred embodiments apply to all aspects of the Commission's patent analysis.

92/ ID at 8 (FF 10).

described in the claims. As noted above, the Commission had determined that "entrance nip" meant a gradual nip into which a jet stream of stock is injected directly. 93/ Further, the Commission found that there is no Fourdrinier section preceding the twin-wire former described in the '758 patent, and that the entrance nip is shaped by the curved stationary surface described in the claims. 94/

Absent these limitations, we conclude that the term entrance nip is susceptible to a broad interpretation, particularly in light of the fact that the relevant patent documents provide no further guidance. Indeed, the CAFC found infringement by respondents' devices which include a nip which is established in the vicinity of the forming roll between the top wire and the bottom wire. 95/ This nip is rather abrupt, beginning at the point at which the two wires approach each other and ending at about the six o'clock position on the forming roll. 96/ Thus, the CAFC found that the term "entrance nip" as used in the '758 patent reads on devices in which the wires abruptly approach each other to receive stock from a Fourdrinier section and ends where they have reached general parallelism, i.e., the point where the wires are spaced apart only by the material therebetween. Using this approach, we determine that the '758 patent does not require that the nip be shaped by a curved stationary surface.

Similarly, the CAFC's rejection of the Commission's earlier findings with respect to the term "adjacent" in describing the relationship of the entrance nip to the curved stationary surface leaves the term open to broader

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93/ Id. at 12-13 (FFs 24, 28); 25 (FF 53).
94/ Id.
95/ Id. at 15 (FFs 32, 33).
96/ Id.

interpretation. The Commission originally determined that adjacency required the entrance nip to be in some "direct functional relationship" between the nip and the curved stationary surface. 97/ This relationship required that at least some portion of the entrance nip lie directly upon the curved stationary surface, which gives to the nip its gradual shape. 98/ In this relationship, there would be no intervening elements between the entrance nip and the curved stationary surface. 99/

The CAFC overturned these findings and gave a broader reading to the claims through its infringement determination. The devices found by the CAFC to infringe, respondents' Sym-Former R and New Sym-Former, include abrupt nips which do not work in a functional relationship with a curved stationary surface. 100/ Indeed, in the infringing devices, the nip ends before the upstream end of the curved surface, with an intervening element between the nip and the surface. 101/

The CAFC's decision interprets the claims in accordance with the plain meaning of the terms "entrance nip" and "adjacent." The problems of this approach are highlighted by the definitional difficulties experienced by the witnesses at the evidentiary hearing before the ALJ. For example, Mr. Gustafson, one of the inventors of the '758 patent, testified that "adjacent . . . can be relative". 102/ Indeed, complainant's counsel noted that "adjacent has different meanings and different connotations in different

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97/ Id. at 19 (FF 44).
98/ Id. at 13 (FF 25); 182-26 (FFs 43-45).
99/ Id. at 20-21 (FF 48).
100/ Id. at 19 (FF 45).
101/ Id. at 19 (FF 46); 26 (FF 54).
102/ Id. at 21 (FF 49).

circumstances." 103/ Virtually the only concrete guide available to the Commission is the broad treatment accorded the claims by the CAFC in reading them on the accused devices.

Viewed in light of the CAFC's decision and the evidence of record, we believe that two broad definitions of the claims are apparent. First, "entrance nip" must be "a nip . . . for receiving the stock" defined by the positioning of the top and bottom wire loops. 104/ This nip may be a gradual nip which receives a jet stream of stock but also encompasses other types of nips, including abrupt nips, such as those found by the CAFC to infringe, and those nips in which the stock is sprayed directly onto the bottom wire with the top wire subsequently being imposed. 105/ Accordingly, we define "entrance nip" as a nip between the first and second foraminous wires for the reception of web-forming stock which begins where the wires approach one another to receive the stock and ends where they have reached substantial parallellism. 106/

With respect to the term "adjacent", we likewise have applied a broad interpretation of the claim language in order to conform to the CAFC's decision. Clearly, an entrance nip that is adjacent to the stationary curved surface may include the functional relationship described in the ID. However, broadly interpreted, the term "adjacent" may also describe a relationship in which no portion of the entrance nip lies upon the arcuate shoe and in which

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103/ Id.
104/ CX-1, col. 2, lines 18-23.
105/ Id. col. 8, line 51; TR 488 (Waller).
106/ CX-1, col. 9, lines 18-23, col. 12, lines 28-34.

there may be intervening elements between the downstream end of the nip and the shoe. 107/

The CAFC's general caveat against limiting claims to preferred embodiments is also applicable to the interpretation of the other terms used in the '758 patent. As noted above, respondents believe the ALJ improperly limited the expression to curves of constant or increasing radius in distinguishing the '758 patent from prior art. Our examination of the ID indicates no point at which the ALJ unequivocally restricted the scope of the curved surface described in the claims to a particular configuration. However, certain findings of fact indicate that the ALJ probably limited the claims to exclude curved surfaces having a small initial radius of curvature (i.e., a parabolic shape) or a curve followed by a flat run (i.e., a parabola followed by a curve of infinite radius). 108/ In addition, the ALJ appears to have read all claims as requiring that the curved surface and the rotary cylinder define a continuous bi-radii path having a first radius of curvature substantially larger than the second. 109/

The specification of the '758 patent does not require the curved stationary surface to be limited to a particular curve shape. The preferred embodiments variously describe a curve having "a constant radius of curvature or a decreasing radius of curvature", 110/ a convex surface, and " an essentially flat surface (having an essentially infinite radius)". 111/

107/ Indeed, the CAFC cautions that the addition of elements to the '758 patent by an infringer would not exclude its devices from coverage by the claims. Beloit, slip. op. at 4.
108/ See, e.g., ID at 75-77 (FFs 152, 153, 155).
109/ See, e.g., id. at 72 (FF 145).
110/ CX 1, col. 2, lines 45-47.
111/ CX-1, col. 17, lines 51-55.

Indeed, during the prosecution of the parent application to the '758 patent, complainant's patent counsel stated that the "curved stationary surface is not limited to one having a decreasing radius of curvature since the invention encompasses any type of curved surface." 112/ Accordingly, we are of the opinion that an interpretation of the term "curved stationary surface" consistent with the CAFC's ruling and with the relevant patent documents would have the claim language broadly encompassing all curves.

As to the bi-radii path defined by the curved surface and the following rotary cylinder, we find that the ALJ erroneously injected this requirement into all of the disputed claims of the '758 patent. The larger-radius/smaller-radius path of wire travel is a limitation found only in claim 10 and its dependent claims. As a matter of law, this requirement cannot be imposed upon the broader claims at issue. 113/ In addition, it must be read consistently with a curved stationary surface which encompasses all forms of curves including an essentially flat surface. Such an interpretation is entirely consistent with the specification, which envisions a continuous bi-radii path of curvature, followed by a smaller radius of curvature. 114/

C. Validity of the '758 patent under 35 U.S.C. § 102.

The ALJ determined that the claims 1, 2, and 10 of the '758 patent are not invalid under 35 U.S.C. § 102(b) and (e) as anticipated by U.S. Letters Patent 3,232,825 issued to D.E. Robinson (the Robinson patent) on February 1,

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112/ RX-377, Amendment A at 7, Item 4.
113/ Kalman, 713 F.2d at 770.
114/ CX-1, col. 77, lines 51-56, 72-75; see also Figure 4.

1966. 115/ The ALJ determined that the disclosure of Robinson, particularly Figure 6 of Robinson, "falls far short" of anticipating claims 1, 2, and 10 of the '758 patent because Robinson only contemplates pairs of drainage grating assemblies as opposed to the single grating claimed in the '758 patent as the "curved stationary surface" and because the grates employed in Robinson include "straight" grating assemblies as opposed to those claimed in the '758 patent. 116/ Moreover, the ALJ found that Figure 6 of Robinson does not include a number of other elements described in claims 1, 2 and 10 including: (1) a curved stationary surface positioned adjacent the entrance nip, the curved stationary surface having a relatively large radius of curvature; (2) a rotary cylinder positioned downstream in close working relation with the curved stationary surface to define a continuous bi-radii curved path of wire travel having a first radius of curvature substantially larger than a second radius of curvature; and (3) a first wire free of restraining means on its outer surface opposite the rotating cylinder, as required in claims 1 and 10. 117/ Finally, the ALJ found that, while Robinson inherently dewatered stock centrifugally this was not an "express objective" of the

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115/ Under 35 U.S.C. § 102, a person shall be entitled to a patent unless:

> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of the application for patent in the United States, or
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> * * * *
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> (e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.
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116/ ID at 120-121; 67-68 (FFs 135-136).

117/ Id. at 121; 68-69 (FFs 137-138).

invention. 118/ Based upon his findings that the prior art Robinson patent does not include each and every element of claims 1, 2 and 10, the ALJ found that there was no anticipation under 35 U.S.C. § 102(b) and (e).

Respondents contend that the ALJ's findings with respect to Robinson are clearly erroneous in light of the evidence of record and the "plain teachings" of the Robinson patent itself, which shows all of the elements of claims 1, 2 and 10. 119/ Further, respondents allege a number of errors of law in the ALJ's analysis including, in particular, the conclusion that Robinson only includes pairs of grating assemblies and the purported failure to consider the "inherent" teachings of Robinson which, in respondents' view, demonstrate centrifugal dewatering as claimed in the later '758 patent.

Specifically, respondents argue that Figure 8 of Robinson discloses a single curved grating assembly, 215, upon which top and bottom permeable belts converge to create a forming zone. 120/ They note that upon the curved grating are curved belt-contacting blades, 216, which cause the belts to converge in a controlled manner. 121/ Respondents maintain that the specific language of the specification of Robinson allows for a single curved stationary surface as described in claims 1, 2 and 10 of the '758 patent. 122/ In addition, respondents note that claims 9 and 10 of Robinson are directed only to a single curved supporting surface. 123/

118/ Id. 68 (FF 138).
119/ See generally Respondents' Brief on Review at 2-28; Respondents' Reply Brief at 8-15.
120/ Respondents' Brief on Review at 11, citing Robinson, col. 10, line 70 to col. 11, line 68.
121/ Id.
122/ Respondent's Brief on Review at 11.
123/ Id. at 12.

Respondents further argue that the ALJ erred in finding no anticipation on the ground that the grating assemblies disclosed in Robinson are straight. They urge the Commission to find that the grating assembly 215 of Figure 8 and assemblies 20' and 21' of Figure 6 are indeed curved. In addition to the specification, respondents point out that the claim language of Robinson describes a permeable curved supporting surface in the same manner as that in the '758 patent. 124/

Respondents also contend that the ALJ's finding that the first wire in Robinson is not free of a restraining means is clearly erroneous and an improper basis for nonanticipation. Respondents maintain that the first wire as described in the '758 patent is the outer wire F1, i.e., the wire that does not engage the rotary cylinder. 125/ Respondents then assert that nothing in Robinson suggests that the outer or first wire (11' of Figure 6 and 208 of Figure 8) is not free of a restraining means opposite the rotating cylinder. In addition, respondents challenge the ALJ's finding that the Robinson reference does not define a continuous bi-radii path of wire travel, pointing out that the bi-radii path limitation applies only to claim 10 of the '758 patent and its dependent claims and that Figure 6 of Robinson clearly shows a curved stationary surface 21' followed by roll C. 126/ Finally, respondents contend that Robinson inherently teaches centrifugal dewatering to anticipate claims 1, 2 and 10.

On the other hand, complainant generally maintains that respondents have failed to make the requisite "exacting claim comparison with the allegedly

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124/ Id. at 15-18.
125/ Id. at 19.
126/ Id. at 21-22.

anticipating reference" to overcome the presumption of validity. 127/ Essentially, complainant contends that respondents have failed to systematically show that each and every element of claims 1, 2 and 10 lie within "one embodiment of Robinson." 128/ In complainant's view, respondents have attempted to combine elements from various embodiments from Figures 6 and 8 of Robinson to derive a "shopping list" of anticipatory elements. Complainant maintains that such an approach is impermissible under 35 U.S.C. § 102.

Complainant next turns to four specific contentions relating to its primary argument that respondents have improperly mixed embodiments within Robinson or distorted the teachings of Robinson to show anticipation. First, complainant urges that the Robinson grating structure is different from the curved stationary surface of the '758 patent claims, that the '758 patent departed from the prior art by using only one curved stationary surface to obtain convergence of the top and bottom wires. 129/

Complainant also argues that the ALJ did not err in finding that Robinson does not teach a single grating structure curved along its entire length as taught by the '758 patent, taking the position that claims 1, 2 and 10 of the '758 patent are limited to a curved stationary surface disposed on the same side of the traveling wires as a rotating cylinder. 130/ Third, complainant asserts that the claims are further limited by a structure teaching a top wire which is free of restraining means on its outer surface opposite the rotary

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127/ Reply Brief of Complainant at 1.
128/ Id. at 1-2.
129/ Id. at 8.
130/ Id. at 6, 10.

cylinder and by a function teaching centrifugal dewatering. 131/ Complainant contends that for claims 1, 2, and 10, as limited, to read on Robinson, Figure 8 would have to be inserted and placed above the wires in Figure 6 or Roll C of Figure 6 would have to be moved and one grating assembly would have to be removed from Figure 6. 132/ Finally, complainant argues that the Robinson reference does not show a bi-radii path of wire travel and centrifugal dewatering.

A party asserting that a patent claim is anticipated under 35 U.S.C. § 102(b) or (e) must demonstrate, among other things, "identity of invention." 133/ Identity of invention is a question of fact which ordinarily requires a challenger of the patent to show that each element of the claim or claims at issue is found, either expressly or under principles of inherency, in a single prior art reference or in a single prior art device or practice. 134/ In analyzing identity of invention, the Commission is required to determine (1) what is the scope of the claim (i.e., what are all the elements of the claimed invention); (2) what does the prior art reference disclose; and (3) does this disclosure include all of the elements as claimed. 135/

131/ Id. at 12-17.
132/ Id. at 12, 14.
133/ Tyler Refrigeration v. Kysor Industrial Corporation, 777 F.2d 687, 689 (Fed. Cir. 1985); Rosemount, Inc. v. Beckman Instruments, 727 F.2d 1540, 1545 (Fed. Cir. 1984); Kalman v. Kimberly-Clark Corp., 713 F.2d 760, 771 (Fed. Cir. 1983), cert. denied, 104 S. Ct. 1284 (1984).
134/ Tyler Refrigeration v. Kysor Industrial Corporation, 777 F.2d at 689; S.S.I.H. Equipment S.A. v. United States International Trade Commission, 718 F.2d 365, 377 (Fed. Cir. 1983).
135/ See S.S.I.H. Equipment S.A., 718 F.2d at 377. We note that the disclosure must show something more than a mere "boxful of elements." To the contrary, the elements in the reference must be combined as in the claim.

A non-identical device has been viewed as anticipating when the differences between it and the claimed invention are merely non-patentable distinctions. 136/ More succinctly, the law of anticipation does not require that the prior art reference "teach", in exactly the same words, what the claimed invention teaches. 137/ Rather, it is only necessary that the claims under attack "read on" something disclosed in the prior art reference, i.e., that there be "a teaching with respect to the entirety of the claimed invention." 138/ Moreover, the "teaching" of the prior art will include those functions or properties inherently possessed in the reference, inherency being defined as a result or property which inevitably or naturally occurs. 139/

It also should be noted that 35 U.S.C. § 102(b) provides that an invention is anticipated if it was patented or described in a printed publication in this or a foreign country or was in public use or on sale in this country more than one year prior to the date of the patent application in the United States. 140/ On the other hand, section 102(e) only requires that the invention be described in a patent granted on an application by another

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136/ See Rosemount, Inc. v. Beckman Instruments, Inc., 727 F.2d at 1545; Kalman v. Kimberly-Clark, 713 F.2d at 772.

137/ Structural Rubber Products v. Park Rubber, 749 F.2d 707, 716 (Fed. Cir. 1984).

138/ Id.; see also, Kalman v. Kimberly-Clark Corp., 713 F.2d at 727. We note that for purposes of anticipation, missing elements may not be supplied by one of ordinary skill in the art or by reference to another disclosure. Such an approach relates to questions of obviousness arising under 35 U.S.C. § 103, rather than anticipation under 35 U.S.C. § 102. See Connell v. Sears, Roebuck & Co., 722 F.2d 1542, 1548 (Fed. Cir. 1983), cited in Structural Rubber Products v. Park Rubber, 749 F.2d at 716.

139/ See, e.g., Tyler Refrigeration v. Kysor Industrial Corporation, 777 F.2d at 689; see also P. Rosenberg, Patent Law Fundamentals § 7.03 (2d ed. 1985).

140/ See ID at 62-64 (FFs 125-128). The priority date of an invention is the effective filing date of a patent application and, thus, the latest date of invention. However, under U.S. law, there may be a "swearing back" to events prior to the application date to prove priority of inventorship.

inventor filed earlier than the date of invention claimed in the challenged patent. 141/ In this instance, the asserted anticipatory reference, the Robinson patent, issued on February 1, 1966, more than one year before the January 24, 1968, priority date for the '758 patent. 142/ Thus, the time constraints of both statutory sections are satisfied.

Having established that the asserted prior art reference satisfies the time limitations of sections 102(b) and (e), we turn to the question of identity of invention between the Robinson patent and the '758 patent. First, we must consider the scope of the claims of the '758 invention. 143/ As has been discussed, the claim language of the '758 patent must be viewed broadly without limiting the claims to preferred embodiments as mandated by the CAFC. The effect of this approach upon the claim terminology was dismissed in the preceding section of this opinion. Accordingly, the question of identity of invention between Robinson and the '758 patent turns upon the two interrelated inquiries of the actual disclosure of Robinson and whether that disclosure includes all of the elements claimed in the '758 patent.

In this instance, we determine that Robinson reveals all of the elements of claims 1, 2 and 10. A side-by-side comparison of these claims with the Robinson patent demonstrates clearly and convincingly that each and every element of the claims at issue are present in Robinson either expressly or under principles of inherency. 144/ Rather than reiterate this comparison, which is included in the appendix to this opinion, we turn instead to

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141/ 35 U.S.C. § 102(b).
142/ 35 U.S.C. § 102(e).
143/ See supra at 22-30.
144/ See claim comparison chart. Appendix at 1-5.

complainant's specific arguments concerning the identity between Robinson and the claimed invention or lack thereof.

As a preliminary matter, complainant has raised a question concerning the disclosure of the proper prior art Robinson reference against which the claims of the '758 patent are to be measured. In complainant's view, the reference is restricted for section 102 purposes to one single embodiment of Robinson, such as that shown in Figure 6, rather than the Robinson patent in toto. 145/ Complainant further argues that the prior art reference may not be modified in any way to support anticipation under section 102. 146/ However, while complainant is correct in stating that the asserted prior art patent must be measured solely by what it teaches, complainant has provided no legal support for the proposition that anticipation may be found only as to a single embodiment of a prior art reference under section 102. 147/

To the contrary, section 102(b) provides, inter alia, for anticipation of an invention that was patented in this or another country more than one year prior to application for patent in the United States. Similarly, section 102(e) states that an invention is anticipated if, prior to its invention, it was described in a patent granted on an application for patent by another in the United States. Nothing in the statute delimits anticipatory prior art to a single embodiment in an earlier patent, and courts have repeatedly relied on entire patents as well as single embodiments in prior art references. 148/

145/ See Reply Brief of complainant at 2-3.
146/ Id.
147/ See id. citing General Electric Co. v. United States, 206 USPQ 344, 346 (Ct. Cl. Tr. Div. 1979).
148/ See, e.g., S.S.I.H. Equipment, 718 F.2d at 377 (patent as prior art reference), Tyler Refrigeration v. Kysor Industrial Corporation, 777 F.2d at 689 (two different claims of single patent as anticipatory art).

However, as is indicated in the attached claim chart, all of the elements of claims 1, 2, and 10 of the '758 patent read on Figure 6 of Robinson, thereby obviating complainant's contentions regarding the necessity for "mixing embodiments" to obtain the claimed invention.

With regard to the existence of a curved stationary surface in Robinson, we note that this surface as claimed in the '758 patent encompasses any type of curve, with the limitation that it be adjacent the entrance nip in all cases. 149/ In Figure 6 of Robinson, grating assembly 21' is "a permeable curved [stationary] surface" which may incorporate a series of wire contacting edges as shown in Figure 4 as 30 and 31. 150/ Figure 6 of Robinson depicts an alternate embodiment of Figure 15, including grating assembly 21'. 151/ The language of both the claims of Robinson and the specification make clear that a grating assembly is one, rather than two, curved surfaces, and that one assembly may be used to establish a controlled convergence of the forming wires. 152/ Moreover, surface 21' in Figure 6 is "adjacent" the entrance nip formed by wires 10' and 11', which converge into a forming zone along its surface. 153/

Figure 6 of Robinson also includes a rotary cylinder on the same side of the wires as the curved surface, and the wires pass around or "wrap" this cylinder with the first wire free of a restraining means as taught by the '758 patent. In the specification and drawings to the '758 patent, the first wire

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149/ See notes 109-111 supra and accompanying text.
150/ Robinson, claim 9, col. 13, line 66; claim 10, col. 14, line 3.
151/ Robinson, col. 5, lines 59-64; col. 4, lines 53-75.
152/ Robinson, claims 9 and 10; col. 1, lines 49-50.
153/ Id. at col. 5, lines 64-75; col. 6, lines 1-13.

is depicted as the top wire, but there is no language restricting it to a "top" wire. In fact, the only definitional language in the claims on the specification concerning the claimed first wire is that it is arranged with a second wire to form an entrance nip and that the first wire is free of restraining means opposite a rotary cylinder. 154/ Therefore, we find that, in Figure 6 of Robinson, wire 11' is arranged with wire 12' to form an entrance nip, and wire 11' is free of restraining means opposite a rotary cylinder, Roll C. 155/

Concerning claim 10 of the '758 patent, complainant maintains that Robinson, particularly Figure 6 of Robinson, does not disclose a continuous bi-radii path defined by the rotary cylinder and curved surface of wire travel having a first radius of curvature substantially larger than the second. Although Robinson does not claim such an arrangement in these precise words, Figure 6 and the accompanying description nonetheless depict such a structure. 156/ Claim 10 of the '758 patent relates to an arrangement of a curved surface and a rotary cylinder defining a larger, then smaller continuous curved path, which may encompass essentially any curved surface of large or infinite radius (i.e., a flat surface) followed by a roll which may include a suction element as is shown in Figure 8 as suction roll 519. 157/ Likewise, Figure 6 of Robinson includes a convexly curved stationary surface

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154/ CX-1, Claim 1, Col. 22, lines 44-47, 62-63.

155/ Both in deposition and at trial, complainant's expert agreed that Robinson included this claim element. TR 271, lines 17-19 (Waller); RX-392 at 661.

156/ We note that the law of anticipation does not require word-for-word correspondence, but only that the prior art references contain a teaching with respect to the entirety of the claimed invention. See Structural Rubber Products, 749 F.2d at 716.

157/ See also CX-1, Col. 17, line 51-75.

21' immediately followed by Roll C, which may or may not include a suction element. 158/ Both Figure 6 itself and the testimony of record demonstrate that surface 21' and Roll C define a bi-radii path having a first radius of curvature substantially larger than the second. 159/

The final factual issue to be resolved is whether Robinson discloses centrifugal dewatering as described in claims 1, 2 and 10 of the '758 patent. Both parties acknowledge and the ALJ found that Robinson does not expressly teach centrifugal dewatering. 160/ However, the ALJ did note that "centrifugal dewatering around roll C, with the assistance of gravity, may be inherent from the structure disclosed in Figure 6." 161/ As has been discussed, the teaching of a prior art reference will include those functions or properties both expressly taught and inherently possessed by the reference. 162/ For an element or function to be inherent, it must inevitably or naturally occur in the prior art reference. 163/ In the device shown in Figure 6 of Robinson, wires or permeable belts 10' and 11'', travelling at speeds of about 2,000 feet per minute, wrap Roll C at an angle of about 15°. 164/ The uncontradicted testimony of both complainant's and respondents' expert witnesses show that the 15° wrap is sufficient to exert centrifugal force upon the material between wires 11' and 12'; and, if the optional vacuum in Roll C were eliminated, some centrifugal dewatering necessarily would occur

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158/ See Robinson, Figure 6, col. 8, line 51.
159/ Id., Figure 6; TR 268-271; 275-276.
160/ ID at 68 (FF 138).
161/ Id. (Emphasis supplied).
162/ See, e.g., Tyler Refrigeration v. Kysor Industrial Corporation, 677 F.2d at 689.
163/ Id. (a function inherent when it "naturally occurs").
164/ Robinson, Col. 8, line 51-52; Col. 10, lines 38-40.

at that roll. 165/ Accordingly, Figure 6 of Robinson discloses each and every element of claims 1, 2, and 10 of the '758 patent, thereby rendering those claims invalid under 35 U.S.C. §§ 102(b) and (e). 166/

D. Validity of the '758 Patent under 35 U.S.C. § 103

Respondents have argued that four prior art patents which were not before the patent examiner during the prosecution of the application for the '758 patent render that patent invalid as obvious under 35 U.S.C. § 103. 167/ Specifically, respondents maintained that the combined teachings of U.S. Letters Patent 3,232,825 (Robinson) and U.S. Letters Patent 3,438,854 (Means) render claims 1-4, 10 and 11 invalid for obviousness to the person of ordinary skill in the art. In addition, respondents contended that the invention of claims 1-4, 7, 8, 10 and 11 would have been obvious to a person of ordinary skill in light of French Patent No. 1,473,988 (Justus) in combination with U.S. Letters Patent 3,150,637 (Lee), or further in combination with the Means patent.

165/ TR 266-268, 273-275, 297-301 (Waller); TR 1086-1087, 1158-1160 (Kalmes). We find that the contention that its expert was testifying only to a hypothetical construct is without basis. The specification of Robinson clearly teaches that the suction in Roll C may be omitted. Robinson, col. 8, line 51. Therefore, complainant's witness admitted to the inherency of centrifugal dewatering in a device clearly contemplated by Figure 6 of Robinson. See Tylor Refrigeration v. Kysor Industrial Corp., 777 F.2d at 689 (effect of admission of inherency in trial testimony).

166/ On cross-examination at hearing and, particularly in deposition, complainant's witness Mr. Waller admitted the existence of virtually every element of claims 1, 2 and 10 in the Robinson prior art reference. See TR 247, 268; RX 392 at 659-666.

167/ 35 U.S.C. § 103 provides:

> A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Respondents first address the question of the definition of a person having ordinary skill in the relevant art. Acknowledging that the ALJ properly determined that the person of ordinary skill was highly educated, respondents maintain that the ALJ failed to identify the actual level of skill such a person would have attained, i.e., what kinds of changes, modifications, and manipulations to existing structures such a person was capable of at the time of the invention of the '758 patent. 168/ In addition, respondents argue that the ALJ failed to assess the person of ordinary skill in terms of prior approaches to the problems in paper forming, the rapidity of innovation in the field, and the sophistication of the technology involved. 169/

Respondents next turn to the issue of whether the claims of the '758 patent would have been obvious to a person of ordinary skill based upon the combined teachings of Robinson and Means. 170/ First, respondents note that the Means patent teaches an improvement in certain aspects of Robinson and reflects an express awareness on the part of the inventor of the possibility of combining the teachings of the two patents. 171/ In turn, the incorporation of Robinson in Means and substitutability of Means, particularly curved forming box 33, into Robinson is obvious to everyone capable of reading the patent, let alone a person of ordinary skill in the art. 172/ Given the substitution of the forming box 33 from Means into Robinson, respondents urge that Robinson includes a single curved stationary surface defining a continuous bi-radii path with roll C. 173/

168/ Respondents' Brief on Review at 30, 34.
169/ Id. at 31.
170/ Id. at 34-35.
171/ Id. at 37.
172/ Id. at 37.
173/ Id. at 37-38. Respondents note that this substitution overcomes three of the five bars to anticipation by Robinson relied upon by the ALJ.

Respondents also contend that the Robinson/Means combination would disclose a first wire without restraining means opposite a rotary cylinder solely within the Robinson reference. As respondents argued in connection with the anticipation issue, this element is roll C of Figure 6 of Robinson. Respondents maintain that centrifugal dewatering is inherent in Means, as well as Robinson. This was proven, according to respondents, by the operation of complainant's St. Francisville PM2 machine, which was manufactured in 1966 in accordance with the teachings of Means. 174/ Respondents further argue that the presence of a top scraper 46 in Means does not negate inherent centrifugal dewatering in the device, noting that the suit patent also employs such an element. 175/ Consequently, respondents contend that Robinson in combination with Means renders claims 1-4, 7, 8, 10 and 11 obvious. 176/

Respondents also assert that all of the claims at issue are obvious in light of the combination of the Justus French patent with Lee and Means. Preliminarily, respondents address the question of the ALJ's finding that the claimed curved stationary surface must be circularly curved on a radius larger than the radius following the rotary cylinder. 177/ As they argued earlier, respondents maintain that the file history to the '758 patent and other relevant evidence of record shows that this surface encompasses any type of curve. 178/

Turning to the Justus French patent, respondents first contend that Figure 2 of Justus teaches a combination of a curved forming shoe 240 and

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174/ Respondents' Reply Brief at 12.
175/ Respondents' Reply Brief at 12-13.
176/ Respondents have not provided a reference with respect to claim 4 within Robinson and Means, and have not carried this burden under 35 U.S.C. § 282 to prove this claim obvious in light of those references.
177/ See ID at 58-59 (FF 117).
178/ Respondents' Reply Brief at 42-43.

rolls 212 and 2323 to describe curved wire run for element 211. Respondents maintain that Justus itself shows a curved supporting surface as described in claims 1-9 of the '758 patent. Moreover, respondents assert that the modification of the parabolically curved surface in Justus to other forms of curve would have been obvious to the reader of Means because that patent describes the use of a number of different curves. 179/

Next, respondents specifically urge reversal of Finding of Fact 156 which states that Justus does not include a rotary cylinder in a close working relationship with a curved stationary surface to define the bi-radii path as described in claims 10 and 12 of the '758 patent. 180/ To the contrary, respondents point to rotary cylinder 232 in Justus which immediately follows the belt converging means R-200. In Justus, forming belts also are described as leaving curved surface 240 and pass around rotary cylinder 232, around which there is centrifugal dewatering. According to respondents, a bi-radii path is formed by elements 240 and 232, with surface 240 having a larger radius than cylinder 232. 181/

Finally, respondents urge that the Lee reference teaches the interchangeability of wires and felts as used in Justus and Means. Lee, which is directed to twin wire paper formation using centrifugal dewatering, discusses the use of both felts and wires depending upon the stock drainage characteristics desired. In respondents' view, the person of ordinary skill reading this reference would be able to select from the options and make the substitution of twin wires for twin felts or a wire and a felt. 182/

179/ Id. at 45-46.
180/ Id. at 46-47.
181/ Id. at 47.
182/ Id. at 48-50.

Respondents therefore maintain that all of the claims at issue would have been obvious in light of the combination of Justus with Means and Lee. 183/

Complainant has countered these assertions with the argument that the ALJ implicitly reached a correct determination of the level of ordinary skill in the art. In complainant's view, the ALJ complied with the requirements of law for determining ordinary skill in the art by evaluating the problems of the prior art and how they were solved by other persons skilled in the art. Complainant further maintains that the ALJ considered the prior art references in combination and reached a legally sufficient conclusion of nonobviousness.

Complainant also addresses the differences between the references cited by respondents in connection with the obviousness issue. First, complainant maintains that the Means patent and its embodiment in the St. Francisville PM2 are distinguishable from the '758 patent in that their aim is not uncontrolled centrifugal dewatering. 184/ By contrast, complainant urges that the Means patent and the PM2 include a top scraper and the use of a vacuum which inhibit centrifugal dewatering, and complainant points out that several witnesses testified that they had never observed centrifugal dewatering in the PM2. 185/ Moreover, complainant asserts that Means does not include a rotary cylinder corresponding to that of the '758 claims because it lacks a sufficient degree of wrap for "significant" dewatering and on the grounds that the separation of the curved surface in Means and roll 50 by a long stretch of wire prevents a close-working relation between these elements. 186/

183/ Respondents present a chart comparing the remainder of the '758 claims with the asserted references. Id. at 52-53.
184/ Brief of Complainant on Review at 26.
185/ Id. at 26-28.
186/ Id. at 28.

Complainant then concludes with two points. First, complainant states that the PM2, which was made in accordance with Means, was a "colossal disaster." By contrast, devices made in accordance with the '758 patent enjoyed commercial success, thereby illustrating the differences between it and the Means devices. 187/ Secondly, complainant argues that there simply is no evidence of record to suggest the combination of Means and Robinson. 188/ Accordingly, complainant asserts that the '758 invention would have been nonobvious in light of Robinson and Means.

With respect to the combination of the Justus French patent with Lee and Means, complainant briefly argues that the Justus patent does not contain a curved stationary surface as taught by the '758 patent. Further, complainant asserts that Justus teaches the reverse of the '758 patent by requiring a smaller followed by a larger radius of curvature by virtue of its use of a parabolically curved forming surface. 189/

Complainant also challenges the substitutability of twin wires as described in Lee for the wire and felt shown in Justus. Complainant maintains that there is no basis for combining Lee with Justus or Means and contends that, in fact, Lee describes the basis for distinguishing the use of wires from the felts and wires used in the Justus and Means references. 190/ Further, complainant notes that the patent examiner had withdrawn a rejection of the claims over another patent similar to Justus when complainant pointed to significant drainage differences achieved over the prior art with the use of twin wires in the '758 application. 191/

187/ Reply Brief of Complainant at 25.
188/ Id. at 24.
189/ Brief on Review of Complainant at 31.
190/ Id. at 32-33.
191/ Id.

In considering the obviousness of the invention of the '758 patent, the ALJ first established the level of skill in the art. 192/ The ALJ found that the person of ordinary skill in the art of papermaking technology at the time of the invention of the subject matter of the '758 patent would be an individual with an engineering or similar technical degree in fluid mechanics and mechanical engineering. 193/ In addition to this educational background, the person of ordinary skill would also have several years direct experience in the design, manufacture, or servicing of headboxes and forming sections, including day-to-day troubleshooting of production line machines. 194/ In the alternative, a person of ordinary skill in the art could, according to the ALJ, be a paper mill superintendent with at least 20 years experience. 195/

Next, the ALJ addressed the scope and content of the prior art through an examination of the particular problems faced by the inventor. 196/ He noted that, from a broad perspective, the objective in the papermaking art at the time of the invention of the '758 patent was to achieve higher machine speeds and an improved quality of web as compared to that which was previously attainable. 197/ Development work in the 1950's addressed this problem with twin-wire formers that rapidly dewatered the stock in both directions through the forming wires. 198/ The ALJ found that by the time of the invention of

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192/ ID at 126-127. We note that the ALJ did not follow the prescribed order of determinations in the section 103 analysis. The ALJ reached the question of level of skill in the art before determining the scope and content of the prior art. This approach is of dubious value in light of the fact that one necessarily must ascertain the relevant field of art before describing a person of ordinary skill in that art. See Graham v. John Deere Co., 383 U.S. 1, 127-18 (1966).
193/ ID at 64 (FF 129).
194/ Id.
195/ Id.
196/ Id. at 127
197/ Id. at 37-38 (FF 78).
198/ Id. at 127; 38-39 (FF 79).

the '758 patent those working in the art were concerned with solving the problems that had arisen with twin-wire formers. These problems included loss of fine fibers with too rapid dewatering, poor quality web, spewing at the entrance nip when the wires were unable to accommodate the volume of stock deposited by the headbox, lower machine speeds, and alternatively damage to the wires from excessive suction in dewatering, or damage to the web from certain types of centrifugal dewatering. 199/

The ALJ then determined that the prior art considered by the examiner as well as the additional art of record in this investigation is all concerned with optimizing methods of dewatering stock in light of the foregoing problems. 200/ As the ALJ noted, the prior art accomplished dewatering by varying means, including pressure, tension, gravity, suction, air flow, and centrifugal force. 201/ The ALJ further found that several prior art patents were concerned with the use of a wire and a felt. 202/

The ALJ next summarized the prior art patents, including the four references relied upon by respondents on review as rendering the '758 patent obvious. The ALJ determined, inter alia, that the Justus patent discloses a system which uses a wire and a felt and which includes a stationary surface inside the felt at the point of convergence of the wire and felt. This shoe is curved to conform with the parabolic curve representative of the drainage curve of the stock. After the stationary shoe, the wire and felt pass around a smaller radius roll which results in centrifugal dewatering through the

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199/ Id. at 127; (FF 80).
200/ Id. at 128.
201/ Id. at 128-129.
202/ Id. at 129.

wire. The ALJ distinguished Justus as not including a rotary cylinder to define a bi-radii path and as not using twin wires. 203/

Concerning the patent to Lee, the ALJ determined that the reference is directed to dewatering stock by means of directional changes, including methods of protecting the stock from damage as it changes direction. Thus, dewatering is accomplished by means of centrifugal force through both wires by a reverse wrap. Centrifugal dewatering is also accompanied by suction and air flow. Lee uses two wires and points out the difference in drainage characteristics between wire and felt. 204/

With respect to Robinson, the ALJ found that the patent is directed to dewatering stock without removing fines and without disrupting the web. The objective of Robinson is to remove large amounts of water from the stock substantially immediately after it is discharged from a slice, and to dispose of the water quickly. Robinson devices accomplished this by controlling the convergence of the wires over an appreciable length after the slice, and gently, smoothly, and continuously expressing water from the stock through both wires. The dewatering occurs in a downward direction and also is aided by gravity. 205/

Finally, the ALJ found that the Means patent is directed to solving several problems inherent in twin-wire formers, namely controlling the convergence of the wires while allowing lumps in the stock and snags in the wires to pass; providing inexpensive, but effective suction boxes; and separating the wires without damaging the web. The convergence of the wires

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203/ Id. at 129; 76-77 (FFs 155, 156).
204/ ID at 130; 77-78 (FF 157).
205/ ID at 130-131; 64-69 (FFs 130-138).

is controlled by a curved forming box, which is designed to gradually increase the pressure on the web as it passes over the curved surface. Dewatering occurs as a result of tension on the wires, suction, gravity, and some centrifugal force. 206/ The ALJ specifically distinguished Means on the grounds that it neither specifically discloses centrifugal dewatering nor includes a bi-radii path as contemplated by claim 10.

Having examined the prior art patents, the ALJ further determined that essentially all of the material elements of the '758 patent are disclosed in the prior art. 207/ However, the ALJ concluded that these were neither more pertinent than the art cited by the patent examiner nor disclosed all of the elements claimed in the '758 patent. In particular, the ALJ determined that the prior art did not disclose a bi-radii path of wire travel as claimed in the '758 patent. Based upon these conclusions and his assessment of "secondary considerations" such as the commercial success of complainant's machines, the ALJ found that the invention of claims 1-4, 7, 8, 10, and 11 of Beloit's '758 patent was nonobvious over the prior art as a whole, and over the specific combinations proffered by respondents. 208/ The ALJ made no specific determination with respect to whether the person of ordinary skill as defined in the ID would have combined the references to reach the claimed invention.

In Graham v. John Deere Co., 383 U.S. 1 (1966), the Supreme Court set forth the analytical framework to be used in determining obviousness or nonobviousness under 35 U.S.C. § 103, stating that:

206/ ID at 131; 69-73 (FFs 139-146).
207/ Id. at 132.
208/ Id. at 134-135.

> [T]he 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, failure 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. 209/

The CAFC has held that the determination as to obviousness is a legal conclusion based on factual evidence, 210/ and that the factual considerations on which the legal conclusion is based are those broadly defined in Graham. 211/

The CAFC has defined relevant prior art to be that "reasonably pertinent to the particular problem with which the inventor was involved." 212/ More precisely, relevant prior art is defined in terms of the problem confronting the inventor. 213/ The test is similarity between the elements, problems, and purposes of that problem and the asserted prior art references. 214/

In inquiries into the level of ordinary skill in an art, the CAFC has observed that:

209/ 383 U.S. at 17-18.

210/ Stratoflex, Inc. v. Aeroquip Corp., 713 F.2d 1530, 1535, 218 U.S.P.Q. 871, 876 (Fed. Cir. 1983); Stevenson v. Int'l Trade Comm'n, 612 F.2d 546, 549, 204 U.S.P.Q. 276, 279 (C.C.P.A. 1979).

211/ Medtronic, Inc. v. Daig Corporation, 789 F.2d 903, 905 (Fed. Cir. 1986); Environmental Designs, Ltd. v. Union Oil Co. of Cal., 713 F.2d 693, 695, 218 U.S.P.Q. 865, 868 (Fed. Cir. 1983); Orthopedic Equipment Co. v. All Orthopedic Appliances, 707 F.2d 1376, 1379, 217 U.S.P.Q. 1281, 1283 (Fed. Cir. 1983).

212/ Stratoflex, Inc. v. Aeroquip Corp., 713 f. 2d 1530, 1535, 218 U.S.P.Q. 871, 876 (Fed. Cir. 1983).

213/ Orthopedic Equipment Co., Inc. v. United States, 702 F.2d 1005, 1009 (Fed. Cir. 1983), citing Weather Engineering Corp. of America v. United States, 614 F.2d. 281, 287 (Ct. Cl. 1980).

214/ Weather Engineering Corp. of America, 614 F.2d at 287.

> The important consideration lies in the need to adhere to the statute, i.e., to hold that an invention would or would not have been obvious, as a whole, when it was made, to a person of 'ordinary skill in the art'— not to the judge, or to a laymen, or to those skilled in remote arts, or to geniuses in the art at hand. 215/

The CAFC has listed six factors which are relevant to a determination of the level of ordinary skill in the art:

> (1) the educational level of the inventor;
>
> (2) the type of problems encountered in the art;
>
> (3) the prior art solutions to those problems;
>
> (4) the rapidity with which innovations are made;
>
> (5) the sophistication of the technology; and
>
> (6) the educational level of active workers in the field. 216/

In addition, the person of ordinary skill, a hypothetical construct, is charged with knowledge of all that the prior art disclosed at the time of the invention. 217/

Having established the scope and content of the prior art and a definition of the person of ordinary skill in that art, the inquiry then turns on whether the person of ordinary skill in the art, having all of the asserted references before him, would have been able to produce the structure defined by the claim. 218/ The asserted references need not be physically combinable

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215/ Environmental Designs, Ltd. v. Union Oil Co. of Cal., 713 F.2d 693, 697, 216 U.S.P.Q. 865, 868-69 (Fed. Cir. 1983).

216/ Id. at 696, 218 U.S.P.Q. at 868. See also Orthopedic Equipment Co. v. United States, 702 F.2d at 1019, 217 U.S.P.Q. at 198 (Fed. Cir. 1983).

217/ See, e.g., In re Grout, 153 U.S.P.Q. 742, 744 (C.C.P.A. 1967).

218/ Polaroid Corporation v. Eastman Kodak Co. 789 F.2d 1556, 1571 (Fed. Cir. 1986); Orthopedic Equipment Co., Inc. v. United States, 702 F.2d at 1013.

to render obvious the invention under review. 219/ It is only necessary that the party asserting a section 103 defense show that the person of ordinary skill would have picked and chosen among the asserted elements to arrive at the claimed invention. 220/

a. Relevant prior art and person of ordinary skill.

As a preliminary matter, we believe that the ALJ correctly identified the relevant prior art in terms of the problems facing the inventor of the '758 patent. The test is similarity between the elements and purposes of those problems and the asserted prior art references. Viewed in the context of this standard, the ALJ's definition of relevant art recognizes that the broad objective in the papermaking art at the time of the invention of the '758 patent was to achieve higher machine speeds and improved quality in the web produced. 221/ In trying to attain these goals, the inventor encountered such specific problems as loss of fine fiber distribution with too rapid dewatering resulting in poor quality web; spewing at the entrance nip from rapid injection of a high volume of stock, thereby slowing machine speed; damage to the forming wires from the excessive use of suction in dewatering; and web damage from centrifugal dewatering. 222/

The prior art references asserted by respondents clearly are directed to the solution of these and other problems. For example, the Robinson patent is

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219/ In Re Sneed, 710 F.2d 1544, 1550 (Fed. Cir. 1983).
220/ Polaroid Corp. v. Eastman Kodak Co., 789 F.2d at 1571. The burden of proof with respect to overcoming the presumption of validity under 35 U.S.C. § 282 is more easily carried when the asserted references were not before the PTO during the prosecution of the application for the suit patent. See EWP Corporation v. Reliance Universal, Inc., 755 F.2d 898, 905 (Fed. Cir. 1985).
221/ ID at 127; 35-38 (FF 77, 78).
222/ ID at 127; 39 (FF 80).

aimed at high-speed paper formation without excessive loss of fine fibers or disruption of the web. 223/ A further object of the invention is to provide means for gently removing large quantities of water from web-forming stock immediately after discharge from the headbox slice and rapidly disposing of that water. 224/ Robinson also sought to remedy problems caused by disturbing the jet of stock, 225/ excess suction, 226/ and disruptive pumping of the stock by the initial breast rolls supporting the two wires into an entrance nip. 227/

Similarly, Lee is directed to efficiently dewatering the web at high speeds at a greatly reduced capital expense. 228/ Lee also seeks to remedy the problem of disruption of the web while dewatering occurs by means of directional changers and centrifugal force. 229/ Finally, Lee reaches the problem of speed of dewatering and achieving the particular type and weight of paper desired through a rescitation of the types of forming carrier to be selected, i.e., felts, canvasses, and nylon belts or wires. 230/

The Means patent is directed to representative problems in paperforming such as insufficient control over the rate of convergence of the top and bottom wires resulting in imperfections in the paper and damages to the forming wires. 231/ Other problems addressed by Means include web separation when the top and bottom wires are separated and the inefficiency of suction

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223/ ID at 130-131; Robinson, Col. 1, lines 30-45.
224/ Robinson, Col. 1, lines 39-45.
225/ Id., col. 3, lines 70-75.
226/ Id., col. 3, lines 14-24.
227/ Id., col. 10, lines 74-75.
228/ Lee, col. 1, lines 54-58.
229/ Id., col. 1, lines 51-60.
230/ Id., col. 5, lines 1-29.
231/ Means, col. 1, lines 44-50.

boxes as a primary dewatering means. 232/ Means addresses these problems through the use of a curved forming box which gradually increases pressure on the stock and achieves dewatering by this pressure in combination with gravity, suction and centrifugal force. 233/

The Justus patent (and its equivalent British disclosure) are generally directed to the problems inherent in use of high speed stock jets and high speed, high quality papermaking. 234/ These problems include impairing the quality of the paper with accelerating drainage rates, 235/ stock deflection against the wires with increased flow into the entrance nip, 236/ and backup of the stock in the zone of convergence between the top and bottom web carrying elements. 237/ Justus is directed to solving there problems through the use of a parabolically curved stationary surface followed by a smaller radius roll. 238/ It will be appreciated that the forming carriers in Justus prevent backup by using a gradual convergence of the forming elements resulting in a gradually increasing buildup of pressure in the stock. 239/

From the foregoing, it is apparent that the asserted prior art references were aimed at solving the problems faced by the inventor of the '758 patent. These include problems in control of water movement as well as "difficulties of web sensitivity in some speeds, premature wear of various components,

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232/ Id., Col. 1, lines 51-60.
233/ ID at 131; (FFs 139-146).
234/ See RX-147, p. 1, lines 72-78; RX-100, p. 2, lines 22-25.
235/ RX 147, p. 2, lines 16-51, RX-100, p. 3, lines 1-25.
236/ RX-147, p. 3, lines 8-20; RX-100, p.6, lines 3-9.
237/ RX-147, p. 5. lines 95-104; RX-100, p.14, lines 14-26. The ALJ apparently did not recognize that Justus was directed to the problem of backup in the nip and concomitant spewing and, in fact, partially distinguished the '758 patent from the prior art on this basis. ID at 132.
238/ ID at 129.
239/ See generally, RX-147, p.5, lines 6-115; RX-100, pp. 12-14.

control of pressure on the new web," and backup of stock in the entrance nip resulting in spewing. 240/ There is likewise a similarity of elements used in the '758 patent and among the four references including the use of centrifugal dewatering, curved stationary surfaces in conjunction with smaller radius rolls, and controlled convergence of the top and bottom forming elements. Consequently, we determine that the asserted prior art references lie within the field of relevant art as defined by the problems and elements discussed above.

Concerning the person having ordinary skill in the art, the ALJ's definition reaches elements of the six factor test, i.e., namely the educational level of the inventor and the educational level of workers active in the field. 241/ However, we find that the ALJ did not define the person having ordinary skill in terms of the type of problems encountered in the art, prior art solutions to those problems, the rapidity of invention in the field and the sophistication of the technology. 242/ Moreover, the ALJ failed to attribute knowledge of all of the prior art disclosed at the time of the invention. 243/

In light of the foregoing discussion of the problems extant at the time of the invention and the types of prior solutions to those problems, we find that the person having ordinary skill in the art in papermaking technology at the time of the invention of the subject matter of the '758 patent would be an individual with an engineering degree or similar technical degree in fluid

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240/ CX 1, Col. 2, lines 4-12; see also Col. 8, lines 39-43.
241/ See ID at 64 (FF 129). Environmental Designs, Ltd., 713 F.2d at 969, 216 U.S.P.Q. at 868.
242/ Environmental Designs, Ltd. 713 F.2d at 969, 216 U.S.P.Q. at 868.
243/ See, e.g., In re Grout, 153 U.S.P.Q. 742, 744 (C.C.P.A. 1967).

mechanics or mechanical engineering. 244/ In addition, the person having ordinary skill in the art would also have several years of direct experience in the design, manufacture, and servicing of forming sections and headboxes, including experience in day-to-day trouble shooting of on-line machines. 245/ Alternatively, such a person could be a paper mill superintendent with at least twenty years of experience. 246/

At the time of the invention, an individual with either of these backgrounds would be aware of problems in high-speed papermaking with twin wire machines including fine fiber distribution difficulties, web disruption, the need for rapid dewatering of the stock, backup of stock in the forming zone resulting in lower speeds, and premature machinery wear. 247/ The person of ordinary skill would also have been aware of a vast array of prior art solutions to the problems dating from two or more years prior to the January 24, 1968, priority date of the '758 patent. 248/ These references would have made the person of ordinary skill aware of the use of curved stationary surfaces of all shapes, the drainage characteristics of various web carriers and their substitutability depending on the desired effect, the use of centrifugal dewatering, and the employment of a number of different arrangements of dewatering elements such as rolls, suction rolls, and suction boxes. 249/ Most importantly, the person of ordinary skill would have

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244/ ID at 64 (FF 129).
245/ Id.
246/ Id.
247/ See notes 234-235 and accompanying text.
248/ See, e.g., Robinson (filed September 16, 1963); Means (filed October 29, 1964); Lee (filed January 4, 1962); Justus French patent (filed January 12, 1966),
249/ See, e.g., Robinson, Means, Lee, and Justus; RX-409 at 25 (dep. of Kallmes).

knowledge that some of the prior art taught interchangeability of references. 250/

b. The Robinson and Means references

Having defined the person having ordinary skill in the relevant art, the Commission must compare the asserted prior art references, in combination, with the challenged claims. 251/ If all of the elements are present in the prior art, then the inquiry turns on whether there is clear and convincing evidence to suggest that the person of ordinary skill would have combined the asserted references to produce the structure defined by the claim. 252/ In this instance, not only does the combination of Robinson and Means reveal all of the elements of claims 1-3, 7, 8, 10, and 11 of the '758 patent, but also the Means reference teaches its combination with Robinson to anyone reading its specification.

Concerning the existence of all of the claimed elements in Robinson and Means, the attached claim charts provide a detailed review of the correspondence between the claims and the prior art. 253/ Indeed, as we have discussed above, the Robinson patent in itself discloses all of the elements of claims 1, 2, and 10. However, before turning to whether the person of ordinary skill would have reached this combination, we must address several specific points.

First, the Robinson and Means references, as well as Justus and Lee, were not before the U.S. Patent and Trademark Office (PTO) during the prosecution

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250/ See Means, col. 3, lines 32-35.
251/ Orthopedic Equipment Co. v. United States, 702 F.2d at 1013, 217 U.S.P.Q. at 200.
252/ Polaroid Corporation v. Eastman Kodak Co., 789 F.2d at 1571.
253/ See Appendix at 6-13 with respect to the Robinson and Means references.

of either the application for the '758 patent or its parent application. 254/ Consequently, the burden of proof with respect to overcoming the presumption of validity and demonstrating obviousness is more easily carried. 255/ Moreover, we note that the ALJ's determination that Robinson and Means are not more pertinent references than the art cited by the examiner is without basis and does nothing to disrupt the effect of the undisclosed references upon the burden of proof. 256/

The ALJ apparently based his "pertinence" findings concerning Robinson and Means on certain purported differences in each individual reference from the claims at issue. 257/ The ALJ noted the absence from each reference of a structure in which a rotary cylinder is positioned downstream in a close working relation with a curved stationary surface to define a continuous bi-radii path of wire travel with a first radius of curvature substantially longer than a second. 258/ Apart from the fact that this limitation applied only to claims 10 and 11, the Robinson and Means patents clearly disclose such a structure in their respective references. 259/ In addition, the ALJ appears to have ignored the express teachings of Means directed to combining the references in a form that shows the claimed element. 260/ Thus, we conclude that Robinson and Means individually and in combination are more pertinent

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254/ See ID at 64-80 (FF 130). Complainant cited Means to the Examiner, but it was apparently never considered. ID at 73 (FF 148).
255/ EWP Corporation v. Reliance Universal, Inc., 755 F.2d at 905.
256/ ID at 68 (FF 138); 73 (148); 79-80 (FF 160-161).
257/ Id. at 80 (FF 161).
258/ Id.
259/ Appendix at 12-13.
260/ Id., Means, col. 2, lines 28-31.

than the references relied upon by the examiner and, therefore, lessen the burden of proof requisite to a showing of obviousness. 261/

The second specific issue relating to obviousness involves the contention that Robinson and Means do not disclose centrifugal dewatering and that Means includes a top scraper and vacuum device which actually inhibit centrifugal dewatering. The evidence of record shows that centrifugal dewatering is inherent in the Robinson disclosure. 262/ Similarly, the Means patent inherently discloses dewatering through the top wire as a result of pressure between the top and bottom wires and by centrifugal force. 263/ The presence of a top scraper and vacuum device in Means does not prevent the claims of the '758 patent from reading on Means because the preferred embodiments of the '758 patent reveal the use of precisely the same elements. 264/ Consequently, we find that centrifugal dewatering is inherent in both Robinson and Means, separately and in combination.

Having established that the prior art references include essentially all of the elements of the claims at issue, the crucial inquiry is whether the person having ordinary skill in the art would combine Means and Robinson to arrive at the claimed invention. On this question, the Means reference itself

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261/ Even if the Means and Robinson references are equally pertinent to those relied upon by the examiner as the ALJ found, they nonetheless may be cited as prior art in an obviousness argument. The effect is simply to heighten the burden of proof upon the party challenging validity. In fact, a patent may be held invalid based upon consideration of prior art references essentially the same as those before the examiner. Surface Technology, Inc. v. United States International Trade Commission, Appeal No. 85-1163, slip op. at 9 (Fed Cir., September 23, 1986); see also Polaroid Corp. v. Eastman Kodak Co., 789 F.2d at 1560.

262/ See note 172, supra, and accompanying text.

263/ ID at 71 (FF 143) citing TR 788-89 (Means).

264/ CX-1; Fig. 3, 1136; Fig. 4, 1136; Fig. 5, 2196, Fig. 6, 3196; Fig. 8, 520; Fig. 8, roll 519.

contains the suggestion to combine its teachings with those of Robinson. The specification to Means provides:

> In certain respects, the invention is an improvement of the invention disclosed in a co-pending application of David E. Robinson, for Paper-Forming Apparatus and methods, Ser. No. 311,278, filed Sept. 16, 1963, now Pat. No. 3,232,825. 265/

Subsequently, Means addresses the use of variety of curves (including a circle, parabola, hyperbola, sine wave, French curve, or any other curve) for the stationary surface 33, which in its preferred embodiment has a 20° arc as in Robinson. 266/ Thus, from Means, the person of ordinary skill in the art, as we have defined him, could apprehend the suggested combination of Means with Robinson. Accordingly, we determine that claims 1-3, 7, 8, 10, and 11 are invalid for obviousness in light of the Robinson Means combination.

c. The Justus patent in view of Means and Lee

As was the case with the Robinson and Means patents, the Justus patent, either alone or in view of Means, together with Lee reveals each and every element of claims 1-3, 7, 8, 10, and 11 of the '758 patent. 267/ In addition, the Justus patent also teaches the use of a guide roll following the rotary cylinder as described in claim 4 of the '758 patent. 268/ However, without addressing the question of whether the person of ordinary skill would have achieved this combination, the ALJ found non-obviousness based on several purported differences between the references and the '758 patent. Accordingly, we turn first to these specific aspects of the ID.

265/ Means, col. 2, lines 27-31.
266/ Id., col. 3, lines 32-35.
267/ See Appendix at 14-24.
268/ See id. at 20.

Preliminarily, the ALJ found that Justus and Lee were not more pertinent than the prior art cited by the examiner in allowing the claims of the '758 patents. 269/ The basis for this determination is the finding that complainant successfully distinguished the '758 claims over an initial rejection by the PTO based upon "grounds comparable to those suggested by the combination of Justus and Lee." 270/ The rejection referred to in the ID involves the examiner's finding that claims 1-9 of the '758 patent's parent application were obvious in light of U.S. Letters Patent 3,326,745 to Graham. 271/ Specifically, the examiner made the following determination:

> Claims 1-5, 9, and 10 are rejected under 35 U.S.C. 103 as unpatentable over Graham. Graham discloses a paper forming apparatus (note especially Figure 2) which includes opposed rolls (55, 56), a rigid plate (54), rolls (57, 33a, 12a), and a headbox 51a which discharges stock into a cavity (49a) formed between a forming wire (10a) and a fabric (19a) as they wrap rolls (55, 56), respectively, and pass over plate (54). Plate (54) includes an arcuate surface between sections (54b) and (54c). Claims 1-5, 9, and 10 are unpatentable since structure, (55, 56, 54, 12a) can be considered to be "first", "second", "third", and "forth" guides, respectively, and members (10a, 19a) can be considered to be "first and section opposed forming wire runs".
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> Claims 6-8 are rejected under 35 U.S.C. 103 as unpatentable over Graham in view of Justus et al. Justus et al. discloses a paper forming apparatus wherein a stock inlet (10) discharges slurry into a formation zone H between two forming wires (20, 40) as they pass along a curved surface of a foil suction box (30), which box functions to aid dewatering of the web being formed between the wires. In light of Justus et al. it would be obvious to anyone of ordinary skill in the art that if additional dewatering capabilities were desired in the Graham formation apparatus the curved plate (54) could be

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269/ ID at 79-80 (FF 160).
270/ Id.; see also 51-52 (FFs 107-108).
271/ RX-377, Office Action of September 21, 1970.

> a water-permeable surface (such as a suction box cover similar to that in Justus et al.,), especially since both references deal with twin-wire structures with headboxes discharging slurries between two forming wires as they converge against a wire guide surface. Claims 6-8 are unpatentable since they fail to define over the modified Graham structure. 272/

On February 19, 1971, the applicants filed Amendment A cancelling the original fifteen claims and proposing eleven claims in their place. 273/ In distinguishing over Graham, the applicants made the following statement:

> . . . Graham does not suggest or relate to twin-wire paper formations since he requires the use of a felt 19 and a wire 10 so that only one sided drainage is attainable and further there is no suggestion of using the combination of a curved plate or shoe and a roll to define a continuous bi-radii path of travel 274/

Thus, the applicants sought to avoid the prior art, inter alia, on the basis that it does not suggest or relate to twin-wire formers, but applies only to the wire and felt combination.

The examiner did not have before him the Lee patent at any time in the prosecution of the application for the '758 patent and its parent applications. Lee expressly recognizes that one may employ different forming carriers in a papermaking machine. 275/ These may include foraminous carriers of synthetic stretchable fabric, 276/ felts, 277/ canvasses, 278/ and metallic wire 279/ depending on the drainage characteristics and durability desired. Indeed, Lee teaches the interchangeability of metallic and synthetic fabric

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272/ Id.
273/ RX-377, Amendment A, February 19, 1971.
274/ Id.
275/ Lee, col. 5, line 14-16.
276/ Id., col. 2, lines 38-40.
277/ Id., col. 5, line 21.
278/ Id.
279/ Id., col. 5, lines 46-47.

carriers in the same fashion as the specification to the '758 patent. 280/ Accordingly, we find Lee is more pertinent than the prior art which was overcome by the applicants in order to obtain issuance of the '758 patent.

The ALJ also found three differences between the prior art and the claimed invention: (1) dewatering through both wires in the prior art devices as opposed to one wire, (2) the use of a reverse wrap in the prior art machines, and (3) the non-existence in the prior art of a continuous bi-radii path as claimed in the '758 patent. 281/ These distinctions are, in fact, distinctions without a difference. First, based upon the ID itself, the Justus patent discloses centrifugal dewatering primarily in one direction through the wire, 282/ while Means involves dewatering through one wire (the top wire) by virtue of pressure and centrifugal force. 283/ Consequently, the claim of centrifugal dewatering through one wire is satisfied based upon the findings in the ID and the evidence underlying those findings.

Second, the existence of a "reverse wrap" in Lee simply has no bearing on the obviousness question. Respondents have cited Lee to show the substitutability of various web carriers in forming machines depending on the drainage and serviceability characteristics desired. There is no assertion that the other elements of Lee be substituted into Justus or Justus and Means in combination. Accordingly, we are of the view that the only element of Lee bearing on the obviousness issue is the forming carrier, and the existence of other elements in Lee is simply not germane to the inquiry.

280/ CX-1, col. 11, lines 66-72.
281/ ID at 133-34.
282/ Id. at 75-77 (FF 155).
283/ Id. at 71 (FF 143).

Third, we must reject the finding that the prior art does not disclose a continuous bi-radii path of the type described in claims 10 and 11 of the '758 patent. Figure 2 of Justus includes roll 232 which is downstream of curved stationary surface 240 in a close working relationship therewith. 284/ Surface 240 defines a relative long parabolic curve followed by the smaller radius of roll 232 to define a continuous bi-radii path. 285/ Similarly, Figure 1 of Means shows curved surface 33, which describes a 20° arc, followed in close-working relationship by Roll 50, which is wrapped by the wires in a 20° arc. 286/ Accordingly, we find that the Justus patent alone, or together with Means, includes a continuous bi-radii path as well as all of the other claimed elements.

Turning to the question of whether the person of ordinary skill would have derived the claimed combination from the asserted references, we note that the Justus patent discloses each and every element of the claimed invention save one: the use of twin wire web carriers as opposed to a wire and felt combination. Had Justus disclosed this element, it would have rendered the '758 patent invalid as anticipated under 35 U.S.C. § 102. However, the Lee patent provides one of ordinary skill a variety of forming carriers to choose from in constructing a papermaking machine using centrifugal dewatering. Indeed, the choices posited by Lee viz. forming element selection were general knowledge at the time of the '758 invention and were merely a matter of engineering choice depending upon the drainage characteristics desired. 287/ Accordingly, we determine that the person of

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284/ Appendix at 22.
285/ Id.
286/ Id. at 21.
287/ TR 440, lines 16-21 (Waller); RX-409, p. 41 (dep. of Kallmes).

ordinary skill in the art was perfectly capable of making the substitution of forming carriers and would have done so based upon the type of paper he desired to manufacture. 289/

With respect to Means and its combination with Justus, the person of ordinary skill in the art would learn from Means that one can employ a variety of curved stationary surfaces to obtain wire convergence in a twin-wire paper forming machine. 290/ Indeed, Means teaches substitutability of this surface into the invention described in another patent, viz., Robinson. 291/ Moreover, Means provides a guide to the construction of this surface regardless of the configuration of the curvature. 292/ Thus, we conclude that Justus in view of Lee or in combination with Means renders claims 1-4, 7, 8, 20, and 11 of the '758 patent invalid as obvious.

E. Infringement

The decision of the CAFC in remanding this investigation to the Commission makes clear that respondents' devices infringe the '758 patent. However, there can be no infringement of an invalid patent. Accordingly, we determine that, because the '758 patent is invalid, there is no infringement.

F. Domestic Industry 293/

The ALJ considered the question of domestic industry in the context of the activities conducted by complainant in the manufacture, sale, and

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289/ Id.
290/ Means, col. 3, lines 16-35.
291/ Id. Assuming arguendo that the parabolic surface of the Justus French patent differs from that described in the'758 patent, Means provides a clear basis for using other types of curves.
292/ Means, claim 2, col. 8, lines 40-51; RX-409 at 35, 36, 42-43 (dep. of Kallmes).
293/ Chairman Liebeler and Vice-Chairman Brunsdale do not join this section of the opinion. Instead, they would affirm the ALJ's determination that a domestic industry exists that produces Bel Baie formers. See ID at 143-50.

servicing of various paperforming machines which complainant claims embody the '758 patent. These include the Bel Baie I, Bel Baie II, Bel Baie III, and "modified" Bel Roll formers. 294/ The ALJ concluded that the relevant domestic industry consists of those portions of Beloit's Paper Machinery Division (PMD) dedicated to the manufacture, sale, and servicing of twin-wire forming sections covered by the claims of the '758 patent, viz., the Bel Baie I, II, and III models, but not the modified Bel Roll formers. 295/

a. The modified Bel Roll formers

Specifically, the ALJ found that complainant's modified Bel Roll forming section could not be included within the domestic industry because that model is not designed in accordance with the teachings of the '758 patent. 296/ The ALJ found that although the modified Bel Roll would include an extended nip which would end on a curved stationary surface (i.e., the nip and shoe would be "adjacent"), the nip would not be an "entrance nip" which receives the jet stream of stock directly from the headbox in accordance with the teachings of the '758 patent. Moreover, the modified Bel Roll design is not that of a true twin-wire former, but is, unlike the '758 patent, a design for a top-wire former. 297/ The ALJ found that complainant's experience with an experimental model of the modified Bel Roll indicated that the only difference between the standard Bel Roll and the modified Bel Roll was that the addition of the shoe made it necessary to use more power to operate the machine. Finally, the ALJ

294/ ID at 82 (FF 163).
295/ Id. at 164.
296/ Id. at 82-83 (FFs 165-166); 149. The ALJ's findings with respect to the modified Bell Roll formers are not the subject of review.
297/ Id.

noted there were no apparent improvements in retention or formation which were the objectives of the '758 patent. 298/

The ALJ also determined that, even if the modified Bel Roll former were covered by the '758 patent, it would not be included within the domestic industry because: (1) no modified Bel Roll has ever been manufactured by Beloit anywhere in the world; (2) there is no convincing evidence of record that the modified Bel Roll existed prior to 1983; (3) there is presently no industry in existence since it does not appear that the modified Bel Roll was conceived until 1983, and (4) although Beloit has offered the modified Bel Roll as an option in several potential sales, no actual sales resulted from those offers—and it appears unlikely that any will, since Beloit has developed another former which combines the advantages of the Bel Roll and Bel Bond models. 299/ The ALJ noted that Beloit's research and development personnel have devoted little attention to the modified Bel Roll and that corporate executives and managers had never formally discussed the modified Bel Roll with anyone at Beloit as of March 31, 1983. 300/

b. The Bell Baie formers

The ALJ determined that there is a domestic industry in the production of the Bel Baie model machines based upon his findings that (1) complainant continues to maintain manufacturing facilities at the PMD and has demonstrated a commitment to the future manufacture and sale of the patented forming

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298/ Id.
299/ Id. at 149-150. The Bel Bond, a top wire former, and the Bel Blade, a so-called "hybrid" former, are other forming sections manufactured by complainant in addition to the patented device.
300/ Id. at 150.

sections; 301/ (2) even when a patented forming section is manufactured abroad, domestic PMD employees undertake all planning and detailed engineering, and manufacture certain parts that will be shipped to the site of manufacture; 302/ (3) the machine is installed and made operational by PMD personnel; 303/ and (4) all future repair and maintenance parts are furnished by the PMD. 304/ In addition, the ALJ found that the PMD contributes approximately [ ] percent of the value added to a machine manufactured abroad. 305/

Respondents first question the ALJ's reliance on Beloit's manufacture of a machine in the United States that was sold to a Taiwanese customer as evidence of the existence of a domestic industry. 306/ Respondents assert that this approach is erroneous in light of the Commission's earlier definition of the domestic industry as that portion of Beloit's facilities which produces articles under the patent and is adversely affected by the infringing imported articles. 307/ Respondents point out that the Commission cannot order any remedy to prevent an alleged foreign infringer from selling its merchandise in a foreign country and, therefore, the definition of the domestic industry must be confined to an industry which is amenable to protection (i.e., it sells U.S. patented products in the United States). Respondents urge that it is simply insufficient to be ready, willing, and able

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301/ Id. at 144; 86 (FFs 175-176); 90 (FF 193); 102-103 (FFs 249-253).
302/ Id. at 145; 86-87 (FFs 179-181); 89 (FF 191).
303/ Id. at 145; 88-89 (FFs 197-189); 93 (FF 207).
304/ Id. at 145-146; 87 (FF 183).
305/ Id. at 146; 92 (FF 201).
306/ Respondents' Brief on Review at 55; Respondents' Reply Brief at 46.
307/ Certain Headboxes and Papermaking Machine Forming Sections For the Continuous Production of Paper, And Components Thereof, Invs. Nos. 337-TA-82, USITC Pub. 1138 (1981) at 29.

to produce a product in the United States, unless prevention of establishment is an issue. 308/

Respondents also have disputed the ALJ's finding that Beloit's domestic operations contributed [ ] percent of the value of the Bel Baie manufactured abroad by a foreign subsidiary for sale to [ ] 309/ They allege that a very substantial portion of the manufacturing costs attributed to the PMD represented outside purchases, not work performed on the PMD premises. Moreover, respondents believe that the inclusion of warranty costs was erroneous because, under the terms of an agreement with Beloit, a foreign manufacturer [ ] was responsible for warranty protection. In addition, respondents challenge the inclusion of the [ ] corporate surcharge since it covers Beloit's worldwide activities, including research and development outside of the United States, as well as the inclusion of sales, general, and administrative (SG&A) costs in the value-added computation. 310/

Respondents note that this latter accounting device is used to recover costs that cannot be allocated to a particular project and are spread over work done at the domestic plant. Inasmuch as a major proportion of the work on the machine was done in Japan—[ ] percent, according to the respondents—the use of this accounting device in the computation of domestic value added is unrealistic and erroneous. Finally, respondents maintain that the [ ] value added by complainant is simply not enough to constitute

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308/ Respondents' Reply Brief at 44-45.
309/ Respondents make this assertion based on the "nature and significance" of the contribution, rather than the underlying figures. Respondents' Brief on Review at 61-62.
310/ Id. at 65; Respondents' Reply Brief at 48-49. Respondents' Brief on review at 64-65.

a domestic industry, particularly in light of the nature and significance of the operations underlying that figure. 311/

Respondents also allege that the ALJ erroneously took into account the manufacture and sale of forming sections other than those alleged to be covered by the patent in determining the existence of a domestic industry. 312/ Respondents note that [

.] 313/ In respondents' view, such manufacture does not constitute evidence that the patent will be exploited domestically in the future. While this may show a capability for manufacturing the Bel Baies, respondents maintain that it does not show that the capability was employed, pointing out that the only recent sale of a Bel Baie in the United States involved a machine made in Japan. 314/

Complainant maintains that it has extensive domestic facilities capable of manufacturing Bel Baie formers. 315/ In this context, complainant argues that the ALJ properly considered the domestic manufacture of a Bel Baie forming section sold in Taiwan in determining the existence of a domestic industry. 316/ In complainant's view, respondents have attempted to fashion the domestic industry definition ad hoc to fit the injury analysis. 317/ Complainant also argues that the ALJ adopted the correct approach in finding that Beloit's domestic facilities which produced the Taiwanese machine in

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311/ Respondents' Reply Brief at 51-52.
312/ Id. at 56-57.
313/ ID at 86 (FF 176).
314/ Respondents' Reply Brief at 57.
315/ Brief of Complainant on Review at 36.
316/ Id. at 40.
317/ Id. at 41.

accordance with the '758 patent are the same facilities that would produce for domestic sale of the Bel Baie machines.

Complainant then turns to the ALJ's findings concerning the value added by Beloit's domestic operations to forming sections manufactured offshore. Complainant maintains that the ALJ correctly found that domestic engineering, manufacturing, research and development, warranty repair, and SG&A activities contributed approximately [ ] percent of the value of the most recent Bel Baie sold in the United States to [ ]. 318/ In complainant's view, this percentage of value added to a foreign-manufactured Bel Baie is sufficient under prior Commission determinations to constitute a domestic industry, particularly in light of the nature and significance of the activities. 319/ Concerning the ALJ's allocation of SG&A expenditures to the [ ] transaction, complainant argues that these activities were carried out in the United States and were correctly allocated by the ALJ as [ ] percent of the total value added and properly included in the value-added analysis. 320/

Finally, complainant asserts that the ALJ correctly included its field erection, start-up, maintenance, and repair activities in the domestic industry and urges that these activities, in themselves, were a sufficient basis upon which to find that a domestic industry exists. 321/ Complainant maintains that start-up, maintenance, and repair activities are properly factored into the value-added equation. Complainant urges that these

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318/ Id. at 36-39.
319/ Id. at 42-50; Complainants' Reply Brief at 32-39.
320/ Complainant's Reply Brief at 32-39.
321/ Id. at 39-40, citing Certain Cast-Iron Stoves, Inv. No. 337-TA-69, USITC Pub. 1126 (1981); Complainants' Brief on Review at 50.

activities provide a basis for a domestic "service" industry based upon these activities. 322/ However, complainant contends that, in any event, the existence of "long-established domestic facilities and a domestic workforce ready, willing and able to carry out domestic production of the involved product from beginning to end" is sufficient basis upon which to find that a domestic industry exists. 323/

The IA briefly addresses the ALJ's conclusions with respect to the Bel Baie forming sections, noting his agreement with the ID. Specifically, the IA maintains that the definition of domestic industry properly is grounded upon domestic production of the subject goods. Accordingly, in the IA's view, U.S. production for sales abroad provide a "strong basis" for concluding that there is a domestic industry. 324/

Concerning the value-added approach used in the ID, the IA argues that the ALJ correctly computed the domestic value added to the product and, based upon this computation, properly found a domestic industry consisting of those resources complainant devotes to the manufacture, sale, and servicing of the Bel Baie machines. 325/ The IA asserts that the value-added analysis includes all costs that are part of United States manufacturing, as opposed to the manufacturing costs alone. 326/ In the IA's opinion, complainant's domestic activities such as quality control, repair, and the like were correctly included by the ALJ in reaching a value added figure of [ ] percent. In view

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322/ Complainants' Reply Brief at 42.
323/ Id. at 49.
324/ Brief of the Commission Investigative Staff at 6-7.
325/ Id. at 7-9.
326/ Id.

of the nature and significance of the activities and amounts underlying this figure, the IA believes that a domestic industry exists. 327/

The Commission has traditionally defined the domestic industry in patent-based section 337 cases as the operations within the United States of the patentee and its domestic licensees devoted to the exploitation of the patent in controversy. 328/ In many cases, there is complete, or nearly complete, production of the patented product in the United States. Where some of the production of the patented product occurs outside the United States, the Commission must determine whether those activities which are conducted in the United States constitute a domestic industry within the meaning of the statute.

In determining the scope or, indeed, the existence of a domestic industry in such situations, the Commission considers the nature and significance of the domestic operations. In applying this test on a case by case basis, among the activities conducted in domestic facilities which the Commission has considered are production, processing or assembly of a semifinished product, packaging, quality control, and production related design. In making its decisions under its "value and significance" test, the Commission has also

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327/ Id. at 9.

328/ Schaper Mfg. Co. v. United States International Trade Commission, 717 F.2d 1368, 1372 (Fed. Cir. 1983); accord Corning Glass Works v. United States International Trade Commission, 799 F.2d 1559, 1569-70 (Fed. Cir. 1986); see also Certain Molded-In-Sandwich Panel Inserts and Methods for their Manufacture, Inv. No. 337-TA-99, USITC Pub. 1246 (1982).

considered the value added by domestic operation to foreign manufactured or semifinished products. 329/

The CAFC has concurred with the Commission's nature and significance test. It specifically agreed that the activities considered in defining the domestic industry may encompass more than the manufacturing of a patented item. 330/ It has elaborated that the domestic activities of a complainant, regardless of their value, must be related to the domestic manufacture, production or servicing of the patented item. 331/ Where such a relation is not shown with regard to particular activities or where the value of the domestic activities is unknown, the Commission has not considered them in analyzing the domestic industry. 332/

As a preliminary matter, both respondents and complainant have raised arguments concerning the inclusion of domestic activities devoted to the Modified Bel Roll in the industry definition. We did not review the ID with respect to the ALJ's findings that the Modified Bel Roll does not exploit the reachings of the '758 patent, and hereby expressly adopt them insofar as they are not inconsistent with this opinion.

We note, however, that even if the Modified Bel Roll former embodied the teachings of the '758 patent, it nevertheless should not be included in the domestic industry because it has never been and was unlikely to be, sold.

329/ See, e.g., Schaper, 717 F.2d 1368 (affirming Commission determination that certain engineering and quality testing activities were insufficient to constitute a domestic industry); Corning Glass Works, 799 F.2d at 1569-70 (affirming Commission's determination that licensed manufacture abroad did not constitute part of the domestic industry).

330/ Schaper, 717 F.2d at 1373.

331/ Schaper, 717 F.2d 1371.

332/ Certain Optical Waveguide Fibers, Inv. No. 337-TA-189, USITC Pub. 1754 (1985) at 100-101, vacated in part, affd, in part, sub. nom. Corning Glass Works v. United States International Trade Commission, 799 F.2d 1559 (Fed. Cir. 1986).

Moreover, no Bel Roll containing the forming shoe taught by the subject patent had ever been manufactured anywhere in the world. The ALJ determined that Beloit's research and development and sales personnel devoted so little attention to the modified Bel Roll design that the PMD's head of manufacturing had not heard of the design's existence until well after this investigation had commenced. Accordingly, the ALJ properly excluded the Modified Bel Roll from the definition of the domestic industry.

Concerning respondent's contention that the ALJ's inclusion of the Bel Baie machine manufactured for sale to Taiwan in the domestic industry was improper because that sale was to a purchaser outside the United States, respondents have confused the definition of domestic industry with the injury determination. The domestic industry determination relates to where the patent is exploited not where the goods are sold. U.S. manufacture of the machine for sale in Taiwan is evidence relating to whether Beloit has domestic operations exploiting the '758 patent. 333/ Therefore, we determine that the domestic industry may properly take into account such facilities.

Turning to the nature and significance of complainant's domestic activities, we note that while complainant does maintain domestic production facilities, it did not show that such facilities were used in the manufacture of products under the '758 patent. The ALJ also stated that complainant engages domestically in "field erection, start-up engineering, and post-installation maintenance and manufacture or repair and replacement parts," but the record reveals no evidence relating to the value of such

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333/ See H. Rep. No. 93-571, 93d Cong. 1st Sess. 78 (1973), cited in Schaper, 717 F.2d at 1372.

activities. In addition, complainant's domestic activities include the activities of its corporate headquarters, design and engineering staffs, and research and development. However, our concern focuses on complainant's domestic activities and the value-added to foreign-manufactured forming sections by those activities. The ALJ concluded that [ ] percent value added, although numerically smaller than that ever before determined by the Commission in other investigations to constitute a domestic industry, was sufficient in light of complainant's extensive activities and the level of expenditure which those activities represent. We hereby modify this portion of the ID.

The ALJ found that the [ ] percent value-added figure consists of a corporate "surcharge" ([ ]), which is a royalty charged on a "proprietary" product to cover the cost of research and development and other domestic activities in support of the PMD; the cost of carrying out warranty obligations ([ ]); and SG&A costs, representing bona fide domestic activities attributable to the transaction and carried out in the United States. 334/ These figures are based upon an analysis of the single U.S. sale of a Bel Baie since 1978, that of the Japanese-manufactured machine sold to [ ]. 335/ The value-added figure does not include complainant's field erection, start up, and maintenance activities because nothing in the record addresses the value-added by these domestic activities. 336/ The only figures relating to complainant's domestic activity

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334/ See Id. at 91 (FFs 196-198).
335/ Id. at 94 (FF 211).
336/ Id. at 90 (FFs 192, 193).

with regard to the Bel Baie since 1981-82 are based, not upon manufacture or production, but upon a research and development surcharge, warranty costs, and the SG&A costs.

The Commission has considered activities such as quality control, repair, and packaging which contributed half of the value of the subject product to constitute a domestic industry. 337/ However, where the actual manufacturing operations, which contribute [ ] percent of the value of complainant's product, have occurred outside the United States, it is not clear that these are sufficient domestic activities to constitute a domestic industry. 338/

In this investigation we are of the opinion that the [ ] percent value-added by complainant's domestic activities in this case is an insufficient basis upon which to find the existence of a domestic industry, particularly in light of the activities which constitute that figure. First, there is a "corporate surcharge" of [ ], which is devoted to general research and development and complainant's other domestic activities. 339/ Essentially, this figure is nothing more than an [ ] royalty for "proprietary" information that does not involve manufacture, production, or servicing of the Bel Baie former. 340/ Similarly, the SG&A

337/ See Certain Cube Puzzles, Inv. No. 337-TA-112, USITC Pub. 1334 (1983).
338/ We note that the Commission recently found products to be part of the domestic industry where the bulk of the production costs of those products were incurred outside of the United States. See Certain Woodworking Machines, 337-TA-174 (October 2, 1985). However, this investigation was a default case and was limited by the Commission in its precedential effect. Id. at 6 n. 21.
339/ ID at 93 (FF 208).
340/ Id. Indeed, the CAFC has found that the collection of royalties does not constitute a part of the domestic industry. Schaper, 717 F.2d at 1371.

costs do not strictly involve manufacture and production, but include, among other items, the [

]. 341/ Finally, it is unclear whether the [ ] warranty costs are even attributable to domestic activity because [

.] 342/

In this instance, complainant alleges and the ID states that the domestic activities of complainant constitute [ ]. Of these activities, the Commission, based on judicial decisions and Commission precedent, has excluded royalties and those portions of SG&A relating to overhead and administration from its domestic industry assessment. With respect to complainant's other activities (i.e., engineering, repair, field-erection), there is nothing on the record to enable us to determine the level of these activities attributable to the patented devices. 343/ Accordingly, we determine that complainant's domestic activities with respect to the Bel Baie formers do not constitute a domestic industry based upon the nature and significance of the domestic activities related to the exploitation of the extant patent utilized in the production of to complainant's papermaking machine forming sections.

341/ SX-140 at 118 (deposition of Regnier); TR 1441-1444 (Regnier); TR 348 (Jenkins).

342/ RX-57 at 102, 199.

343/ Complainant's assertions that it is capable of manufacturing the Bel Baie are not dispositive. The record shows that it has domestically manufactured [ ]. ID at 91 (FFs 196-198). By contrast, complainant used its domestic facilities to manufacture [ ]. Id. at 86 (FF 176).

G. Tendency to Substantially Injure

There have been three sales of the accused devices in the United States since 1982: (1) Abitibi/Augusta PM2; (2) Augusta PM1, and (3) FSC Paper Corp. Complainant alleged that the domestic industry experienced declining sales and lost customers due to respondents' sales of the allegedly infringing forming sections, and that the industry has experienced decreased employment, production, and profitability as a result of the lost sales. The ALJ determined, however, that (assuming infringement) the three sales did not cause substantial injury to the domestic industry because there was no direct competition between Beloit's patented forming sections and those of respondents. 344/

On the other hand, the ALJ found that the record demonstrates that respondents enjoy a foreign cost advantage over the domestic industry and that they possess the manufacturing capacity and intent to penetrate the United States market further. 345/ Additionally, the ALJ determined the limited number of potential future sales of forming sections and specific instances of current direct competition between Beloit and Valmet establish the strong potential for Beloit to lose future sales and customers. 348/ In the ALJ's view, the record also demonstrates that, but for the loss to Valmet of such

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344/ The ALJ found that respondents' activities with respect to the accused devices in the United States, did not have the effect of substantially injuring complainant. The Commission did not review this portion of the ID.
345/ ID at 162.

future sales, Beloit would probably produce the Bel Baie formers for U.S. customers at PMD. 349/ In view of the infrequency of sales in the U.S. market and the substantial dollar value of a single former, the ALJ points out the loss of even one sale by the domestic industry would represent substantial injury.

The ALJ further found that if the modified Bel Roll former were to be included within the domestic industry, there would be further evidence of a tendency to injure the domestic industry, based on an analysis of Valmet's foreign cost advantage, capacity, and intent with respect to future sales of the Sym-Former R. 350/ Finally, the ALJ noted that there were several negotiations for forming section rebuilds pending at the time of the ID, and respondents were offering the accused Sym-Former R in direct competition with machines offered by Beloit, which included the modified Bel Roll, among other alternatives. 351/ Accordingly, the ALJ determined that respondents' sale of the accused devices in the United States has the tendency to injure the domestic industry.

Respondents argue that the ALJ's findings on this issue are conjectural and speculative. In support of this assertion, respondents point to various evidentiary references which they claim demonstrate that not only was there no

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348/ Id., see also id. at 86 (FF 178); 113-114 (FF 302).
349/ ID at 162-163.
350/ Id. at 161.
351/ Id.; 115-117 (FF 309).

competition between domestically-produced, patented machines and the accused imports, but also that there was no likelihood of imminent lost sales. 352/ First, respondents point out that the accused devices are not a substitute for the Bel Baie. Rather, respondents maintain that their machines are essentially "rebuilds" for existing machines, while complainant's Bel Baie is sold predominantly as a part of a new papermaking machine. 353/ Consequently, respondents maintain that there will not be any significant amount of sales lost by complainant in the market in which it competes. 354/

Respondents also point out that the ALJ found that among the three lost sales alleged by complainant, there was no instance in which the accused devices competed with the Bel Baie. 355/ In the one instance in which the ALJ found direct competition between an accused device and the Bel Baie (FF 306), respondents argue that there was no indication whether complainant would lose the sale or, indeed, whether the project being bid upon would ever go forward. 356/ According to respondents, this lack of evidence concerning imminent lost sales and direct competition, in addition to the use of different dewatering technology in the accused devices, provides an inadequate basis for a determination of tendency to injure.

Finally, respondents contend that complainant has failed to prove "other necessary elements of a 'causal nexus'." 357/ In particular, respondents note that several foreign firms offer papermaking machine forming sections in

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352/ See generally Respondents' Brief on Review at 70-77; Respondents' Reply Brief at 61-68.
353/ Respondents' Brief on Review at 72.
354/ Id.
355/ Id. at 73.
356/ Id. at 73-74.
357/ Respondents' Reply Brief at 66.

competition with complainant's product and that one of these firms [ ] has actually made one sale for which complainant competed. 358/ According to respondents, these factors coupled with the lack of imminent lost sales or competition provide the basis for reversing the ALJ's threat determination.

On the other hand, complainant argues that the tendency findings are well supported by the record evidence which shows that respondents possess the capacity and the intent to increase their U.S. market penetration, together with a significant cost advantage. 359/ Moreover, complainant maintains that the accused devices and the Bel Baie formers will compete in both the rebuild and new forming section market. Therefore, in complainant's view, there is a tendency to substantially injure.

Specifically, complainant asserts that, at the close of the record, respondents had [ ] for the accused forming sections in the new, as opposed to the rebuild, machine market. 360/ Further, complainant argues that the Bel Baies, in fact, compete in the domestic market for rebuilds in instances in which a paper manufacturer wishes to replace the Fourdrinier section of an existing machine. 361/ Complainant points out that one of the accused machines, the New-Sym Former, is directed to such "rebuild" situations. 362/ As a result, complainant maintains that there will be competition between the accused devices and the Bel Baie machines with the concomitant possibility of lost sales. 363/

358/ Id.
359/ See generally Brief of Complainant on Review at 66-75; Complainant's Reply Brief at 50-56.
360/ Brief of Complainant on Review at 67.
361/ Id. at 68.
362/ Id.
363/ Id.

Concerning the nexus between the alleged unfair acts and potential lost sales of the Bel Baie, complainant points out that respondents employ the same "forming shoe technology" in their devices as is used in the Bel Baie and, indeed, have predicated their promotional activities in the United States upon this technology as it is employed in the Syn-Former R and New Syn-Former machines. 364/ In addition, complainant urges that the presence of five alleged competitors in the domestic market does not weaken the causal link because these firms are not accepted suppliers to the U.S. paper industry. 365/

Finally, complainant contends that, in view of the substantial revenue obtained from each sale of a Bel Baie, the loss of a single sale is highly significant. 366/ Moreover, the "market realities" of such a single sale include the loss of a subsequent rebuild sale, because most paper companies prefer to purchase the rebuild from the source of the original forming section. 367/ Complainant maintains that these factors, as well as respondents' manufacturing capacity and market penetration with respect to the accused devices, demonstrate a tendency to substantially injure the domestic industry. 368/

The IA asserts that the ALJ correctly concluded that respondents' activities in the United States have a tendency to injure the domestic industry. 369/ The IA maintains that the character of the industry, through

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364/ Id.
365/ Id. at 69-70.
366/ Id. at 71.
367/ Id.
368/ Id. at 71-74. Complainant also contends that there is an effect to substantially injure and that the modified Bel Roll should have been included in the injury analysis. Id. at 76-82. The ALJ's determinations with respect to these questions are not subject to this review.
369/ Brief of the Commission Investigative Staff at 10-11.

the importance of a single sale, in this case "strikingly affects any assessment of injury." 370/ Moreover, respondents' cost advantage and capacity militate in favor of the ALJ's tendency finding. 371/ Finally, the IA urges that respondents' commitment to the U.S. market, in addition to the foregoing factors, supports the ALJ's determination. 372/

The question of injury in a section 337 investigation has recently been addressed by the CAFC in Corning Glass Works v. United States International Trade Commission. 373/ In Corning, the court noted that section 337 does not function merely as an international extension of United States patent law. 374/ Rather, upon patentee's proof of continuning infringement of a valid and enforceable patent, the patentee must show that there is proof of an effect or tendency of the infringing imported products to destroy or substantially injure the domestic industry. 375/

Even if there is no present effect to substantially injure, the Commission may find a section 337 violation based solely upon tendency, i.e., the likelihood of future substantial injury. 376/ Where the Commission makes such a determination, the record must establish the relevant conditions or circumstances from which such injury reasonably can be inferred. 377/ For example, if the domestic industry can show in a patent-based case that an infringer threatens to hold a significant share of the domestic market in the

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370/ Id. at 10.
371/ Id. at 10-11.
372/ Id. at 11.
373/ Appeal No. 85-2632 (Fed. Cir. Aug. 27, 1986).
374/ Id., slip op. at 13 citing Textron, Inc. v. United States International Trade Commission, 753 F.2d 1019, 1028-29 (Fed. Cir. 1985).
375/ Corning, slip op. at 14-15.
376/ Id. at 15-16.
377/ Id. at 16.

subject articles or threatens to make a significant number of sales of those articles, a finding of tendency to substantially injure may be warranted. 378/ However, the injury contemplated must constitute a substantial and clearly foreseen threat to the future of the industry not based on allegation, conjecture, or mere possibility. 379/

Assuming arguendo that the Commission upheld the validity of the '758 patent and found that a domestic industry exists, we believe that a finding of tendency to substantially injure is warranted. In this instance, the record reveals that respondents have already sold the accused devices in the United States, albeit not yet in direct competition with the patented paper forming sections. 380/ While there have been no demonstrable sales lost to the accused devices, the record reflects that they were competing with the Bel Baie formers in the rebuild market in at least one instance. 381/ Moreover, as the ALJ found, respondents have the capacity to manufacture more Sym-Former Rs, have continued to offer machines for sale in the United States, and have a commitment to future sales in the United States. 382/ Indeed, the record indicates that complainant and respondents will continue to compete for business in the future.

Based upon the foregoing considerations, we hereby adopt those portions of the ID relating to the tendency of the accused devices to substantially injure or destroy the domestic industry.

378/ Corning, slip op. at 17; Certain Combination Locks, Inv. No. 337-TA-45, USITC Pub. 945 (1979). Although the court's statements in Textron concerning factors relevant to tendency provide guidance, they are not all inclusive. Corning, slip. op. at 17.

379/ Textron, 753 F.2d 1019.

380/ ID at 106-109 (FFs 264-282).

381/ See id. at 114 (FF 306).

382/ See id. 111-112 (FFs 288-293).

APPENDIX

Claims 1, 2, and 10 of the '758 Patent and the Robinson Patent Compared

Claim 1	Prior Art (Robinson)
An apparatus for forming fibrous webs comprising:	
a. first and second continuous looped foraminous forming wires which are arranged to converge and provide an entrance nip for the reception of web-forming stock;	The Robinson patent describes apparatus for forming fibrous webs (Col. 1, ll. 46-58). "Apparatus comprising a first permeable belt having a web-contacting side and a water-drainage side, a second permeable belt having a web-contacting side and a water drainage side, said belts being mounted with portions of said web-contacting sides in opposed relation and defining therebetween a forming zone wherein a stock mixture is received and formed into a web. . . ." Robinson Claim 2, Col. 12, lines 40-45. Fig. 6 describes two forming wires 11' and 12', which lead around two breast rolls 13' and 14' and converge to form entrance nip. Col. 5, lines 64-75, Col. 6, lines 1-13.
b. a curved stationary surface positioned adjacent said entrance nip;	"a permeable curved [stationary] supporting surface Robinson Claim 9, col. 13, line 66 (emphasis supplied); Claim 10, col. 14, line 3. Figure 6 of Robinson, which represents an alternate embodiment of Figures 1-5, includes grating element 21', which incorporates edges 30 and 31 of Figure 4. Col. 5, lines 59-64; Col. 4, lines 53-75. These blades may be adjusted in curvature to control the rate of belt convergence including a convex curve. Col. 4, lines 53-75. See also Fig. 8, 215' and col. 11, lines 23-24.
c. means for supporting said wires within their respective loops and moving said wires into said entrance nip;	"Conventional impervious breast rolls". Robinson, Fig. 6, 13', 14'; col. 5, line 67.

d. said forming wires being arranged to travel over said stationary curved surface downstream of said entrance nip while having stock therebetween,	"In a method of forming paper, the steps comprising moving a pair of permeable paper-forming members in closely-spaced apart paper-making relation at substantially the same direction through a paper-forming zone, introducing a paper stock between said members, training at least one of said members in a curved path in said forming zone about a permeable curved supporting surface, maintaining said supporting surface stationary, and withdrawing water from said stock through said supporting surface to facilitate formation of said stock into a paper web." Robinson Claim 9, Col. 13, lines 59-69 (emphasis supplied). This is shown in Figure 6 as grating 21' which is downstream from the commencement of entrance nip formed by 10' and 11'. Figure 8, 215' Col. 11, lines 23-34.
e. a rotary cylinder,	"a roll having a surface defining a foraminous sheet opposable to the water drainage side of one of said belts through at least a portion of said forming zone." Robinson Claim 2, Col. 12, lines 46-49; Figure 6, Roll C; Col. 5, lines 71-79.
f. said wires traveling around a part of the periphery of said rotary cylinder immediately following the stationary forming surface, with said surface and said cylinder being on the same side of said wires;	Wires 11' and 12' travel around part of the periphery of roll C immediately following stationary forming surface 21'. Figure 6; Col. 6, lines 67-67.

g. said stationary curved surface having a relatively large radius of curvature:	"At least one of said members [is trained] in a curved path in said forming zone about a permeable curved supporting surface." Robinson Claim 9, Col. 13, lines 63-69. This surface is depicted in Figure 6 as surface 21', which is shown as a durve of infinite radius or may have a surface curved as described in b, supra. This curved surface is shown in Figure 8 as grating assembly 215' with blades 216', which are "convexly cylindrically curved about at least one horizontal axis." Col. 11, lines 27-28. Figure 8. The arc of the grating assembly 215' is about 20°. Col. 11, lines 41-44; Figure 8. 1/
h. the first wire being free of restraining means on its outer surface opposite said rotating cylinder;	Figure 6, 11'. See also Figure 8', 208'; TR 271, lines 17-19 (Waller).
i. said wires arranged for traveling at a speed so that the stock is dewatered centrifugally; through the first wire.	Wires travel at speeds of about 2000 feet per minute. Robinson, Col. 10, lines 38-40. Wires or permeable belts 10' and 11' wrap Roll C, Figure 6 in an arc of about 15°. Robinson Col. 5, line 73. Roll C, a cellular or other open roll, may or may not include a suction means shown as S in Fig. 6. Col. 8, lines 51-52. The 15° wrap of the wires around roll C is sufficient to exert centrifugal force upon the material between the wires or belts, and, if the vacuum in Roll C were omitted, the water would continue in a straight path causing some centrifugal watering to occur at Roll C. TR 266-268, 273-275, 297-301 (Waller); TR 1086-1087, 1158-1160 (Testimony of Otto Kallmes).

1/ See also TR 271, lines 14-16 (Testimony of Michael Waller).

Claim 2	Prior Art (Robinson)
2. An apparatus as defined in claim 1 wherein the first wire passes over a roll for guiding it into said entrance nip.	Anticipatory art as described above with theaddition of Roll 13' of Figure 6, which is a conventional impervious breast roll. Robinson Col. 5, lines 65–67.

Claim 10	Prior Art (Robinson)
An apparatus for forming a fibrous web comprising; first and second continuous looped foraminous forming wires which are arranged to converge and provide an entrance nip for the reception of web–forming stock;	Anticipatory art as described in Claim 1(a) above.
a curved stationary surface positioned adjacent said entrance nip;	Anticipatory art as described in Claim 1(b) above.
means for supporting said wires within their respective loops and moving said wires into said entrance nip;	Anticipatory art as described in Claim 1(c) above.
said forming wires being arranged to travel over said stationary curved surface downstream of said entrance nip while having stock therebetween;	Anticipatory prior art as described in Claim 1(d) above.
a rotary cylinder positioned downstream in close–working relation with said curved stationary surface to define a continuous bi–radii curved path of wire travel having a first radius of curvature substantially larger than a second radius of curvature;	Roll C, Figure 6 of Robinson is positioned downstream of curved stationary surface 21', in a close–working relationship with said surface, to define a continuous bi–radii curved path of wire travel having a first radius of curvature substantially larger than the second radius of curvature. See also TR 270–271, 275–76 (Waller);

said wires traveling around a part of the periphery or said rotary cylinder immediately following the stationary curved surface, with said stationary surface and said rotary cylinder being on the same side of said wires;	Anticipatory prior art as described in Claim 1(f) above.
the first wire being free of restraining means on its outer surface opposite said rotary cylinder;	Anticipatory prior art as described in Claim 1(h) above.
said wires arranged for traveling at a speed so that the stock is dewatered centrifugally through the first wire.	Anticipatory prior art as described in Claim 1(i) above.

Claims 1-3, 7, 8, 10 and 11 of the '758 Patent Compared With the Combined Robinson and Means Prior Art References 2/

Claim 1	Robinson and Means Prior Art References 3/
An apparatus for forming fibrous webs comprising:	
a. first and second continuous looped foraminous forming wires which are arranged to converge and provide an entrance nip for the reception of web-forming stock;	"Apparatus comprising a first permeable belt having a web-contacting side and a water-drainage side, said belts being mounted with portions of said web-contacting sides in opposed relation and defining therebetween a forming zone wherein a stock mixture is received and formed into a web." Robinson Claim 2, Col. 12, lines 40-45. Fig. 6 describes two forming wires 11' and 12', which lead around two breast rolls 13' and 14' and converge to form entrance nip. Col. 5, lines 64-75, Col. 6, lines 1-13. A paper-making wet-end machine comprising the combination of first and second foraminous elements movable in substantially parallel paths at substantially the same velocity in contact with and on opposite sides of an inchoate paper web through at least a part of a forming zone. Means, Claim 1, Col. 8, lines 23-28. In Means, Figure 1, the first and second foraminous elements (which may be wire or nylon belts) 26 or 30 and 28 pass over lower and upper breast rolls. Means, Col. 2, lines 63-72; Col. 3, lines 1-11. "A wide flat stream of paper stock 19 is ejected at high speed from a slice 20, the 'wide' dimension of the stream extending into the plane of the figure. The stock 19 is directed between lower and upper breast rolls 22, 24 rotatably mounted in a spaced-apart relation with respect to each other." Means, Col. 2, lines 63-68.

2/ We note that the ALJ determined that "essentially all of the material elements of the '758 patent can be located in the prior art." ID at 132.

3/ The Means patent took into account the problems addressed by the Robinson patent and, indeed, the invention of Robinson itself, application for which was co-pending with that for Means. See Means, col. 3, lines 32-35.

b. a curved stationary surface positioned adjacent said entrance nip;	"a permeable curved supporting surface" Robinson Claim 9, col. 13, line 66 (emphasis supplied); Claim 10, col. 14, line 3. See also Fig. 8, 215', col. 11, lines 23-24.
	In a forming box for mounting on a paper-making machine to facilitate the making of paper, said box having a surface operatively associated with a foraminous paper-forming element moving in a given direction, the improvement comprising the combination of (a) a plurality of blade means having edges extending transversely of said direction of movement and assisting in the definition of said surface, said surface being (i) permeable, (ii) stationary, and (iii) curved in said direction of movement; Means Claim 2, Col. 8, lines 40-50. In Means, Figure 1, this is curved surface 33 over curved forming box 32. Means, Col. 3, lines 12-35.
c. means for supporting said wires within their respective loops and moving said wires into said entrance nip;	"Conventional impervious breast rolls". Robinson, Fig. 6, 13', 14'; col. 5, line 67.
	Lower and upper breast rolls 22 and 24, respectively. Means, Col. 2, lines 66-69; Figure 1.

d. said forming wires being arranged to travel over said stationary curved surface downstream of said entrance nip while having stock therebetween,	"In a method of forming paper, the steps comprising moving a pair of permeable paper-forming members in closely-spaced apart paper-making relation at substantially the same direction through a paper-forming zone, introducing a paper stock between said members, training at least one of said members in a curved path in said forming zone about a permeable curved supporting surface, maintaining said supporting surface stationary, and withdrawing water from said stock through said supporting surface to facilitate formation of said stock into a paper web. Robinson Claim 9, Col. 13, lines 59-69 (emphasis supplied); Figure 8, 215' Col. 11, lines 23-34. "The elements 26, 28, 30 are trained about the open, curved surface 33 of the forming box 32 in such a way that the forming box 32 assists in the establishment of a convergence between the movable paper-forming foraminous element 26 and the movable foraminous drainage element 30 on the one hand and the paper-forming foraminous element 28 on the other. As noted above, the surface 33 of the forming box 32 adapted to contact the movable foraminous drainage element 30 (or if the element 30 is not employed, the movable paper-forming foraminous element 26) is curved." Means, Col. 3, lines 17-26; Figure 1.
e. a rotary cylinder,	"a roll having a surface defining a foraminous sheet opposable to the water drainage side of one of said belts through at least a portion of said forming zone." Robinson Claim 2, Col. 12, lines 46-49; Figure 6, Roll C; Col. 5, lines 71-79. "A vacuum break roll 50 rotatable about its axis." Means, Col. 4, line 5; Figure 1.

f. said wires traveling around a part of the periphery of said rotary cylinder immediately following the stationary forming surface, with said surface and said cylinder being on the same side of said wires;	Wires 11' and 12' travel around part of the periphery of roll C immediately following stationary forming surface 21'. Figure 6; Col. 6, lines 67–67. The foraminous elements 26, 28 and 30 wrap Roll 50 at an angle of about 6°. Means Col. 4, lines 51–56; Figure 1. Roll 50 is immediately downstream from and on the same side of the wire as the curved stationary surface 33 depicted in Figure 1. 4/
g. said stationary curved surface having a relatively large radius of curvature:	"At least one of said members [is trained] in a curved path in said forming zone about a permeable curved supporting surface." Robinson, Claim 9, Col. 13, lines 63–69. This curved surface is grating assembly 215' with blades 216', which are "convexly cylindrically curved about at least one horizontal axis." Col. 11, lines 27–28. Robinson, Figure 8. The arc of the grating assembly 215' is about 20°. Robinson, Col. 11, lines 41–44; Figure 8. 5/ "In a cross action taken in the plane of Figure 1, the curve described by the surface 33 may be part of a circle, parabola, hyperbola, or sine wave, or it may be a French curve or some other curve. In a typical case, the curve is part of a circle, which means that the surface 33 itself describes part of a cylinder. The surface 33 preferably curves through an arc of about 20° as disclosed in the co-pending Robinson application Ser. No. 311,278 referred to above." Means, Col. 3, lines 26-34. ID 60–70 (FF 140).

4/ The existence in Means of suction boxes 38, 40, 42 and 44 do not interfere with the "immediately downstream" requirement of Claim 1(f) of the Parker '758 patent. Means, Figure 2. The '758 patent teaches that the actual spacing between the curved stationary surface and the rotary cylinder is not critical and that other dewatering elements may be spaced between these two elements. Parker Col. 8, lines 70–75; Figure 3, 71 (curved stationary surface) and 52 (roll).

5/ See also TR 271, lines 14–16 (Waller).

h. the first wire being free of restraining means on its outer surface opposite said rotating cylinder;

Figure 6, 11'. See also Figure 8', 208'; TR 271, lines 17-19 (Waller).

The first wire 28 of Figure 1 of Means is free of a restraining means on its outer surface opposite rotating cylinder 50. Means Col. 4, lines 61-65. See also Means Col. 4, lines 42-43 (Roll 54, Figure 1 is somewhat downstream of Roll 50).

i. said wires arranged for traveling at a speed so that the stock is dewatered centrifugally through the first wire.

Wires travel at speeds of about 2000 feet per minute. Robinson, Col. 10, lines 38-40. Wires or permeable belts 20' and 21' wrap Roll C, Figure 6 in an arc of about 15°. Robinson Col. 5, line 73. Roll C, a cellular or other open roll, may or may not include a suction means shown as S in Fig. 6. Col. 8, lines 51-52. The 15° wrap of the wires around roll C is sufficient to exert centrifugal force upon the material between the wires or belts, and, if the vacuum in Roll C were omitted, the water would continue in a straight path causing some centrifugal watering to occur at Roll C.
TR 273-275, 266-268, 297-301 (Waller); TR 1086-1087, 1158-1160 (Kallmes).

Centrifugal dewatering is inherent in the structure disclosed in Means as manufactured in the St. Francisville, PM 2 paperforming machine. TR 788-94; 832-833, 836 (Testimony of J. A. Means); ID 71 (FFs 243-44).

Dewatering occurs centrifugally through top wire 28 as it passes over curved grating 33 of Figure 1. TR 865 (Means); TR 709, 749 (Testimony of Paul J. Thoma).

Claim 2

2. An apparatus as defined in claim 1 wherein the first wire passes over a roll for guiding it into said entrance nip.

Prior art as described above with the addition of Roll 13' of Figure 6, which is a conventional impervious breast roll. Robinson, Col. 5, lines 65–67.

Top wire 28 passes over top breast roll 24 of Figure 1 of means for guiding the wire into the forming zone. Means, Col. 2, lines 63–69.

Claim 3

An apparatus as defined in claim 2 including means for adjusting said roll relative to the entrance nip.

Breast rolls 13' and 14' of Figure 6 of Robinson are "adjustably elevated." Robinson, col. 5, lines 68–95.

Prior art as described above with the addition of the spacing of the breast rolls 22, 24 with respect to each other of the points of their respective circumferences closest to each other may be varied. Means, Col. 2, lines 70–73; see also Col. 3, lines 1–7 and 16–22.

Claim 7

An apparatus for forming fibrous webs as defined in claim 1 including means for separating the first wire from the second wire following the rotary cylinder with the web being carried on the second wire.

Prior art as noted in Claim 1 above with the addition of: "means adjacent to said first foraminous element for training said first foraminous element through an arc of about 6° and separating said first foraminous element from said second foraminous element, said first foraminous element approaching said training means at an angle 3° above the horizontal and departing from said training means at an angle 3° below the horizontal and said seond foraminous element being free of restraining means at the locus of separation of said first and second foraminous element, whereby said paper web is separable from one of said foraminous elements integrally and without being crushed." Means, Claim 1, Col. 8, lines 18–34.

	The embodiment of this claim is found in Figure 1 of Means at roll 54 following Roll 50 where the web is carried solely on wire 26. See also Means, Col. 4, lines 57–69.
Claim 8	
An apparatus for forming fibrous webs as defined in claim 7 including a web transfer means positioned downstream of the rotary cylinder and in working relation with the second wire for transferring the web away from said second wire.	Inherently taught by the invention in both Means and Robinson in which the web must be transferred from the bottom wire to the press section. The typical paperforming apparatus at the time of Robinson included a means for transporting the web from the forming section to the press section for further processing. See Robinson, Col. 1, lines 29–30. In addition, Means teaches that there must be an arrangement working with second wire 26 or 30 to provide for separation of the first wire 28 without crushing the formed web. Col. 5, lines 25–33. By inference, the web is removed then from the second wire 26 or 30 to be transferred into the press section from the former.
Claim 10	
A device as described in Claim 1(a)–(d) and (f)–(i) above with the addition of:	Prior art as described in Claim 1 above with the addition of:
a rotary cylinder positioned downstream in close-working relation with said curved stationary surface to define a continuous bi-radii curved path of wire travel having a first radius of curvature substantially larger than a second radius of curvature;	Roll C, Figure 6 of Robinson is positioned downstream of curved stationary surface 21', in a close-working relationship with said surface, to define a continuous bi-radii curved path of wire travel having a first radius of curvature substantially larger than the second radius of curvature. TR 275–76 (Waller).

Roll 50 of Means Figure 1 is positioned downstream of curved survace 33 in a close-working relationhip with that surface. See, e.g., Means, Col. 4, lines 70-75; Col. 5 lines 1-7. The wires travel over curved surface 33 of Figure 1 in a 20° arc followed by Roll 50 in a 6° arc. Means, Col. 3, lines 63-65.

Claim 11

An apparatus for forming fibrous webs as defined in claim 10 wherein the curved stationary surface is a substantially water-permeable surface defined by a plurality of longitudinally spaced generally transverse wire-contacting relatively thin edges, the longitudinal contours of said wire-contacting edges defining the curve of said surface.

Prior art as described in Claim 10 above with the addition of:

In a forming box for mounting on a paper-making machine to facilitate the making of apaper, said box having a surface operatively associated with a foraminous paper-forming element moving in a given direction, the improvement comprising the combinations of

(a) a plurality of blade means having edges extending transversely of said direction of movement and assisting in the definition of said surface, said surface being
  (i) permeable,
  (ii) stationary, and
  (iii) curved in said direction of movement.

Means, Claim 2, Col. 8, lines 40-51.

Figures 2-5 of Means show in detail one form of curved forming box constructed in accordance with the invention. Figure 2 shows a first plurality of blades 74 disposed on the right half of the box as seen in the figure, and a second plurality of blades 76 disposed on the left half of the box. The blades 74 and 76 may be about 1/16 of an inch or less thick in a "transverse" direction parallel to the plane of stock flow and substantially transverse of the "longitudinal" direction or direction of stock flow. The latter direction is indicated by the arrow at the bottom of the figure.

Claims 1-4, 7, 8, 10 and 11 of the '758 Patent Compared With the Justus French Patent, Means and Lee Prior Art References In Combination 6/

Claim 1	Justus, Means, and Lee Prior Art References 7/
An apparatus for forming fibrous webs comprising:	
a. first and second continuous looped foraminous forming wires which are arranged to converge and provide an entrance nip for the reception of web-forming stock;	A paper-making wet-end machine comprising the combination of first and second foraminous elements movable in substantially parallel paths at substantially the same velocity in contact with and on opposite sides of an inchoate paper web through at least a part of a forming zone. Means, Claim 1, Col. 8, lines 23-28. In Means, Figure 1, the first and second foraminous elements (which may be wire or nylon belts) 26 or 30 and 28 pass over lower and upper breast rolls. Means, Col. 2, lines 63-72; Col. 3, lines 1-11. "A wide flat stream of paper stock 19 is ejected at high speed from a slice 20, the 'wide' dimension of the stream extending into the plane of the figure. The stock 19 is directed between lower and upper breast rolls 22, 24 rotatably mounted in a spaced-apart relation with respect to each other." Means, Col. 2, lines 63-68.

6/ We note that the ALJ determined that "essentially all of the material elements of the '758 patent can be located in the prior art." ID at 132.

7/ The Justus French patent No. 1,473,988 issued February 15, 1967, (RX-100) is comparable to British Patent No. 1,129,893 (RX-147).

The Justus French patent relates to the art of forming paper webs. RX-100, p. 1, lines 16-17, RX-147, p. 1, lines 14-15. Figure 2 of Justus shows first and second continuous looped forming elements, one of which is wire 211 and the other a porous felt 220. RX-100, p. 8, lines 27-22; p. 11, lines 5-26; p. 12, lines 1-26; p. 13, lines 1-22. Lee teaches the substitutability of wires and felts depending upon the nature of the drainage rate desired. Lee, Col. 5, lines 14-22, 42-48.

Forming elements 220 and 211 of Justus Figure 2 are arranged to form an entrance nip for the reception of web-forming stock from the headbox jet slice 216. RX-147, p. 4, line 85-91; p. 5, lines 20-47; RX-100, p. 11, lines 7-9; p. 12, lines 24-26; p. 13, lines 1-14. It should be further noted that Justus refers to the felt described in 220 of Figure 2 also as an "upper porous belt" without limitation as to material of this web carrying element. RX-100, p. 8, lines 17-18; RX-147, p. 3, lines 114-116.

b. a curved stationary surface positioned adjacent said entrance nip;

In a forming box for mounting on a paper-making machine to facilitate the making of paper, said box having a surface operatively associated with a foraminous paper-forming element moving in a given direction, the improvement comprising the combination of

(a) a plurality of blade means having edges extending transversely of said direction of movement and assisting in the definition of said surface, said surface being

(i) permeable,

(ii) stationary, and

(iii) curved in said direction of movement;

Means Claim 2, Col. 8, lines 40-50. In Means, Figure 1, this is curved surface 33 over curved forming box 32. Means, Col. 3, lines 12-35.

	An arcuate convex face in the substantial vicinity at which the stock jet is fed into the wire reach. Justus, Claim 1; RX-147, p. 9, lines 48-53; RX-100, p. 22, lines 16-25. Figure 2 of Justus depicts a curved stationary surface 240 which is positioned adjacent an entrance nip with the entrance nip terminating on the shoe 240 and having one side of the nip shaped by the shoe 240. RX-100, p. 11, line 29; p. 14, line 11-28; RX-147, p. 4, lines 88-91, 101-107.
c. means for supporting said wires within their respective loops and moving said wires into said entrance nip.	Lower and upper breast rolls 22 and 24, respectively. Means, Col. 2, lines 66-69; Figure 1. Rolls 231, 232, 233, 212 shown in Justus figure 2 support wire 211 and felt 220 within their respective loops and for moving these wires into said entrance nip. RX-100, p. 11, lines 5-7, 15-19; p. 12, lines 3-15; RX-147, p. 4, lines 85-88.
d. said forming wires being arranged to travel over said stationary curved surface downstream of said entrance nip while having stock therebetween,	"The elements 26, 28, 30 are trained about the open, curved surface 33 of the forming box 32 in such a way that the forming box 32 assists in the establishment of a convergence between the movable paper-forming foraminous element 26 and the movable foraminous drainage element 30 on the one hand and the paper-forming foraminous element 28 on the other. As noted above, the surface 33 of the forming box 32 adapted to contact the movable foraminous drainage element 30 (or if the element 30 is not employed, the movable paper-forming foraminous element 26) is curved." Means, Col. 3, lines 17-26; Figure 1.

	In figure 2, wire 211 and felt 220 travel over curved stationery surface 240 downstream of the entrance nip while having stock there between, with the entrance nip terminting in the convergence region or zone R-200 on shoe 240. RX-100, p. 11, lines 9-15, 24-27; p. 13 lines 1-22; RX-147, p. 4, lines 129-30, p. 5, lines 1-6.
e. a rotary cylinder,	"A vacuum break roll 50 rotatable about its axis." Means, Col. 4, line 5; Figure 1. Roll 232 of figure 2 of Justus is a "rotary cylinder." RX-100, p. 13, lines 4-22; RX-147, p. 5, lines 50-51.
f. said wires traveling around a part of the periphery of said rotary cylinder immediately following the stationary forming surface, with said surface and said cylinder being on the same side of said wires;	The foraminous elements 26, 28 and 30 wrap Roll 50 at an angle of about 6°. Means Col. 4, lines 51-56; Figure 1. Roll 50 is immediately downstream from and on the same side of the wire as the curved stationary surface 33 depicted in Figure 1. 8/ In Justus Figure 2, wire 211 and felt 220 with web W-200 therebetween travel through a relatively sharp curve defined by roll 232 which is on the same side of wire 211 as the curved surface 240. RX-100, p. 13, lines 14-22; RX-147, p. 5, lines 46-57.

8/ The existence in Means of suction boxes 38, 40, 42 and 44 do not interfere with the "immediately downstream" requirement of Claim 1(f) of the Parker '758 patent. Means, Figure 2. The '758 patent teaches that the actual spacing between the curved stationary surface and the rotary cylinder is not critical and that other dewatering elements may be spaced between these two elements. CX-1 (Parker), Col. 8, lines 70-75; Figure 3, 71 (curved stationary surface) and 52 (roll).

g. said stationary curved surface having a relatively large radius of curvature:

"In a cross action taken in the plane of Figure 1, the curve described by the surface 33 may be part of a circle, parabola, by-parbola, or sine wave, or it may be a French curve or some other curve. In a typical case, the curve is part of a circle, which means that the surface 33 itself describes part of a cylinder. The surface 33 preferably curves through an arc of about 20° as disclosed in the co-pending Robinson application Ser. No. 311,278 referred to above." Means, Col. 3, lines 26-34. ID 60-70 (FF140).

The shoe 240 is curved initially to receive the downwardly travelling felt 22 and then is curved to conform with a generally parabolic curve. The shoe 240 causes the formation of a region of convergence R-200 which is relatively long indicating a large degree of curvature. RX-100, p. 22, lines 15-19, p. 12, lines 9-15, p. 13, lines 6-13; RX-147, p. 4 lines 101-107, 129-30, p. 5, lines 20-46.

h. the first wire being free of restraining means on its outer surface opposite said rotating cylinder;

The first wire 28 of Figure 1 of Means is free of a restraining means on its outer surface opposite rotating cylinder 50. Means Col. 4, lines 61-65. See also Means Col. 4, lines 42-43, Roll 54, Figure 1 is somewhat downstream of Roll 50.

First wire 211 is free of restraining means on its outer surface opposite roll 232. RX-147, Figure 2.

i. said wires arranged for traveling at a speed so that the stock is dewatered centrifugally; through the first wire.

Centrifugal dewatering is inherent in the structure disclosed in Means as manufactured in the St. Francisville, PM 2 paperforming machine. TR 788-94; 832-833, 836 (Means); ID 71 (FFs 243-44).

Dewatering occurs centrifugally through top wire 28 as it passes over curved grating 33 of Figure 1. TR 865 (Means); TR 709, 749 (Thoma).

In Justus, water is eliminated beyond the forming zone by the combined action of gravity and centrifugal force. RX-100, p. 23, lines 10-11, 21-23; RX-147, p. 9, lines 88-94. The longer convergence region R-200 allows for high speeds of production with drainage comparable to slower machines. The elimination of residual water is "advantageous favored by centrifugal force" as the forming elements wrap roll 232. RX-100, lines 26-22; RX-147, p. 5, lines 20-57.

Claim 2

2. An apparatus as defined in claim 1 wherein the first wire passes over a roll for guiding it into said entrance nip.

Top wire 18 passes over top breast roll 24 of Figure 1 of means for guiding the wire into the forming zone. Means, Col. 2, lines 63-69.

The prior art of Justus in view of Lee is described in connection with claim 1 with the addition of breast roll 212 of Figure 2 of Justus, which guides wire 211 into the entrance nip. RX-147, Figure 2.

Claim 3

An apparatus as defined in claim 2 including means for adjusting said roll relative to the entrance nip.

Prior art as described above with the addition of the spacing of the breast rolls 22, 24 with respect to each other of the points of their respective circumferences closest to each other may be varied. Means, Col. 2, lines 70-73; see also Col. 3, lines 1-7 and 16-22.

The prior art of Justus in view of Lee as discussed in connection with Claim 2 with the addition of breast roll 212 of Figure 2 of Justus. RX-147, Figure 2. the adjustability of roll 212 relative to the entrance nip is expressly taught by Means and known to persons of ordinary skill in the art. Means, col. 2, lines 70-73; TR 277-78.

Claim 4

An apparatus as defined in Claim 1 wherein said wires wrap a guide roll after leaving the rotary cylinder with the first wire engaging said guide roll.

The prior art of Justus in view of Lee as described in connection with Claim 1 with the addition of roll 213 of Figure 2 which is wrapped by elements 211 and 220 after leaving rotary roll 232. RX-100, p. 14, lines 1-5; RX-147, p. 5, lines 60-70.

Claim 7

An apparatus for forming fibrous webs as defined in claim 1 including means for separating the first wire from the second wire following the rotary cylinder with the web being carried on the second wire.

Prior art as noted in Claim 1 above with the addition of: "means adjacent to said first foraminous element for training said first foraminous element through an arc of about 6° and separating said first foraminous element from said second foraminous element, said first foraminous element approaching said training means at an angle 3° above the horizontal and departing from said training means at an angle 3° below the horizontal and said seond foraminous element being free of restraining means at the locus of separation of said first and second foraminous element, whereby said paper web is separable from one of said foraminous elements integrally and without being crushed." Means, Claim 1; Col. 8, lines 18-34.

The embodiment of this claim is found in Figure 1 of Means at roll 54 following Roll 50 where the web is carried solely on wire 26. See also Means, Col. 4, lines 57-69.

Prior art Justus in view of Lee as discussed under Claim 1 with the addition of guide roll 233 of figure 2 where felt 220 and wire 211 are separated following the rotary cylinder. Felt 220 and the web W-200 are there separated from wire 211. RX-100, p. 14, lines 5-7; RX-147, p. 5, lines 70-75.

Claim 8

An apparatus for forming fibrous webs as defined in claim 7 including a web transfer means positioned downstream of the rotary cylinder and in working relation with the second wire for transferring the web away from said second wire.

Inherently taught by the invention in both Means in which the web must be transferred from the bottom wire to the press section. The typical paperforming apparatus at the time of Means included a means for transporting the web from the forming section to the press section for further processing.

In addition, Means teaches that there must be an arrangement working with second wire 26 or 30 to provide for separation of the first wire 28 without crushing the formed web. Means, Col. 5, lines 25–33. Thus, by inference, the web is removed from the second wire 26 or 30 to be transferred into the press section from the former.

Prior art as described in Claim 7 above with the addition of roll 422 of Figure 4 of Justus, which shows the web W–400 being drawn away from upper felt belt 420. Justus, Figure 4. In fact, such web transfer means were well–known to persons of ordinary skill in the art. TR 280 (Waller).

Claim 10

A device as described in Claim 1(a)–(d) and (f)–(i) above with the addition of:

a rotary cylinder positioned downstream in close–working relation with said curved stationary surface to define a continuous bi–radii curved path of wire travel having a first radius of curvature substantially larger than a second radius of curvature;

Prior art as described in Claim 1 above with the addition of:

Roll 50 of Means Figure 1 is positioned downstream of curved surface 33 in a close–working relationhip with that surface. See, e.g., Means, Col. 4, lines 70–75; Col. 5 lines 1–7. The wires travel over curved surface 33 of Figure 1 in a 20° arc followed by Roll 50 in a 6° arc. Means, Col. 3, lines 63–65.

In Figure 2 of the Justus French patent, rotary cylinder roll 232 is downstream of curved stationary surface 240 in a close working relationship therewith. The region of convergence R-200 is a relatively long parabolic curve followed by the smaller radius of roll 232 to define a continuous bi-radii path. RX-100, p. 12, lines 9-12, p. 13, lines 17-18, RX-147, p. 4, lines 101-107; p. 5, lines 35-57.

Claim 11

An apparatus for forming fibrous webs as defined in claim 10 wherein the curved stationary surface is a substantially water-permeable surface defined by a plurality of longitudinally spaced generally transverse wire-contacting relatively thin edges, the longitudinal contous of said wire-contacting edges defining the curve of said surface.

Prior art as described in Claim 10 above with the addition of:

In a forming box for mounting on a paper-making machine to facilitate the making of apaper, said box having a surface operatively associated with a foraminous paper-forming element moving in a given direction, the improvement comprising the combinations of

(a) a plurality of blade means having edges extening transversely of said direction of movement and assisting in the definition of said surface, said surface being
  (i) permeable,
  (ii) stationary, and
  (iii) curved in said direction of movement.

Means, Claim 2, Col. 8, lines 40-51.

Figures 2-5 of Means show in detail one form of curved forming box constructed in accordance with the invention. Figure 2 shows a first plurality of blades 74 disposed on the right half of the box as seen in the figure, and a second plurality of blades 76 disposed on the left half of the box. The blades 74 and 76 may be about 1/16 of an inch or less thick in a "transverse" direction parallel to the plane of stock flow and substantially transverse of the "longitudinal" direction or direction of stock flow. The latter direction is indicated by the arrow at the bottom of the figure.

TWIN-WIRE WEB FORMING SYSTEM WITH DEWATERING BY CENTRIFUGAL FORCES

Filed July 8, 1971 6 Sheets-Sheet 1

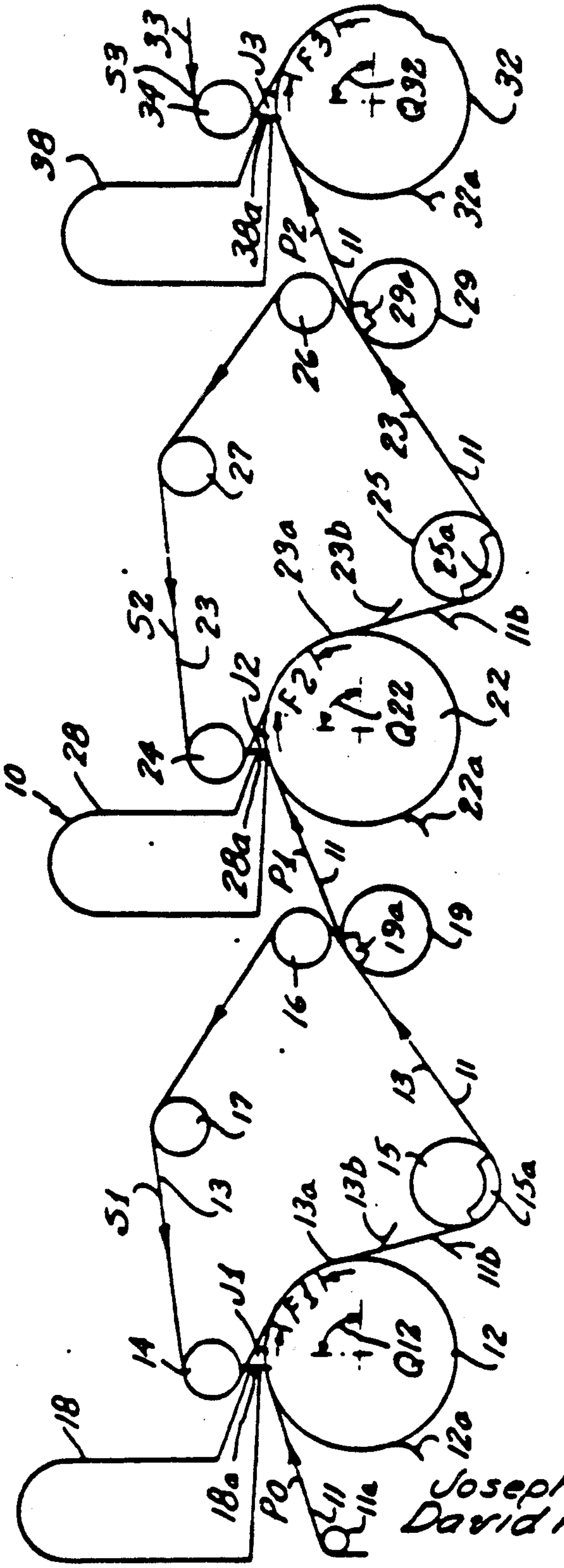
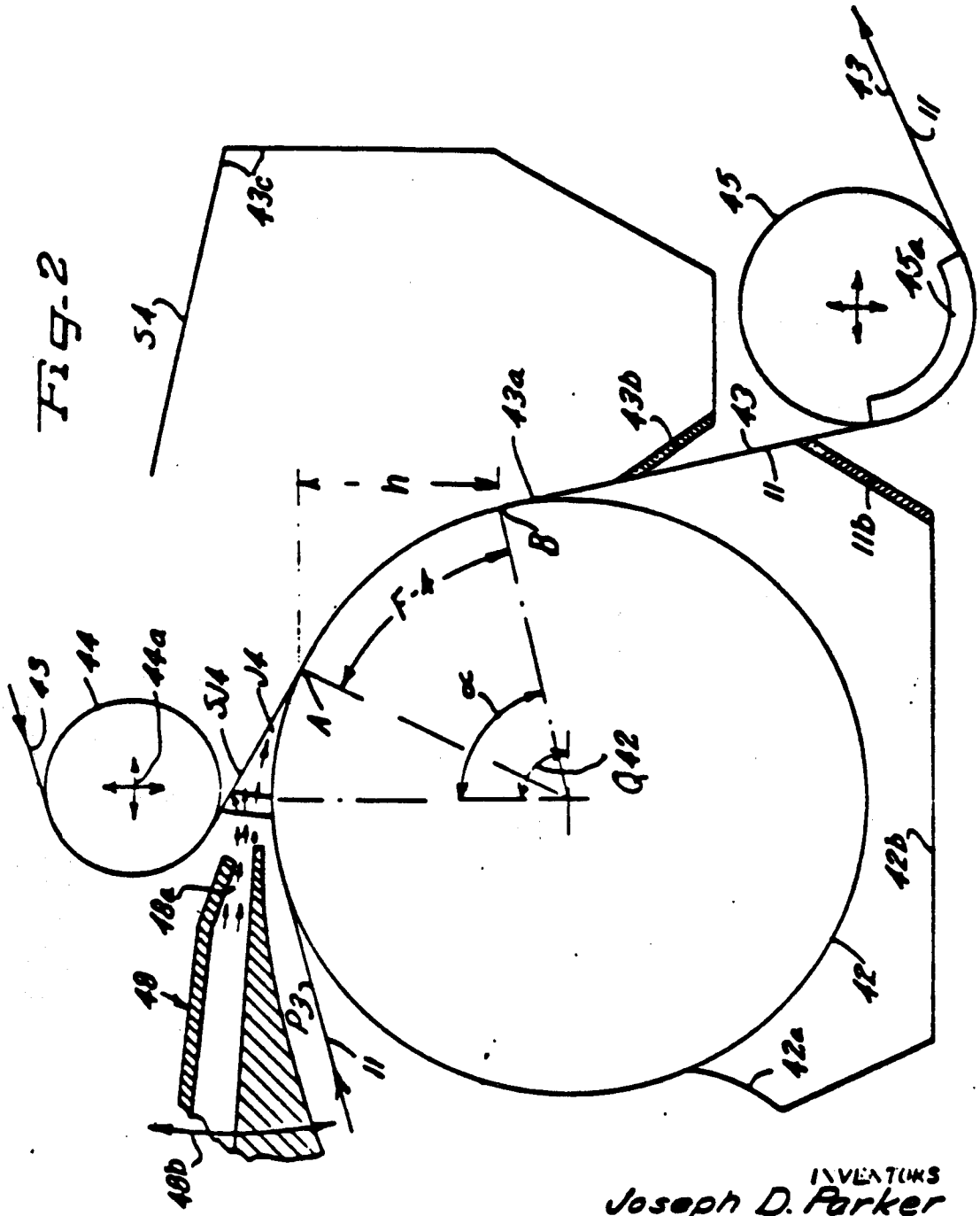


Fig-1

INVENTORS
Joseph D. Parker
David R. Gustafson

BY Hill, Sherman, Meroni, Gross & Simpson ATTORNEYS

Fig-2



INVENTORS
Joseph D. Parker
David R. Gustafson
Hill, Sherman, Meroni, Gross & Simpson ATTORNEYS

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Fig-3

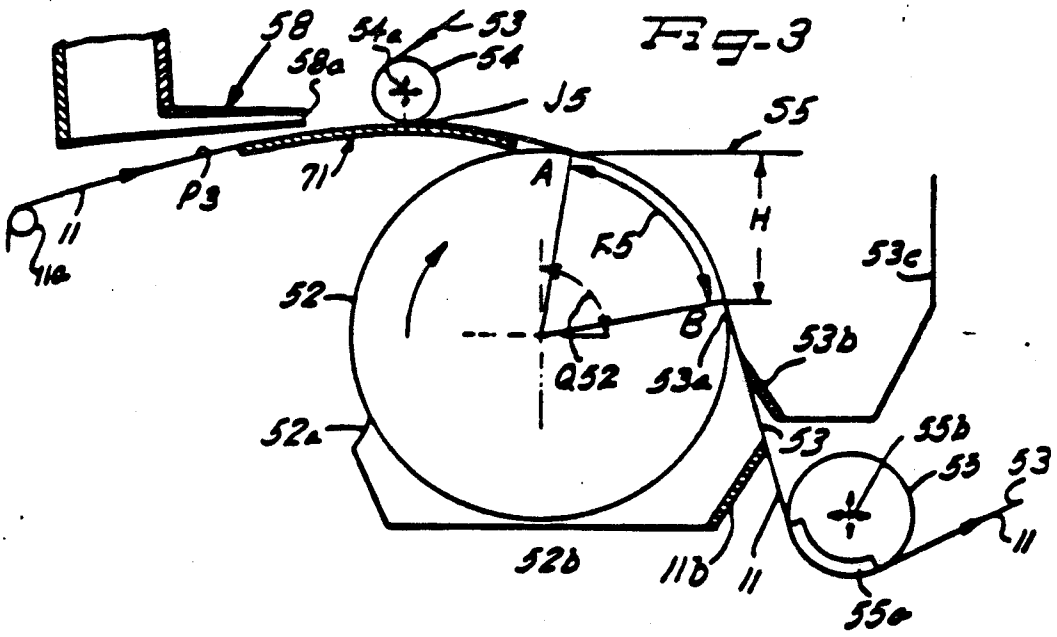
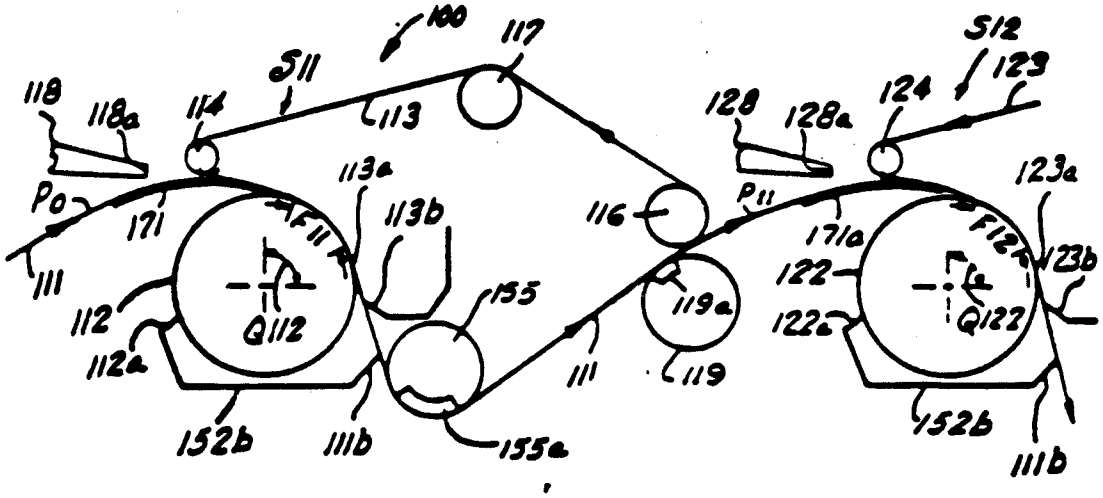


Fig-4



INVENTORS
Joseph D. Parker
David R. Gustafson

Hill, Sherman, Meroni, Gross & Simpson ATTORNEYS

11Y

April 10, 1973 J. D. PARKER ET AL 3,726,758

TWIN-WIRE WEB FORMING SYSTEM WITH DEWATERING BY CENTRIFUGAL FORCES

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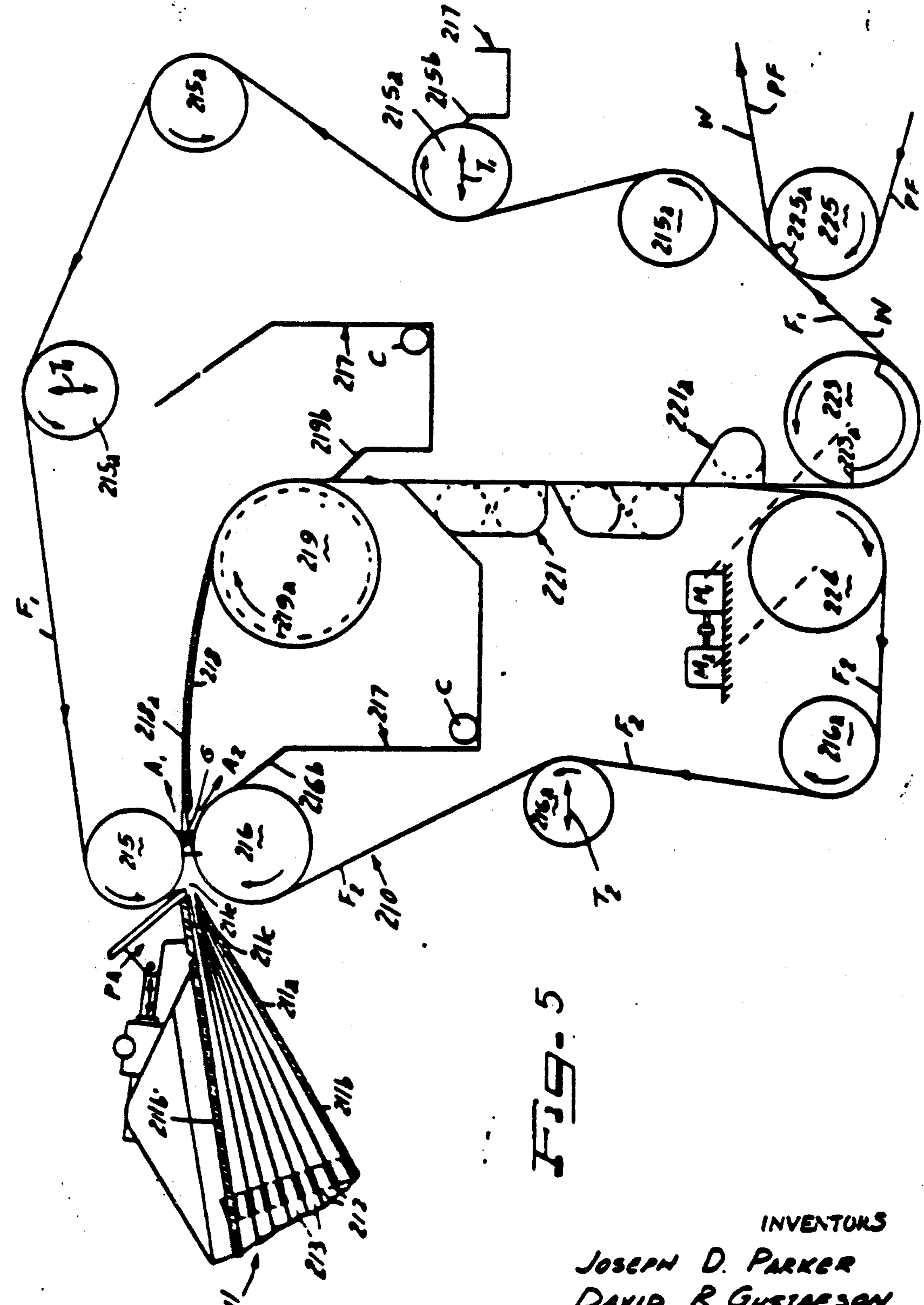

Fig. 5

INVENTORS
JOSEPH D. PARKER
DAVID R. GUSTAFSON

BY Hill, Sherman, Meroni, Gross & Simpson ATTORNEYS

April 10, 1973 J. D. PARKER ET AL 3,726,758

TWIN-WIRE WEB FORMING SYSTEM WITH DEWATERING BY CENTRIFUGAL FORCES

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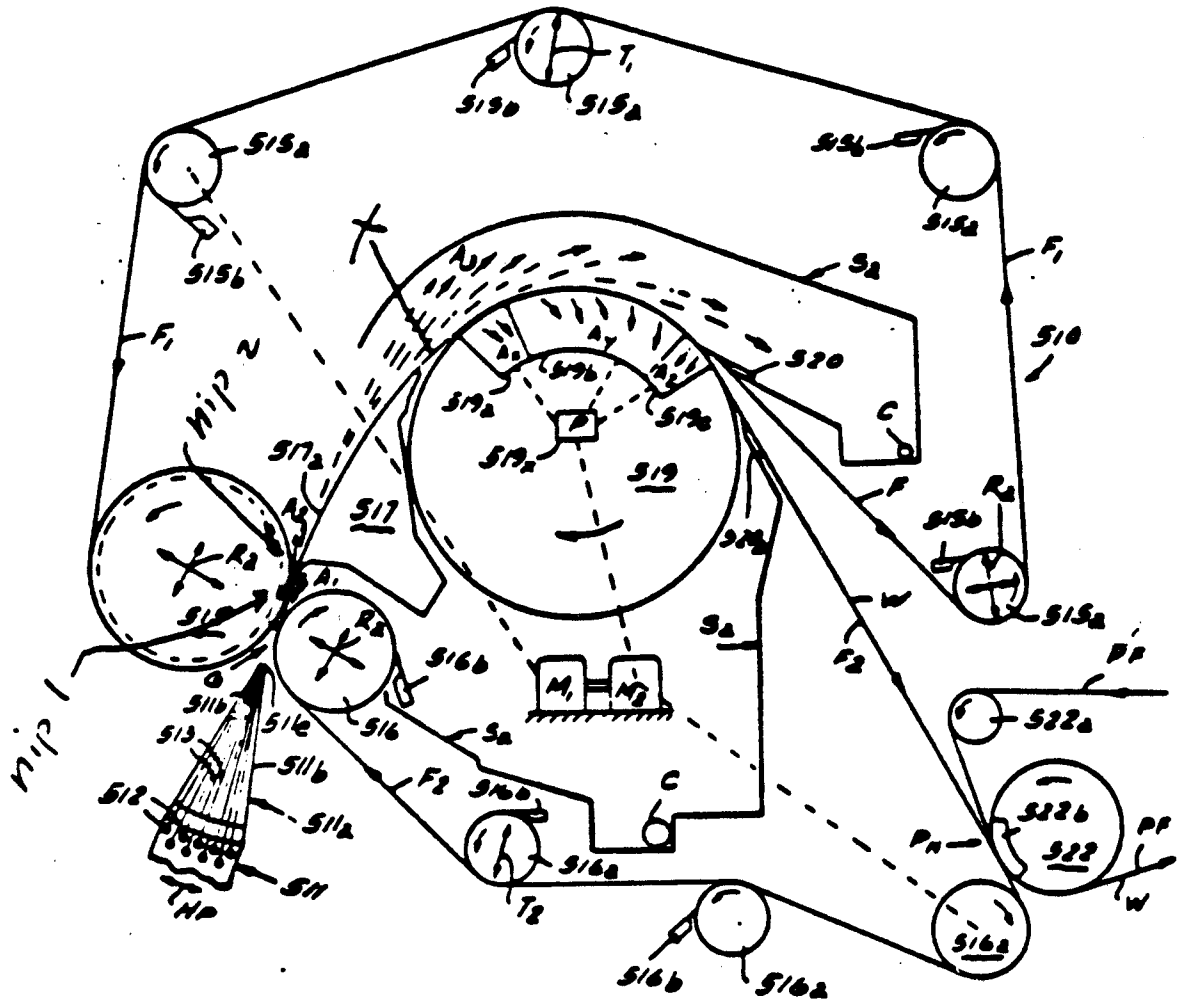
Fig. 8



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3,726,758

TWIN-WIRE WEB FORMING SYSTEM WITH DEWATERING BY CENTRIFUGAL FORCES

Joseph H. Parker, R.R. 1, Southgate Road, Reeves, Ill. 61073, and David R. Gustafson, 717 E. Franklin St., Rochelle, Ill. 61072

Continuation-in-part of abandoned applications Ser. No. 792,713, Jan. 21, 1969, and Ser. No. 795,954, Feb. 3, 1969. This application July 8, 1971, Ser. No. 160,879
Int. Cl. D21f 1/36
U.S. Cl. 162—299 23 Claims

ABSTRACT OF THE DISCLOSURE

A twin-wire web making system for use in forming multi-ply or single-ply webs wherein a web stock is discharged into a nip between opposed forming wire runs arranged to converge with one another over guide elements. In one embodiment a plurality of individual forming sequences are associated with a main forming wire for receiving successive plies and merging the same together at each sequence. In another embodiment a single forming sequence is associated with a pick-up felt for removal of the ply from the forming sequence. At each sequence a head box means discharges web stock between twin wires supported by spaced breast rolls defining the nip therebetween and the wires gradually converge into general parallelism over curved guides by wrapping a portion of their surfaces so as to centrifugally dewater the stock sandwiched between the wires. In one aspect of the invention, a stationary curved surface and a rotary cylinder are positioned on the same side of the wires to guide the wires into general parallelism. The stationary surface and the roll combine to define a bi-radii path of wire travel having a first radius of curvature larger than the second radius of curvature. The stationary surface is water impermeable or permeable and includes surfaces having a decreasing radius of curvature in the direction of wire travel. The rotary cylinder includes solid rolls, open rolls and suction rolls. The head box means includes structures containing a plurality of flexible trailing elements therein defining therebetween channels converging in the direction of the nip for producing a stream having a relatively low degree of turbulence and a relatively high degree of dispersion.

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a continuation-in-part application of our copending U.S. Ser. Nos. 792,713, filed Jan. 21, 1969, now abandoned, and Ser. No. 795,954, filed Feb. 3, 1969, now abandoned.

BACKGROUND OF THE INVENTION

Field of the invention

The invention relates to fibrous web formation and more particularly to improved apparatus, systems and processes for forming fibrous webs from dilute aqueous suspensions thereof.

Prior art

In relatively recent years the art of web making, particularly paper making, has undergone a number of significant advances in the field of web formation using two opposed forming wire runs for web formation therebetween in contrasted to the heretofore more conventional Fourdrinier-type web making machines employing only a single forming wire. Although such twin wire forming machines have met with limited commercial success, these machines are still in the stage of being improved and various aspects of the operation thereof and the resulting quality of web may leave something to be desired, at least in certain specific instances. For example, as the speed of the web making machine is increased, operational difficulties are often encountered in connection with deposition of certain types of stock requiring rather high dilution. The problems encountered are not limited to difficulties in control of water movement (with resulting "rolling" and/or "streaking") but include difficulties of web sensitivity in some speeds, premature wear of various components, control of pressure applied on the new web, etc. Essentially, the instant invention provides a new and unique forming arrangement which accommodates higher machinery speeds as well as improved quality web so made.

SUMMARY OF THE INVENTION

The invention generally comprises a forming machine and system including a head box means for providing a ribbon-thin jet stream of web stock in a given direction (horizontal or vertical); two endless loop forming wires arranged to travel in the given direction so as to define a forming zone; a breast roll positioned within each of the looped wires to define a nip therebetween for receiving the stock and curved guide elements positioned downstream of the breast rolls and within the loop of one of the wires to dewater the stock sandwiched between the wires.

In one embodiment, a main forming wire is guided through a plurality of sequences, each sequence having an individual head box means and an auxiliary wire converging with the main wire over curved guide elements so as to dewater the ply formed in that sequence and merge it with preceding plies. In one specific form of this embodiment, the guide elements comprise a large diameter roll, which can be perforated or imperforated, positioned within the loop of the main wire and having its outer surface partially wrapped by the traveling wires so as to centrifugally dewater the stock between the wires. In another specific form of this embodiment, the guide elements comprise a stationary (perforated or unperforated) curved surface followed by a roll, both positioned within the loop of the main wire so as to define a continuous bi-radii curved path of travel having a first radius of curvature larger than the second radius of curvature. A portion of the outer surfaces of the stationary surface and the roll is wrapped by the wires to centrifugally dewater the sandwiched stock. The stationary surface has a constant radius of curvature or a decreasing radius of curvature in the direction of wire travel.

In another embodiment of the invention, a pair of forming wires are guided through an individual sequence having a head box means and means gradually converging the wires into general parallelism over curved guide elements to centrifugally dewater the stock between the wires. A specific form of the head box means includes walls converging toward the outlet opening thereof and a plurality of flexible trailing elements within the head box slice chamber converging toward the opening for guiding sequences such as a ribbon-thin jet stream having a relatively low degree of turbulence and a relatively high degree of dispersion into the nip between the wires. A specific form of curved guide elements comprise a stationary curved surface followed by a cylindrical roll, both positioned within the loop of one of the wires for guiding the wires through a change of travel direction to centrifugally dewater the stock between the wires. The stationary surface is solid or formed of a plurality of thin edges, the longitudinal contour of which define the desired curve. The cylindrical roll is a relatively large diameter dewatering roll (open, suction, grooved, drilled, etc.). Couch and turning rolls are positioned within the forming run for separating the web from one of the wires and guiding the web-carrying wire to a pick-up station for transferring the web from the forming zone. In a specific arrange-

most, both wires wrap a portion of the couch roll to insure that the web remains in contact with the desired wire through a change of wire travel direction.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an essentially schematic elevational view showing a portion of a web forming machine comprised of a plurality of sequences embodying the instant invention;

FIG. 2 is an essentially schematic elevational somewhat enlarged view of an individual sequence as the type shown in FIG. 1;

FIG. 3 is an essentially schematic elevational somewhat enlarged view of another embodiment of the individual sequence shown in FIG. 2;

FIG. 4 is an essentially schematic elevational view showing a portion of a web forming machine somewhat similar to the type shown in FIG. 1 but utilizing the individual sequences shown in FIG. 3;

FIG. 5 is an essentially schematic elevational view illustrating a further embodiment of the invention;

FIG. 6 is an essentially schematic elevational partial view of a modified form of the embodiment illustrated at FIG. 5;

FIG. 7 is an essentially schematic elevational partial view of yet a further modified arrangement of the embodiment illustrated at FIG. 5; and

FIG. 8 is essentially a schematic elevational view illustrating yet a further modification of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 generally indicates, as at 10 a portion of a forming section of a twin wire web forming machine embodying the instant invention and comprising from left to right, a first sequence S1, a second sequence S2 and a portion of a third sequence designated as S3. In each of such sequences, S1, S2 and S3, a new ply of web is formed and is merged with the moist web ply or plurality of plies already on a main bottom forming wire 11. Such pre-formed moist web ply or plies carried on the bottom main wire 11 is designated as P_0 coming into the first sequence S1; P_1 coming into the second sequence S2, and P_2 coming into the third sequence S3.

It will be seen that the main bottom wire 11, which is a conventional woven metal fabric wire (although it might be a plastic wire or other wire for special purposes) is guided, as by breast roll 11a so as to pass over an initial large roll 12 (having a large curved surface) so that the wire 11 wraps an substantially its upper downrunning quadrant Q12. In the first sequence S1, there is also a short looped upper auxiliary wire 13 having a plurality of guide and drive rolls 14, 15, 16 and 17 mounting the same and driving the looped auxiliary wire 13 at substantially the speed at which the bottom main wire 11 is traveling through the sequence S1. It will be seen that there is a reach 13a of the auxiliary wire 13 which extends from a first top guide roll 14 to a lower guide roll 15 (which may be considered a third guide in the sequence, since the large roll 12 guides the top wire reach 13a as well as the bottom wire 11). The rolls 14 and 15 maintain the top wire reach 13a under tension as it is wrapped into the configuration shown about the bottom wire 11 on the large roll 12. As is apparent, the deflected top wire reach 13a is free from restraining means in contact therewith opposite the bottom wire 11 throughout the quadrant Q12 of the large roll 12. Skimming deflector means, indicated at 13b and 11b at approximately the oncoming side of the guide roll 15 are shown only schematically, but such deflectors operate in close-running relation to the wires 11 and 13, and are actually closely spaced therefrom so as to skim water carried along the back side of such wires without exerting excessive pressure or bearing force on the traveling wires in the sense of a direction changing guiding type of contact (or pressure). These type of skimmers can also be positioned

devices (not shown) may be positioned beneath each such deflector and wipers 12a, 22a, etc. may be provided along the on-coming side of rolls 12, 22, etc.

The top guide roll 14 may thus be considered as a first guide in the succession of guides 14, 12, and 15 whereby the top wire 13 traveling over the first guide roll 14 and bottom wire 11 traveling over the second guide roll 12 at substantially the same speeds are brought into initially close spacing, as at J1 for receiving therebetween a jet-stream of web forming stock from a head box means, indicated essentially schematically at 18 and having a slice outlet at 18a. The slice outlet 18a feeds a stock jet stream into a spacing J1 between the wires 11 and 13. The wires 11 and 13 are brought through gradual convergence to a web forming zone (generally indicated by the dimension of F1) and into substantial parallelism with the thusly formed fibrous web ply being substantially merged with the original preformed web P_0 carried into the forming zone F1 on the bottom wire 11. It will be appreciated that the wires 11 and 13 are in such substantial parallelism, that the tension on the wires will cause a continued squeezing of moisture in the stock (or main web) therebetween. Additionally, the change of the direction of wire travel over the surface of roll 12 causes centrifugal force to be exerted on the moisture in the web and to be thrown through the wires and away from a forming zone. The wires also pass the skimming deflectors 13b and 11b and then turn comparatively abruptly about the third guide, i.e. the suction roll 15, so as to wrap the suction area 15a of such suction roll in order to effect yet further dewatering. In this instance, the dewatering is carried out in part by water drawn in and held in a suction area and also by water thrown through and from the main wire 11 as it turns about roll 15. The wires 13 and 11 then continue in such substantial parallelism with the newly formed moist web P_1 therebetween until they reach the guide roll 16 for separating the top auxiliary wire 13 from the web and a suction roll 19 having a suction area 19a engaging the underside of the main bottom wire 11 for maintaining the newly formed web P_1 thereon as a paven to the next sequence S2.

It will be appreciated that the elements shown in the second sequence S2 which correspond to those already described in connection with the first sequence S1 are designated by the same reference numerals in the twenty series. Thus, the initial three successive guides are shown as the top roll 24, the large roll 22 and the lower suction roll 25. A fresh dilute aqueous suspension of entangled co-moving web fibers will exit from the slice 28a as a high speed substantially unidirectional ribbon-like jet-stream into the spacing J2 that is effected initially by the guides 24 and 22 serving to bring the top wire 23 into initially close spacing with the bottom wire 11 at the large end J2 of the region of convergence which defines the forming zone F2 for the new ply that is being formed in sequence S2 and ultimately merged into the composite web product P_2 leaving the sequence S2.

As indicated in FIG. 1, the arrangement in each of the sequences S1, S2, S3, etc. are extremely simple and afford a considerable amount of versatility in operation. Also, such arrangements are found to give good wire life to the typical short wire loops 13, 23, etc. in that such short wire loops 13 are carried entirely by co-moving guide elements in the form of rolls 14, 16 and 17 and the suction roll 15, arranged to avoid excessive reverse bending. Likewise, the main bottom forming wire 11 is mounted only on co-moving elements which are indicated as the large rolls 12, 22, etc. and the smaller rolls 19, 29, etc. The bottom wire 11 will actually have a lower return run, and the view in FIG. 1 shows what constitutes the upper run of the wire 11, but it is functionally the bottom wire in the arrangement hereabove and is so designated for convenient reference.

In spite of the apparent simplicity of the overall ar-

significant operational advantages are afforded in this arrangement. It has been indicated that in all except an original web forming sequence in the overall system designated 10, there will be a pre-formed moist web ply traveling on the bottom wire 11. This being the case, the dewatering at the forming zone indicated in FIG. 1 at F1, F2, F3, etc. involved forming steps wherein dewatering will take place primarily through the top wire runs 13a, 23a, etc. although some dewatering will also take place through the lower main wire. This affords a substantial convenience in cost and maintenance by allowing the use of a plain large roll for the rolls 12, 22, 32, etc. Of course, perforated or imperforated (i.e. open) rolls (as more clearly described hereinafter) can also be used, especially where an initial web ply is first applied to the bottom wire 11, but this would not be absolutely necessary either and the very first sequence could operate substantially as has been described already in connection with the sequence S1, except there would be no initial ply P_0 carried on the bottom wire 11. The bottom wire 11, however, should wrap the roll 12 to obtain the desired centrifugal dewatering of the stock in the area of the forming zone F1.

Referring now to FIG. 2, certain of the more significant advantages of the individual sequences will be described; and the sequence in FIG. 2 will be designated for a convenient reference as S4 and all of the various elements of FIG. 2 which correspond to elements previously described will be designated by the same reference numeral in the 40 series. Thus, the inlet 48 shown only partially, has a slice from which a substantially unidirectional ribbon-thin jet-stream exit in a predetermined direction at a predetermined linear speed (signified merely by the arrows and dashed lines). Also, this sequence S4 is provided with spaced successive first 44, second 45 and third 45 guides (or guide rollers) and opposed top 43 and bottom 11 forming wires or belts traveling at substantially the jet stream speed over the first guide roll 44 and the second guide roll 45, respectively and through initially close spacing at J4 for receiving therebetween the jet-stream and substantially immediately thereafter through gradual convergence in a web forming zone F4 and into general parallelism with the fibrous forming web therebetween, in which parallelism the wire runs 11 and 43 travel downstream together over the third roll guide 45 in a manner already described in connection with the previously discussed sequences.

In the embodiment of FIG. 2, it will be seen that the skimming deflector 43b for the inside of the top wire 43 is shown in closely spaced close-running relation to the wire 43 and is also shown as part of a larger save-all assembly 43c. A skimming deflector 11b is likewise shown in a very closely spaced close-running relation to the wire 11 and is a part of a save-all assembly 42b, which includes a wiper 42a at the up-running side of the large roll 42.

There are several advantages which may be considered in connection with the specific form of the invention illustrated at FIG. 2. For example, although adjustability as to the extent of wrap by the top wire 43 and also as to the tension of the top wire reach 43a between the guide 44 and 45 may be adjusted by a number of different ways, such adjustability as indicated only schematically by the double-headed arrow designated 44a for the top roll 44 hereinshown. It has already been pointed out that a substantial amount of wrap of both wires on the upper down-running quadrant Q42 for the large roll 42 is important. In the light of the available control of tension on the wire reach 43a, it will be appreciated that, at any given operating speeds and conditions at the stock jet slice 48a, the tension of the reach 43a affords a self-adjusting and steady pressure forming zone wherein control of these essential conditions is readily achieved.

Under such conditions as the self-adjusting of the pressure within the forming zone F4 which is here afforded,

it may be appreciated that the overall length or peripheral dimension available for use as the forming zone may extend from approximately the location designated A near the top of the roll 42 to the location designated B near the end of the quadrant Q42 (at which location the wires 11, 43 are actually separated from the surface of the roll 42 by the guide roll 45, which can also be adjustably positioned so as to change to some extent the point of separation of the wires from the surface of the roll 42). The present arrangement, the roll 42 has a preferred diameter of four feet and the actual forming zone F4 has a peripheral dimension a, preferably equal to about 75°. As a practical matter, however, the peripheral dimension of the forming zone may range from about 10° to as much as about 180° (and preferably ranges from about 60° to about 90°). Dewatering of the jet-stream at the relatively large diameter arcuate surface A–B of the roll 42 is effected by the centrifugal force resulting from the arcuate travel of the wires carrying the newly forming web therebetween around the portion A–B of the roll 42 and by the pressure caused by the wire tensions acting against the web expressing water therefrom.

Still an additional feature of significance in connection with this arrangement resides in the fact that there will be a hydraulic head "h," substantially equal to the overall vertical dimension from A to B, which affords development of higher drainage pressures within the forming zone F4, without a sacrifice of velocity head of the stock between the wires. In this respect, the size in alignment of the forming zone F4 will reflect the development of pressure resulting from this hydraulic head h independently of the machine speed which affords a distinct advantage in additional control of the operation. In other words, the head h will be constant irrespective of the speed of the machine and the extent of the centrifugal force.

Another at least partially independent aspect of control of the drainage pressure is afforded via the alignment in speed of the jet-stream feeding into the initial close spacing J4 between the wires 11 and 43. It will be appreciated that the traveling speeds of the wires 11 and 43 are controlled so as to be substantially equal; and such speed is likewise substantially equal to that of the stock jet-stream, but not necessarily absolutely identical thereto. In other words, as shown by the slight apparent expansion of the stock jet as at SJ4 just beyond the top of roll 42, the stock jets may be adjusted so that at this specific region SJ4, a certain amount of the jet-stream speed is lost and converted to pressure normal to the wires 11 and 43, i.e., an initial drainage pressure. In this way, the inlet to the forming zone is adequately sealed (i.e. in the general region of J4) and effective drainage and incipient web formation is thus initiated rapidly.

Also, the general curvature of the wires 11 and 43, and primarily of the bottom drainage wire 11, is a curvature that is generally coincident with the trajectory of the jet, at least to the extent that by selective adjusting of the alignment of the jet (by an adjustable means, indicated schematically at 48A by the two-headed arrow) it is possible to co-relate the jet trajectory much more closely with the general curvature of the wire in this arrangement, and as so doing, effect the type of sealing of the jet at the nip region SJ4 in the manner indicated schematically herein, which essentially involves the continuous maintenance of a slight expansion of the stock stream to slightly greater thickness than the jet-stream itself at this closely spaced nip of the converging wires. It will be appreciated that the maintenance of the slight stock expansion at the region SJ4 is a condition that can be stabilized during operation and the expansion thus maintained continuously so as to afford a pressure within the stock body during the initial web formation. Impingement of the stock into the area SJ4 avoids any significant disturbance of the jet stream, such as may be caused by the partial pressure experienced on the off-running side

of solid surfaces is phenomenon commonly known as pumping.

As indicated previously, in the case of the formation of an initial ply, an open roll (perforated or imperforated) free from the wrap of the forming wires and facing down in the position 42 would have its advantages because of the convenience of gravity assisting dewatering of the roll into which water had been forced during the forming period; but in the case subsequent formation applies, the economic advantages of a solid roll are available and the problem of drainage control is quite simple and easily handled. There is no need for deflectors or other devices causing a pressing of the wires together, since the wires 11 and 43 are pressed together while co-moving and while engaging a co-moving guide in the form of roll 46. The skimmers 43b and 11b simply serve to avoid any tendency to over-load a connection with the drainage at the immediate location of the roll 46 which will, of course, press the wires together against the newly formed moist web sandwiched therebetween and effect additional dewatering thereof.

In the embodiment described in FIG. 2, it will be appreciated that the hydraulic head h is approximately one foot or slightly more in dimension, but advantage resulting from the use of such hydraulic head in dimensional ranges from one inch to perhaps six feet are effected (the preferred dimensional range for the hydraulic head ranges from about one half to two feet).

Additionally, it will be appreciated that the arrangement of FIG. 1 permits formation of an initial ply as a first sequence S1 (where P_0 would have no meaning or would indicate that no ply was already on the oncoming wire 11); and subsequent sequences could then apply successive plies as disclosed. In so forming the initial ply the forming zone is readily adjustable with regard to its peripheral dimension. Below the first quadrant Q12 (i.e. for as much as the next 90° of the right-hand lower down-running quadrant) the second wire 13 will be used to control stock flow while web formation is still in progress to the extent that there may be free stock on the surface of the web undergoing formation. The hydraulic head would, in the last mentioned situation, extend from the point of initial departure of the jet-stream J1 onto the roll 12 downwardly to substantially the lower end of the actual forming zone, so that the jet-stream may continue in this path without substantial velocity loss but with continuous internal pressure increase via the increase hydraulic head.

An important advantage of the invention resides in the use of a relatively large diameter roll 12 having a peripheral contour in the upper quadrant Q12 such that the configuration of the lower wire 11 supported thereby may closely approximate the natural configuration (i.e. trajectory) of the stock jet-stream J1 exiting from the inlet at the selected thickness and linear speed (and as it is effected by gravity, etc.). The more closely the traveling wire 11 may be co-related to the configuration (i.e. jet trajectory) and to the speed of the jet-stream, the less necessary the top wire 13 becomes (at least at the early stages of web formation); but conversely the advantages afforded by the top wire 13 varies from helping to contain the jet-stream, to affording still more fine and delicate control as to the jet-stream speed, as by excluding resistance of ambient atmosphere, and by the pressure which wire 13 can exert in complementing the hydraulic head effect. The optimum control under the foregoing conditions is obtained in the upper quadrant Q12, and by using this region as the main forming zone (so that its configuration as defined by both wires 11 and 13 most closely represent the jet trajectory), the additional advantage of separating both wires 11 and 13 from the periphery of the roll 12 at least substantially by the end of the upper quadrant Q12 permits gravity dewatering of the unwrapped roll 12 under the most favorable conditions. In conforming both wires to the

optimum size (i.e. diameter) and optimum position below the inlet 18a. The jet-stream velocity and thickness are likewise co-related to conform as closely as possible to those required for producing the trajectory best suited for the roll size and position, which will determine primarily the lower wire 11 configuration. The configuration of the upper wire 13 is determined by roll 12 and the wire 11 positions and configurations, plus the tension effect of rolls 14 and 15 on the wire 13 as urged against the jet-stream on the wire 11 which, of course, forces the wire 13 (deflecting it with the initial force of the stock stream).

Referring now to FIG. 3, certain of the most significant advantages of another embodiment of the individual sequences discussed in relation to FIG. 2 will be described; and the sequence in FIG. 3 will be designated for convenient reference as S5 and all of the various elements in FIG. 3 which correspond to elements previously described will be designated by the same reference numeral in the 50 series. Thus, the inlet 58, shown only partially, has a slice 58a from which exits a substantially unidirectional ribbon-like jet-stream in a given direction and at a predetermined linear speed. Also, this sequence S5 is provided with space successive first 54, second 71, and 52, and third 55 guide members and opposed top 53 and bottom 11 forming wires traveling at substantially the jet-stream speed over the first guide 54 and second guide 71 and 52 respectively and through initially close spacing at 15 for receiving therebetween the jet-stream and thereafter through gradual convergence in a web forming zone F5 and zone general parallelism with the fibrous forming web therebetween, in which parallelism the wire runs 11 and 53 travel downstream together over third guide 55 in the manner described in the previously discussed sequences. Of course, as will be appreciated, if desired, a single ply can be formed and removed from the sequence S5 by an appropriately positioned pick-up felt (not shown) downstream of the roll 55.

The sequence illustrated at FIG. 3 is especially useful where there is a tendency for the jet-stream of stock to be trapped between the converging wires 53 and 11 and be squeezed outwardly at the sides of the machine so as to "spew." To reduce this tendency, the arrangement illustrated in FIG. 3 is utilized to reduce the rate of convergence of the wires as gradually as possible. In other words, the effective diameter of the roll 52 is increased by the utilization of a stationary curved surface for plate 71 located between the roll 52 (at the oncoming side thereof) and the head box outlet 58a so as to extend into the nip or area of convergence formed between the wires 53 and 11 as they meet on the periphery of roll 52. The bottom wire 11 is trained over the arcuate stationary surface of the plate or shoe 71 as the jet-stream is deposited thereon from the head box nozzle 58a. In this manner, the rate of convergence between the two wires is more gradual and consequently dewatering pressure on the jet-stream is applied in a more uniformly increasing manner. It will thus be appreciated that the combination (or cooperation) of the plate or shoe 71 with a large diameter roll 52 provides a relatively large arcuate surface which more readily assumes the trajectory of the jet-stream and allows for a more uniform application of pressure to the jet-stream as it is deposited between the wires. Thus, in effect, the portions of the curved stationary surface 71 and the cylindrical roll 52 cooperate to provide a single wire guide having a relatively large diameter arcuate surface whereby the initial curvature of the nip between the converging wires is much less than would otherwise be available. Thus, the roll 52 is positioned immediately adjacent the off-running side of the shoe 71 and the actual spacing between elements 71 and 52 is not critical. Only the cooperation of these elements to define a gradually converging path of wire travel is essential so that other dewatering elements, not interfering with this cooperation, can be positioned therebetween. The curved plate 71 effectively increases

the diameter of the forming rolls in a relatively simple manner and, since the rate of curvature of this plate is relatively small, very little, if any, normal (i.e. perpendicular) loading of the wires occurs at such plate. The curvature is such that as the wires are nipped together, they experience every increasing curvature up to that of the roll and thereafter experience a relatively constant curvature substantially as shown to produce centrifugal forces on the newly deposited web between such wires for dewatering thereof. The curved plate 71 is machined or manufactured for having a desired radius of curvature, which may be constant (as shown at FIG. 4 at plate 171) or have a decreasing radius of curvature in the direction of wire travel (as shown at plate 71). Additionally, the surface of plate 71 may be perforated or imperforated.

The wires 11 and 53 gradually converge until they actually attain general parallelism, as by contacting the rotating peripheral surface of roll 52. The term general parallelism or substantial parallelism as utilized herein is defined for the purposes of the instant discussion as describing a dynamic concept of two wires spaced apart by a moist web continuously moving closer to each other as water is removed from such a web. The wires continue traveling in such substantial parallelism through the forming zone FS and down to third guide 55. Guide 55 is here shown as a suction roll having a suction gland 55a, and in one embodiment, an adjustment means 55b is mounted thereon to allow adjustment of the amount of wire wrap on the roll 52. A similar adjustment means 54a is also provided on roll 54 to likewise control the amount of wrap of the wires over the guide surfaces. As the wires diverge from the surface of roll 52 they contact skimming devices 53b and 11b along the respective inner surfaces to remove water therefrom. These skimming devices 53b and 11b may be incorporated with conventional save-all devices 53c and 52b to prevent the removed water from re-contacting the forming web. Save-all device 52b may also be provided with a wiping device 43a for removing adherent water droplets and the like from the peripheral on-coming surface of roll 52 prior to its contact with the main forming wire 11.

FIG. 4 indicates generally, at 100, a portion of a forming system of a twin-wire web forming machine embodying the instant invention the sequence described in FIG. 3. It will be noted that generally the various elements are quite similar to that illustrated in FIG. 1, except that various elements are designated in the 100 series and that only successive sequences are shown. From left to right a first sequence S11, a second sequence S12 (only a portion of which is shown) are designated and it will be understood that additional sequences may be utilized as desired, and that these sequential sequences cooperate to produce a multi-ply web of a desired thickness. In each such sequence S11, S12, etc. a new ply of web is formed and merged with a moist web ply or a plurality of plies already on the main bottom wire 111. A pre-formed moist web ply or plies carried on the bottom main wire 111 designated P_0 coming into the first sequence S11; P_{11} coming into the second sequence S12, etc. It will be seen that the main bottom wire 111 passes over a stationary curve (water-impermeable) shoe or plate 171 having a relatively constant radius of curvature and immediately thereafter over a relatively large diameter rotating roll 112, to wrap roll 112 on substantially its upper down-running quadrant Q112. In the first sequence S11, there is a short loop upper or auxiliary wire 113 having a plurality of guide and drive rolls 114, 115, 116 and 117 mounting the same and driving the looped wire 113 at substantially the speed at which the bottom wire 111 is traveling through the sequence S11. The reach 113a of the top wire 113 extends from the first upper guide roll 114 to a lower guide roll 115. The guide rolls 114 and 115 maintain the top wire reach 113a yieldably under tension as it is wrapped in the configuration shown about the bottom wire 111 on the large roll 112. Also the deflected top wire reach 113a is free from restraining means opposing the bottom wire 11 throughout its travel of the quadrant Q12 of the large roll 112. However, it will be appreciated that dewatering elements, such as skimming deflectors and the like, could be positioned in close running contact with the wire 113 throughout its travel of the quadrant Q12 for removal of any expressed water. Various skimming devices and foil means, as indicated at 113b and 111b are positioned in close-running relation with opposed surfaces of the wires to skim water therefrom without exerting excessive pressure on such wires and may be integrally connected with conventional save-all devices 152b. Of course, wiping means, such as schematically indicated at 112a, can be connected with the various rolls for cleaning the on-coming surfaces of such rolls.

The gradual convergence of the bottom wire 111 with the upper wire 113 over the relatively large radius guide surface defined by the stationary shoe 171 and the roll 112 prevents spewing of the jet-stream from between the wires and serves to define a continuous bi-radii path of travel having a first radius of curvature substantially larger than the second radius of curvature. Apparently, spewing of stock from between the wires is limited or at least dependent upon the rate of pressure increase in the nip. Thus, when the pressure between the wires increases to a sufficiently high value, which may be only a few inches of water, the stock between the wires becomes thickened through drainage and such stock will be forced out between the wires in a spewing manner. Decreasing of the initial curvature of the nip between such wires allows the jet stream of stock to be subjected to generally uniformly increasing gradual pressure, materially aiding in the dewatering thereof and preventing spewing. The stationary arcuate plate or shoe, designated 171 in the sequence S11 and 171a in the sequence S12, increases the effective diameter of the roll 112 and 122 respectively and thereby allows a more gradual consolidation of the jet-stream between the two wires as they approach each other and the roll surface.

A method embodiment of the invention based on the foregoing system comprises introducing a stream of web stock between on-moving and converging opposed wires, guiding the superimposed wires with the stock sandwiched therebetween around a portion of a periphery of a wire guide having a large curved surface whereby the stock is dewatered through one or both wires as the combined action of centrifugal force and consolidation of the stock by the wire tension acts to dewater the stock. The newly forming web is carried onwardly for further dewatering over additional guides before the wires are separated to expose a web. The curved wire guide may comprise a large diameter roll or a combination of a stationary arcuate plate positioned on the on-coming side (preferably without the intervention of any elements which cause any meaningful change in the direction of wire travel) of a large diameter perforated or imperforated roll whereby the effected diameter of such a roll is materially increased.

The apparatus embodiment based on the systems of the invention described comprises first and second continuous forming wires, which are preferably foraminous, arranged to converge and provide an entrance nip for the reception of stock, a curved guiding element adjacent the entrance nip, means for supporting the wires within their respective loops and moving them into said entrance nip, with the wires being arranged to travel over the guide elements downstream of the entrance nip while having stock therebetween around a part of the periphery of the guide elements so as to centrifugally dewater the stock between such wires. In one specific form, the guide element comprises a portion of the surface of a large diameter perforated or imperforated roll and in another specific form the guide element comprises such a roll preceded by a curved stationary perforated or imperforated surface positioned to define a continuous bi-radii path of travel with the roll.

The remainder of the discussion will now be devoted to the embodiments of the invention forming a single web ply, however, it will be understood that this is not a limitation but merely further exemplary embodiments of the invention.

FIG. 5 illustrates a forming section 210 of a web forming system. The head box means 211 is connected to a slice chamber 211a, having a plurality of simultaneously converging sidewalls 211b, 211b' and a slice outlet 211c. The head box provides a supply of web stock to the slice chamber 211a. The slice outlet 211c is positioned at the upstream end of the system 210 so as to provide a jet-stream of stock in a given direction. Upper sidewall 211b' is provided with an adjustable lip 211c for selectively adjusting the size of the slice opening 211c. A power adjustment means PA is positioned above movable lip 211c for selective adjustment as indicated. A plurality of flexible trailing elements 212 are suitably mounted within a slice chamber 211a. It will be noted that the trailing members 212 are arranged to define plurality of converging channels 213 therebetween directing the passage of web stock therethrough toward the opening 211c. Thus, an essentially symmetrical slice chamber 211a is attained. The slice chamber 211a is exceptionally well suited for producing a dilute aqueous suspension of entangled cumoving fibers having a relatively low degree of turbulence and a relatively high degree of dispersion exiting downstream-wise from the slice opening 211c as a high-speed substantially unidirectional ribbon-thin jet-stream. Additional details of such a preferred slice chamber are disclosed and claimed in copending Hill et al. application, U.S. Ser. No. 698,633, now Pat. No. 3,607,625, which disclosure is incorporated herein by reference. It will be appreciated that other slice chambers producing in the desired characteristics within the jet-stream may also be utilized.

A pair of breast rolls 215 and 216 (open or solid) are mounted along a common plane in working relation with the slice chamber 211a. The breast rolls 215 and 216 are spaced apart a distance somewhat greater than the transverse or ribbon-thinness dimension of the jet-stream so as to define a nip or gap G therebetween. In this regard, it will be appreciated that rolls 215 and 216 need not have their axes exactly aligned along either a horizontal or vertical plane and that one or the other of such rolls may be aligned so as to have its axes along the generally parallel but different vertical or horizontal planes. The spacing between the surfaces of such rolls actually defines the gap G and not the roll axial alignment. The jet-stream exits from the opening 211c of the slice chamber 211a into the gap G in a pressure-creating relationship. The relationship is such that substantially no flooding occurs at the gap G and the speed of the jet-stream is substantially converted into pressure. It will be noted that in the arrangement shown, the jet-stream is orientated upwardly. A first forming wire F_1 wraps the first breast roll 215 and travels therewith through the gap G, while the second forming wire F_2 wraps the second breast roll 216 and likewise travels through the gap G. The forming wires are respectively trained over a plurality of wire guides 218, 219, 221 and then respectively over guides 223, 218a, 224 and 216a to define a first and second wire run. For sake of convenience, the first wire and first wire run will be referred to by reference designation F_1, while the second wire and second wire run will be referred to by the reference designation F_2. These forming wires may be comprised of bronze, steel, copper, plastic or even fabric strands woven in an open mesh to define endless loops. The forming wires may also be formed of a plurality of different materials combined to yield certain specific characteristics, i.e. wear, stretch, weight, strength, dewatering characteristics, etc.

While it is previously indicated that the jet-stream of stock impinges into the gap G between the rolls 215 and [illegible] that the jet stream impinges

on the surfaces of the forming wires F_1 and F_2 as they travel over the rolls 215 and 216 and that the stream contacts one of the wires, i.e. F_1 before the other. Dewatering occurs at the off-running side of the roll 215 and 216 by essentially a drainage phenomena without any "pumping" by the rolls. Pumping is generally defined as the action of a diverging solid surface acting on a moving stream (of stock or newly forming web) by creation of at least partial vacuum at the off-running side of such surface which tends to pump or pull water from the stream and thereby disrupt it. During early stages of web formation, pumping is detrimental to proper distribution and thus is to be avoided. At this early stage of the forming section, substantially little, if any mechanical pressure is exerted on the stock. This "easy" pressure allows a substantial portion of the water to be drained from the forming zone without the application of disruptive pressures, which may cause shearing or like effect disturbing the proper formation of a web. The dewatering, as indicated at a first area A_1 and at a second area A_2 is in substantially opposing directions so that simultaneous drainage, without pumping, takes place along both surfaces of the newly forming web allowing proper distribution of the fibers within the web. The forming wires F_1 and F_2 continue to travel convergingly together into general parallelism over dewatering guides positioned downstream of the gap G.

The term "general parallelism" as used herein is to be understood to include the dynamic or changing relation of the wires toward one another as caused by the slight spacing or separation of such wires by the sandwiched web or web stock therebetween and allow the slight movement of the respective wires toward one another as water is removed from such sandwiched web. As will be appreciated, as the stock (sometimes referred to as the jet-stream) is dewatered, the wire tension urges the wires closer toward one another due the smaller quantity of matter between such wires. Thus, the convergence of the respective wire runs essentially aids in properly dewatering the forming web.

The first curved guide surface encountered by the converging wires is wire guide 218 which comprises an essentially elongated, smooth, stationary generally convexly curved surface urging the wire F_2 into general parallelism with wire F_1. It is to be noted that wire F_1 is free from restraining means throughout its travel through the forming zones, i.e. it is not associated with any elements which would prevent water from being expressed through its inner surface. In the embodiment here illustrated, wire guide 218 is shown as being water-impermeable, however, as will be discussed in relation to FIG. 7, it may also be water-permeable. The generally elongated curvature of the wire guide 218 allows the application of "easy" pressure (a gradual build up of pressure between the forming wires) and avoids spreading or spewing large volumes of water from between the wires causing flow disturbances due to relatively abrupt and/or intensified pressure changes between such wires. In addition, the general curvature of the wire guide 218 causes little if any normal loading of the traveling wires against the wire guide 218. The greatest loading actually occurs at the off-running side of the wire guide 218. Substantially little, if any wear takes place along the surface of the wire guide 218 since a minimal amount of frictional contact between the moving wires and the stationary surface takes place. It will be noted that the forming wires F_1 and F_2 do not come into actual parallelism with one another until some point 218a well beyond the lead edge of wire guide 218. During the gradual convergence of the wires into general parallelism additional pressure is exerted upon the newly forming web to express additional water therefrom. The water is thrown through and away from the exposed side of the forming wire F_1 which is, of course, free from contact with any restraining means as defined herein before. The expressed water is collected in a [illegible]

ated. The drive means may drive the respective wire runs at speeds substantially equal to the jet-stream speeds, however, they may be regulated to drive the wire at other speeds for certain special effects.

Referring now to FIG. 6 wherein a further modification of the embodiment of the invention is illustrated. A forming system or section 320 is comprised of a head box means 311 having a slice chamber 311a orientated to have its outlet 311c directed in an upward direction. The slice chamber 311a is likewise provided with a plurality of flexible trailing members 311b arranged to define a plurality of converging channels 313 extending from the head box toward the outlet opening 311c. The converging trailing members 311b have a degree of flexibility allowing them to assume hydrodynamic stability within the stock flow. By positioning the entire head box means 311 upwardly, the bottom apron member 311a of the head box means need not be curved and the opening 311c can be positioned much closer to the forming gap G.

The arrangement of the various elements in the forming section 320 is quite similar to that described in conjunction with FIG. 6 and they are designated by the same reference numeral in the 300 series. Thus, a pair of breast rolls 315 and 316 are mounted for rotation along a generally common plane spaced apart a distance to define a somewhat vertically-extending gap G therebetween. The gap G is in close working relation with the slice opening 311c to receive the jet-stream of web stock therefrom. The rolls 315 and 216 are wrapped by forming wires F_1 and F_2 respectively and guide such forming wires through an initially close spacing at the gap G. The forming wire F_1 is a substantially continuous looped traveling wire having a path of travel defined by a plurality of wire guides 315, 318, 319, 321, 323 and finally 315a so as to constitute a first wire run; for convenience also designated F_1. The second forming wire F_2 is similarly a looped traveling forming wire having a path of travel defined by a plurality of wire guides 316, 318, 319, 321, 324 and 316a so as to constitute a second wire run, for convenience designated F_2. Wire guides 315a and 316a are provided with tensioning means T_1 and T_2 for maintaining a desired degree of tension within their respective wire runs. The paper stock discharges as a low-turbulence, high-dispersion and jet-stream toward the forming gap G so as to come into contact with the porous surfaces of the forming wire F_1 and F_2.

In a preferred embodiment, the jet-stream does not contact the wires until the wires are well beyond the area of pumping influence rolls 315 and 316. Of course, in arrangements where rolls 315 and 316 are open rolls pumping is avoided without use of such expedients. In general, the speed of the jet-stream is sufficient to cause the water to be driven through the exposed surfaces of the forming wires at the off-running side of the breast rolls 315 and 316 by a drainage phenomenon, without disruptive pumping taking place. In this manner, a first dewatering area A_1 occurs through forming wire F_1 and a second dewatering area A_2 occurs through the forming wire F_2 so that substantially equal drainage takes place along opposed sides of the newly forming web. The traveling wires continue to converge together into general parallelism as they travel toward wire guide 318 and wrap a portion of its surface. The wires actually tend to assume general parallelism at a point 318a along the surface of guide element 318 so that a gradual build-up of pressure occurs throughout the area of convergence. As the wires continue converging together, the exposed side of forming wire F_1 is free from contact with any detrimental restraining means, thereby defining a third dewatering area A_3 wherein water is driven through and away from the exposed side of the forming wire F_1. Skimming means and the like can be positioned along this portion of the forming wire run F_1 (along with appropriate save-all devices) to insure that overloading of this

The wire guide element 318 is substantially a stationary, smooth, generally convexly curved surface having a relatively large radius of curvature. The large radius of curvature prevents any substantially loading of the wires against the surface of guide element 318 so that relatively little frictional engagement takes place between the stationary surface and the traveling wire runs. A large diameter dewatering roll 319 is positioned in close-running relationship with the off-running side of the guide element 318 so as to provide an essentially continuous path of travel for the sandwich arrangement of the traveling wires and the newly forming web. The dewatering roll 319 is here shown as having an open or foraminous structure 319a, wherein the inner peripheral surface of roll 319 is provided with a plurality of pins or support structures carrying an outer water-permeable wire mesh or the like of conventional construction. Of course other dewatering rolls, such as suction rolls, grooved rolls, drilled rolls, etc. can also be utilized. The rotating surface of roll 319 offers essentially no frictional drag on the traveling wires and directs the sandwich arrangement through a rather abrupt curve in relation to the jet-stream direction at the forming gap G. The abrupt change of direction causes additional water to be removed from the sandwich arrangement at a further dewatering area A_4. Of course, water is also driven in an opposing direction into openings 319a of roll 319. A save-all device 317 is positioned in the vicinity of the various dewatering areas to receive the express water for collecting the same and delivering it via a conduit C back to the head box for dilution of stock or to another location as desired. A laterally continuous dewatering means 319b and a doctor means 316b are operatively associated with save-all device 317 for directing any matter coming in contact therewith into such save-all device. The dewatering means 319b may be of any structure desired, however, preferably it is an air foil means such as shown and claimed in U.S. Pat. No. 3,377,236 generally comprising a stationary dewatering element having a rounded lead edge which engages water carried along the exposed surface of the forming wire F_1 without causing any wire-directional-changing engagement with the traveling wires. The sandwich arrangement continues traveling in a downward direction past a stationary dewatering guide 321, 321a substantially as earlier described. The wires F_1 and F_2 then diverge from one another with the newly formed web W adhering to the wire F_1 for travel therewith around a couch roll 323 having suction gland 323a. Wire F_2 travels around turning roll 324 and back to the forming gap G. The forming wire F_1 and the newly formed web W travel away from the forming section 320 and toward a pick-up station or the like substantially as explained in conjunction with FIG. 1. In certain embodiments of the invention, it may be preferable to position the turning roll 324 substantially below and to the right of couch roll 323 so that both wires wrap the couch roll during this area of direction change to insure that the newly formed web does not disintegrate or otherwise become disrupted as it is being guided away from the forming section. This type of couch-turning roll arrangement is further illustrated in FIG. 8.

Referring now to FIG. 7 wherein a somewhat modified web forming section 430 is partially illustrated. Various elements shown in forming section 430 corresponding to elements discussed in conjunction with FIGS. 5 and/or 6 carry the same reference numeral in the 400 series. Thus, a head box means 411 is positioned in working relation to a forming gap G. A pair of breast rolls 414 and 416 are mounted to rotation in a substantially vertical plane, each within the loop of one of the forming wires F_1 and F_2 substantially as set forth. It will be noted that the head box means outlet 411c is orientated generally upwardly to feed the jet-stream of co-moving fibers into contact first with the upper wire, i.e. F_1 and then with the other wire. This orientation allows sub-

stantial amounts of water to be driven through such upper wires. After the dewatering areas A_1, A_2 the wires continue traveling convergingly together into general parallelism over a curved-face guide 428 to attain such parallelism (which has heretofore been defined as a dynamic relation undergoing slight geometric changes as water is removed from the newly forming web) at a point 428a along the surface of the guide element 428. Respective forming wires F_1 and F_2 are trained over a plurality of wire guides as indicated heretofore to define first and second wire runs which are driven by substantially jet-stream speeds and maintained under tension as desired. As the wires converge together with the stock therebetween, a first dewatering area A_1 occurs at the off-running side of breast roll 415 and a second dewatering area A_2 occurs at the off-running side of the breast roll 416. As the wires travel in general parallelism substantially greater pressure is gradually applied on the jet-stream and additional dewatering takes place along a third dewatering area A_3 through the exposed side of the forming wire F_1 which is free from contact with any detrimental restraining means. The initial dewatering areas A_1 and A_2 apply easy pressure on the stock between the wires which is defined for purposes of the invention as a compromise between abrupt pressure necessary to expel water from a web and slowly increasing or intensified pressure that avoids spreading or spewing of the paper stock beyond the wires.

The guide element 428 presents a substantially water-permeable surface to the second wire run F_2 and is defined by a plurality of longitudinally spaced generally transverse wire-contacting relatively thin edges 428b. The longitudinal contour of the wire-contacting edges 428b define the elongated convex curve of the wire guide 428. The relatively large radius of curvature of the guiding surface of guide element 428 prevents substantial normal or perpendicular pressure loading of the wires against the edges 428b thereby preventing undue frictional engagement between the traveling wires and the guide surface of the element 428. In certain embodiments, the guide element 428 includes a housing 428c along with an associated pump means 428d operationally connected therewith for maintaining of subatmospheric pressure at the water-permeable surface so as to aid water removal through the longitudinal spacing between the wire-contacting edges 428b. The conduit C is provided within the housing 428c for directing collected water away to another location. Thus, the water-permeable surface of element 428 defines a fifth dewatering area A_5 substantially opposed to the third dewatering area A_3. While guide element 428 preferably has a convexly curved surface, it will nevertheless be appreciated that an essentially flat surface (having an essentially infinite radius) may also be utilized. The arrangement shown at FIG. 7 is especially useful for continuously dewatering a newly forming web along substantially opposed sides thereof thereby providing proper distribution of fibers within the web.

The sandwich arrangement continues traveling in the jet-stream direction so as to contact the portion of the surface of a relatively large diameter foraminous roll 419. Roll 419 is here shown as having an open surface 419a, however, other dewatering surfaces are also useful. The roll 419 presents a rotating surface to the traveling sandwich arrangement guiding the same through a substantial curve away from the jet-stream direction at a rate of turn sufficient to centrifugally dewater the sandwiched web and define a fourth dewatering area A_4 driving water through and away from the exposed side of the first forming wire F_1. Of course, some water is also dewatered by the surface 419a of the roll 419. The roll 419 and guide element 428 cooperate to guide the wires through a continuous bi-radii path of travel substantially as described earlier. The forming wires then continue traveling to an appropriate pick-up station, for example as discussed in conjunction with FIG. 6.

Referring now to FIG. 8, a forming section 510 is generally illustrated showing an arrangement somewhat similar to that discussed at FIG. 3 and including additional modifications, such as discussed at FIG. 6. A preferred head box means 511 is provided with an essentially symmetrical slice chamber 511a which includes trailing flexible members 512 defining a plurality of converging channels 513 therebetween allowing passage of stock toward an outlet 511c. A power adjustment means HP is operatively connected with the head box means 511 for orienting the slice chamber and outlet as desired. Continuously looped forming wires F_1 and F_2 are arranged to converge with one another at a gap G. Breast rolls 515 and 516 are each mounted within the loop of one of the wires in the manner described. The rolls 515 and 516 are provided with plural direction adjustment means Ra, as schematically indicated by the four-headed arrows, allowing selective adjustment of the gap dimension as desired. In the arrangement shown, roll 515 is shown as being an open breast roll, while roll 516 is shown as being a solid breast roll, however, both rolls could be solid or open as desired. The upward orientation of the slice outlet 511c and the gap G provides a more compact forming system wherein gravity assists in forming desired webs. Further, any excess stock or the like will fall down and away from the forming section and not interfere with the proper web formation. The wires are respectively trained over a plurality of guide elements 517 and 519 and then respectively over guides 515a and 516a so as to define first and second wire runs similar to those described earlier. The stock is impinged onto the surface of the forming wires F_1 and F_2 so that water is removed therefrom by an essentially drainage phenomena without any pumping or the like by the rolls that may cause streaking of the newly forming web. The dewatering, as indicated at a first area A_1 and a second area A_2, is in substantially opposing direction so that simultaneous drainage, without pumping takes place along both surfaces of the newly web for proper fiber distribution within the web, yielding optimum strength, printing and the like characteristics. The forming wires continue to travel together convergingly into general parallelism over the guide element 517. The guide element 517 is essentially an elongated smooth stationary generally convexly curved surface urging wire F_2 into general parallelism with wire F_1 while having stock sandwiched therebetween. The guide element 517 is here shown as being essentially water-impermable, however, it will be appreciated that some slight amount of water as a film, will form on its working surface to act as a lubricant for the traveling wire run. Further, as discussed in conjunction with FIG. 7, a water permeable surface can also be utilized. The generally elongated curvature of the guide element 517 is beneficial in allowing a gradual build-up of pressure between the forming wires and avoids spewing of large volumes of water from between the wires causing flow disturbances due to relatively abrupt and or intensified changes between such wires. As already discussed, the curvature of guide element 517 avoids wear of the wire or of the guide element and is less expensive than providing a rotating surface having a similar radius of curvature.

The wires F_1 and F_2 do not come into actual parallelism with one another until a point 517a well beyond the lead edge of the guide element 517. The point of convergence 517a is actually adjustable by selective positioning of the breast rolls 515 and 516 via their respective adjustment means Ra as explained hereinbefore. This adjustment is necessary to allow the formation of various grades of webs, i.e. when tissue paper webs are being produced, the point of convergence will be substantially closer to the lead edge of the guide element 517 than when, for example, newspaper grade paper webs are being produced. During this area of gradual convergence of the wires into ge-

eral parallelism with one another, additional pressure is gradually applied upon the newly forming web so that water is thrown through and away from the exposed side of the forming wire F_1 in the manner shown, to define a third dewatering area A_c. The expressed water (such as at areas A_b, A_c, etc.) is collected in an appropriate save-all device Sa, having a conduit C directing the expressed water back to a desired location. Similar devices are provided beneath the various areas where water is removed from the sandwiched forming web.

The utilization of an open breast roll and a stationary curved guide element in the initial stage of the forming zone provides a positive means of water movement control in this critical area of web formation and additionally provides increased drainage capacity with attending low drainage pressure which are very important for proper web formation. A flexible control is provided by the ability to adjust the clearance between the two traveling wire runs at the open roll location (i.e. at the forming gap G), control of the drainage capacities is presented by virtue of the increased length over which the traveling wires converge into general parallelism, while the low drainage pressure is primarily controlled via the relatively large radius of curvature of the guide element S17.

The large diameter suction roll S19 is positioned downstream of the guide element S17, preferably in close running relationship so as to define a continuous bi-radii path of travel having a first radius of curvature substantially larger than the second radius of curvature. As will be appreciated, the guide element S17 defines such first radius of curvature while the guide element S19 defines such second radius of curvature. The suction roll S19 is shown as a large diameter suction roll having a plurality of vacuum or subatmospheric chambers S19a, S19b and S19c, each operatively associated with a means S19z, such as pump means P schematically illustrated, for providing a select amount of subatmospheric pressure to each of the chambers. The vacuum pressure in each of the chambers S19a, S19b and S19c are of varying strength and are preferably progressively of greater strength, i.e. of increased vacuum, than the preceding chamber in the direction of wire travel. Thus, for example, chamber S19a is weaker than chamber S19b which in turn is weaker than S19c. As shown, the suction roll S19 receives the traveling sandwich arrangement of wire-web-wire and directs it through a curve away from the direction of the jet-stream at the slice opening S11e. Since the surface of roll S19 is rotating, substantially little frictional force is developed between the surface of the roll and the traveling wires so that no detrimental effects are encountered by virtue of the increased loading on the wires. The rate of turn through which the traveling wires are forced by surface of the roll S19 is sufficient to ensure dewatering to occur by centrifugal forces driving water through and away from the exposed side of the forming wire F_1. Of course, water is also driven and retained within the individual chambers of the suction roll S19 so as to define additional dewatering areas A_b, A_c and A_d.

The roll S19 is driven (as by drive means M_2) at substantially the jet-stream speed of the stock and of the traveling wires so that there is little relative movement between the traveling wire runs and the supporting surface of the roll S19. At the initial wrap of the traveling wires over roll S19, the chamber S19a provides a controlled amount of vacuum against the inner peripheral surface of forming wire F_2 drawing substantial amounts of water into the dewatering area A_b. This area is of relative small size, i.e., having an arc length of about 20°, since in this initial area of wrap the traveling wires are first guided away from the jet-stream direction and a substantial amount of centrifugal force will be produced on the traveling sandwich arrangement so that substantial amounts of water will be thrown away from this traveling structure and excessive vacuum at this area could be detrimental. The next subatmospheric compartments S19b is substantially larger in size and has a higher degree of vacuum thereby drawing additional amounts of water into the dewatering area A_c as shown. The arc length of compartment S19b may be about 60°, which corresponds to a length of about 61 inches and would be comparable to about five or so suction boxes having a 12 inch length (conventional suction boxes). During this portion of the forming zone dewatering continues to take place upwardly through the forming wire F_1 with the aid of centrifugal forces and wire tension and downwardly by virtue of gravity and subatmospheric pressure. The final compartment S19c generally compares to the vacuum length and drainage capacity available over a conventional suction couch roll and draws additional amounts of water into the dewatering area A_c as indicated.

As will be appreciated, greater amounts of vacuum can be applied in suction rolls than in conventional vacuum flat boxes due to less wire wear, less chance of seizure, etc. Thus, it will be noted that the instant forming arrangement completely does away with the necessity of utilizing stationary suction boxes, such as shown in the arrangements of FIGS. 5–7 and thereby decreases the dimension of the forming section while substantially increasing the water handling capacity thereof. Additionally, it will be appreciated that the area of wire wrap around section S19 may be adjusted so as to obtain more wire wrap thereby obtaining additional dewatering as desired. Of course, less wrap may also be utilized for forming light weight webs.

The further advantage of this arrangement is that roll S19 here functions as a couch roll so that the newly formed web W adheres to the lower wire F_2 and departs from the upper wire F_1. The upper wire F_1 is guided by a turning roll S15e and directed back towards a forming gap G while the forming wire F_2 continues to travel along an essentially straight line to a pick-up station generally indicated at PN having elements substantially similar to those previously described. Laterally continuous dewatering means S20 and S20a are each respectively trained on the exposed inner peripheral surface of the forming wires F_1 and F_2 so as to shear off any water that may be adherent to the backside of the forming wire runs. The dewatering means engage and remove the water on the backside of the wire runs without causing any wire-direction change and there is little, if any, frictional engagement between the traveling wires and the dewatering means S20 and S20a.

The forming system S10 allows the combination of centrifugal forces, gravity and vacuum to effect substantial amounts of dewatering in a relatively short space so that a very compact forming section is provided. As indicated hereinbefore, the roll S19 is driven by a suitable drive means M_2 and thereby reducing the load or tension on the forming wire F_2 and insure a longer useful life for the wire and less disturbances on the sandwich web. The drive requirements of the other forming wire, F_1 are also very low since there is no surface causing a heavy drag on this wire. Of course, wire F_1 is shown as being driven by second suitable drive means M_1, which is synchronized with drive means M_2 so that both wires travel at substantially the jet-stream speed over the various guides and there is little relative movement between the two wires thereby avoiding scuffing or the like of the web that is sandwiched between such wires.

It will be noted that suction roll S19 functions as a couch roll in that it positions the newly formed web W for removal from the forming section S10. As the traveling wires F_1 and F_2 pass over the last subatmospheric compartments S19c of the roll S19, they quickly diverge from one another and the newly formed web W adheres to the wire in contact with the couch roll, i.e. F_2. In forming arrangements where a change of travel direction occurs at a couch roll, it is important to insure that the newly formed web does not depart from the couch roll but remains in contact with the wire contacting said couch roll for guidance to a pick-up station. In the arrangement shown, both wires wrap the couch roll S19 for a substantial portion of its peripheral surface thereby preventing the

newly formed web from deviating from the desired path of travel. Wire turning roll 518a controls the amount of wire wrap by wire F_2 about the couch roll 519. In certain arrangements, wire turning roll 518a is provided with a plural direction adjustment means, schematically indicated at Ra, allowing selective positioning of the roll 518a in respect to roll 519. It is important to position the roll 518a at a location insuring that the upper wire F_1 at least wraps that portion of the couch roll 519 wherein the greatest amount of direction change occurs.

An additional advantage of the arrangement shown is that if the web W should, for some reason break after passing beyond the protective sandwich arrangement, it will naturally fall downwardly into a broke-pit or the like and not otherwise interfere with the remaining web being produced.

The forming wire F_2 carries the newly formed web W along its outer surface along an essentially straight line of travel to a pick-up station PN. An exemplary pick-up means is here illustrated as comprised of a pick-up felt PF which is trained over a plurality of rolls, of which only roll 522a is shown, to define a conventional endless loop. A web transfer roll 522 is positioned within the loop of the pick-up felt PF and in close running contact with the wire F_2 so as to contact the web W carried by the wire F_2. The transfer roll 522 is provided with a suction gland 522b, which is maintained under subatmospheric pressure in a conventional manner and functions as an aid in transferring the newly formed web W from the forming wire to the pick-up felt. The pick-up felt carries a newly formed web for further processing as desired, i.e. to a first press section or the like.

As described earlier, the wire guide rolls 518a and 516a are positioned within the respective loops of the wires of F_1 and F_2 to guide the same in the continuous loop throughout the forming section 510. These wire guide rolls can be provided with conventional doctor means 518A and 516A respectively as well as tension means T_1 and T_2 as desired. Suitable drive means M_1 and M_2 are connected to certain of the rolls within the wire runs F_1 and F_2 to maintain the speed of the traveling wire runs at a selected speed, preferably at substantially the jet-stream speed. In the embodiment here shown, one of the rolls within the loop of wire F_1, i.e. roll 518A and two of the rolls within the loop of wire F_2, i.e. suction roll 519 and guide roll 516a are the driven rolls, however, other arrangements also provide satisfactory operation.

Accordingly, the instant forming arrangement provides a path of travel for a pair of opposed forming wires over a plurality of curved guide surfaces defining a bi-radii path of travel that substantially corresponds to the jet-stream trajectory at a slice chamber opening so that substantial amounts of natural drainage are allowed to take place, augmented by various other forces, i.e. centrifugal forces, gravity, vacuum, etc. to obtain efficient and fast dewatering of a forming web and that there is no second and/or reverse wrap in the path of travel of the wires carrying the web therebetween thereby avoiding detrimental wear of the wires or any possibility of web scuffing or the like. The forming system of the invention and particularly of the arrangement here shown, is capable of operations well above 3000 feet per minute for a variety of paper grades and it is extremely compact and easy to maintain, affording numerous advantages.

In summation, the invention provides a web forming system (preferably for use in paper formation) generally comprising a head box means for supplying a stream of web stock in a given direction, a pair of looped forming wires arranged to converge and provide an entrance nip for the reception of stock, means for supporting the wires within the respective loops and moving them into the entrance nip, curved guide elements positioned downstream and adjacent the entrance nip, within the loop of one of the wires so that the wires travel over a portion of the surfaces of the guide elements while having stock therebetween at a speed so that the stock is dewatered at least in part by centrifugal forces through one of the wires.

A specific preferred form of head box means comprises a stock supply means and a slice chamber means positioned in working relation with the supply means and with respect to the entrance nip of the forming wires. The slice chamber means has an outlet opening, first and second walls converging toward the outlet opening and a plurality of flexible trailing elements within the slice chamber arranged to define therebetween converging channels extending toward the outlet opening for feeding a dilute aqueous stock suspension therethrough as a suspension of entrangled co-moving fibers having a relatively low degree of turbulence and a relatively high degree of dispersion in a high speed, ribbon thin, substantially unidirectional, jet-like stream toward the outlet opening.

A specific preferred form of the curved guide elements comprises a stationary curved surface positioned adjacent the entrance nip and a rotary cylinder positioned downstream of the stationary surface so as to define therewith a continuous bi-radii curved path of wire travel having the first radius of curvature substantially larger than a second radius of curvature so that initially relatively gentle pressure is exerted on the stock between the wires and thereafter increased amounts of pressure are exerted on the stock. The stationary surface and rotating cylinder are arranged on the same side of the wires and have water-permeable or water-impermeable constructions. Also, the stationary curved surface has a relatively large radius of curvature, which is constant or decreasing in the direction of wire travel. In certain arrangements the rotary cylinder is provided with suction glands and functions as a couch roll in transferring the newly formed web away from the forming system.

The drawings and the specification present a detailed disclosure of the preferred embodiments mentioned and it is to be understood that the invention is not limited to the specific forms disclosed. Accordingly, it will be understood that modifications and variations may be effected without departing from the spirit and scope of the novel concepts of the present invention.

We claim as our invention:

1. An apparatus for forming fibrous webs comprising:
first and second continuous looped foraminous forming wires which are arranged to converge and provide an entrance nip for the reception of web-forming stock;
a curved stationary surface positioned adjacent said entrance nip;
means for supporting said wires within their respective loops and moving said wires into said entrance nip;
said forming wires being arranged to travel over said stationary curved surface downstream of said entrance nip while having stock therebetween,
a rotary cylinder,
said wires traveling around a part of the periphery of said rotary cylinder immediately following the stationary forming surface, with said surface and said cylinder being on the same side of said wires;
said stationary curved surface having a relatively large radius of curvature;
the first wire being free of restraining means on its outer surface opposite said rotating cylinder;
said wires arranged for traveling at a speed so that the stock is dewatered centrifugally through the first wire.

2. An apparatus as defined in claim 1 wherein the first wire passes over a roll for guiding it into said entrance nip.

3. An apparatus as defined in claim 2 including means for adjusting said roll relative to the entrance nip.

4. An apparatus for forming a fibrous web as defined in claim 1 wherein said wires wrap a guide roll after leaving the rotary cylinder with the first wire engaging said guide roll.

8. An apparatus for forming fibrous webs as defined in claim 4 wherein the guide roll is a suction roll.

6. An apparatus for forming fibrous webs as defined in claim 4 including means for adjusting said roll relative to the rotary cylinder.

7. An apparatus for forming fibrous webs as defined in claim 1 including means for separating the first wire from the second wire following the rotary cylinder with the web being carried on the second wire.

8. An apparatus for forming fibrous webs as defined in claim 7 including a web transfer means positioned downstream of the rotary cylinder and in working relation with the second wire for transferring the web away from said second wire.

9. An apparatus for forming fibrous webs as defined in claim 8 including means forming a second sequence for forming a new ply of web over the web on the second forming wire comprising a third looped forming wire arranged to provide an entrance nip with the second forming wire after it has been separated from the first forming wire for the reception of stock on the surface of the web carried by the second forming wire, a curved stationary surface positioned adjacent said entrance nip, means for supporting said second and third wire within their respective loops and moving said second and third wires into said entrance nip, said second and third wires being arranged to travel over said stationary curved surface downstream of said entrance nip while having stock therebetween, a rotary cylinder, said second and third wires traveling around a part of the periphery of said rotary cylinder immediately following the stationary curved surface, with said stationary surface and said rotary cylinder being on the same side of the wires to support said second wire, said stationary curved surface having a relatively large radius of curvature, the third wire being free of restraining means on its outer surface opposite the rotary cylinder, said second and third wires arranged for traveling at a speed so that the stock is dewatered centrifugally through the third wire.

10. An apparatus for forming a fibrous web comprising:

first and second continuous looped foraminous forming wires which are arranged to converge and provide an entrance nip for the reception of web-forming stock;

a curved stationary surface positioned adjacent said entrance nip;

means for supporting said wires within their respective loops and moving said wires into said entrance nip;

said forming wires being arranged to travel over said stationary curved surface downstream of said entrance nip while having stock therebetween;

a rotary cylinder positioned downstream in close-working relation with said curved stationary surface to define a continuous bi-radii curved path of wire travel having a first radius of curvature substantially larger than a second radius of curvature;

said wires traveling around a part of the periphery of said rotary cylinder immediately following the stationary curved surface, with said stationary surface and said rotary cylinder being on the same side of said wires;

the first wire being free of restraining means on its outer surface opposite said rotary cylinder;

said wires arranged for traveling at a speed so that the stock is dewatered centrifugally through the first wire.

11. An apparatus for forming fibrous webs as defined in claim 10 wherein the curved stationary surface is a substantially water-permeable surface defined by a plurality of longitudinally spaced generally transverse wire-contacting relatively thin edges, the longitudinal contour of said wire-contacting edges defining the curve of said surface.

12. An apparatus for forming fibrous webs comprising:

first and second continuous looped foraminous forming wires which are arranged to converge and provide an entrance nip for the reception of web-forming stock;

a curved stationary surface positioned adjacent said entrance nip;

means for supporting said wires within their respective loops and moving said wires into said entrance nip;

said forming wires being arranged to travel over said stationary curved surface downstream of said entrance nip while having stock therebetween;

a rotary cylinder;

said wires traveling around a part of the periphery of said rotary cylinder following the stationary surface with said stationary surface and said rotary cylinder being on the same side of said wires;

said curved surface being a substantial water-permeable surface defined by a plurality of longitudinally spaced generally transverse wire-contacting relatively thin edges, the longitudinal contour of said wire-contacting edges defining the curve of said water-permeable surface;

the first wire being free of restraining means on its outer surface opposite said rotary cylinder;

said wires arranged for traveling at a speed so that the stock is dewatered centrifugally through the first wire.

13. An apparatus for forming a fibrous web as defined in claim 12 wherein the wire-contacting thin edges are connected to a housing and means are connected to said housing for maintaining a subatmospheric pressure in the spacing between said wire-contacting thin edges for water removal through said spacing.

14. An apparatus for forming fibrous webs comprising, in combination:

first and second continuous looped foraminous forming wires which are arranged to converge and provide an entrance nip for the reception of web forming stock;

means for supporting said wires within their respective loops and moving said wires into said entrance nip;

a stock supply means and a slice chamber means positioned in working relation with said stock supply means and with respect to said entrance nip;

said slice chamber having an outlet opening, a first and second wall converging toward said outlet opening and a plurality of flexible training elements within said slice chamber arranged to define therebetween converging channels extending toward said outlet opening and guiding a dilute aqueous stock suspension therethrough as a suspension of entangled co-moving fibers having a relatively low degree of turbulence and a relatively high degree of dispersion in a high-speed ribbon-like substantially unidirectional jet-like stream toward said outlet opening;

a curved stationary surface positioned adjacent said entrance nip;

said forming wires being arranged to travel over said stationary curved surface downstream of said entrance nip while having stock therebetween;

a rotary cylinder positioned downstream with said curved stationary surface to define therewith a continuous bi-radii curved path of wire travel having a first radius of curvature substantially larger than a second radius of curvature;

said wires traveling around a part of the periphery of said rotary cylinder following the stationary curved surface, with said stationary surface and said rotary cylinder being on the same side of said wires;

the first wire being free of restraining means on its outer surface opposite said rotary cylinder;

said wires arranged for traveling at a speed so that the stock is dewatered centrifugally through the first wire, whereby initially relatively gentle pressure is exerted on the stock between the wires and thereafter increased amounts of pressure are exerted on said stock.

15. An apparatus for forming fibrous webs as defined in claim 14 including means for adjusting the outlet opening of the slice chamber in relation to the entrance nip.

16. An apparatus for forming fibrous webs as defined in claim 14 wherein a stationary water-removing surface is positioned downstream of the rotary cylinder.

17. An apparatus for forming fibrous webs as defined in claim 14 wherein the curved stationary surface is defined by a relatively large radius of curvature for preventing substantially perpendicular pressure loading by the forming wires as they travel over said stationary surface.

18. An apparatus for forming fibrous webs as defined in claim 14 including means to orientate the slice chamber outlet so as to guide aqueous suspension of co-moving fibers generally upwardly in respect to the entrance nip whereby the aqueous suspension generally contacts the first wire before coming into contact with the second wire.

19. An apparatus for forming fibrous webs as defined in claim 18 including a web transfer means positioned downstream of the rotary cylinder in working relation with the second wire for transferring the web away from said second wire.

20. An apparatus for forming fibrous webs as defined in claim 14 wherein the rotary cylinder is a dewatering roll.

21. An apparatus for forming fibrous webs as defined in claim 20 wherein the dewatering roll is a foraminous roll.

22. An apparatus for forming fibrous webs as defined in claim 21 wherein the foraminous roll is a suction roll.

23. An apparatus for forming fibrous webs as defined in claim 22 including means for separating the first wire from the second wire following the rotary cylinder with the web being carried on the second wire and a web transfer means positioned downstream of the rotary cylinder in working relation with the second wire for transferring the web away from said second wire.

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S. LEON BASHORE, Primary Examiner

R. H. TUSHIN, Assistant Examiner

U.S. Cl. X.R.

162—123, 203, 210, 301, 303, 317

UNITED STATES INTERNATIONAL TRADE COMMISSION
Washington, D.C.

In the Matter of
CERTAIN PAPERMAKING MACHINE FORMING SECTIONS FOR THE CONTINUOUS PRODUCTION OF PAPER AND COMPONENTS THEREOF

Investigation No. 337-TA-147

INITIAL DETERMINATION

John J. Mathias, Administrative Law Judge

Pursuant to the Notice of Investigation in this matter (48 Fed. Reg. 21213, May 11, 1983), this is the presiding officer's initial determination under Rule 210.53(a) of the Rules of Practice and Procedure of this Commission. (19 C.F.R. 210.53(a)).

The presiding officer hereby determines that there is no violation of Section 337 of the Tariff Act of 1930, as amended (19 U.S.C. 1337, hereafter Section 337), in the importation of certain papermaking machine forming sections for the continuous production of paper and components thereof into the United States, or in their sale. The complaint herein alleges that such importation or sale constitutes unfair methods of competition and unfair acts by reason of alleged: (1) direct infringement, (2) contributory infringement, and (3) induced infringement of claims 1, 2, 3, 4, 7, 8, 10, 11 and 12 of U.S. Letters Patent 3,726,758. It is further alleged that the effect or tendency of the unfair methods of competition and unfair acts is to destroy or substantially injure an industry, efficiently and economically operated, in the United States.

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PROCEDURAL HISTORY

Beloit Corporation (hereinafter Beloit), 1 St. Lawrence Avenue, Beloit, Wisconsin 53511 filed a complaint with the United States International Trade Commission on April 5, 1983, pursuant to section 337 of the Tariff Act of 1930, as amended (19 U.S.C. §1337). The complaint alleges unfair methods of competition and unfair acts in the importation of certain papermaking machine forming sections for the continuous production of paper and components thereof into the United States, or in their sale, by reason of alleged (1) direct infringement, (2) contributory infringement, and (3) induced infringement of claims 1, 2, 3, 4 7, 8, 10. 11 and 12 of U.S. Letters Patent 3,726,758 (the '758 patent). The complaint further alleges that the effect or tendency of the unfair methods of competition and unfair acts is to destroy or substantially injure an industry, efficiently and economically operated, in the United States

After considering the complaint, the Commission voted to institute an investigation into such charges. A notice of investigation was published on May 11, 1983. (48 Fed. Reg. 21213).

Denise T. DiPersio, Esq., Unfair Import Investigations Division, was designated a party as the Commission investigative attorney.

Named as respondents in the May 11 notice were:

Valmet Oy
P.L. 155 SF-00131
Helsinki 13, Finland

TVW Paper Machines, Inc.
180 Interstate North
Atlanta. Georgia 30339

On May 11, 1983 Chief Administrative Law Judge Donald K. Duvall designated Administrative Law Judge Janet D. Saxon as Presiding Officer in this investigation. For "reasons of judicial economy [and] administrative necessity," Chief Judge Duvall, on September 8, 1983, relieved Judge Saxon and designated Administrative Law Judge John J. Mathias as Presiding Officer in this investigation.

Preliminary conferences were held on May 25, 1983, and October 26, 1983, before the presiding officer. At the conferences appearances were made by the Commission investigative attorney, counsel for the complainant and counsel representing the respondents.

A prehearing conference was held on November 28, 1983, and the hearing commenced immediately thereafter on that same day before the presiding officer to determine whether there is a violation of Section 337. The hearing concluded on December 8, 1983.

The issues have been briefed and proposed findings of fact submitted by the participating parties.

This initial determination is based upon the entire record including proposed findings of fact and conclusions of law and supporting memoranda filed by the parties, as well as their replies. I have also taken into account my observation of the witnesses who appeared before me and their demeanor. Proposed findings not herein adopted, either in the form submitted or in substance, are rejected either as not supported by the evidence or as involving immaterial matters.

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

The following abbreviations are used in this Initial Determination.

Tr. - Official Transcript, usually preceded by the witness' name and followed by the referenced page(s);

CX - Complainant's Exhibit, followed by its number and the referenced page(s);

CPX - Complainant's Physical Exhibit;

RX - Respondents' Exhibit, followed by its number and the referenced page(s);

RPX - Respondents' Physical Exhibit;

SX - Staff Counsel's Exhibit;

CF - Complainant's Proposed Findings;

CB - Complainant's Supporting Brief;

RF - Respondents' Proposed Findings;

RB - Respondents' Supporting Brief;

SF - Staff Counsel's Proposed Findings;

SB - Staff Counsel's Supporting Brief;

CR - Complainant's Reply Brief;

RR - Respondents' Reply Brief;

SR - Staff Counsel's Reply Brief;

CRF - Complainant's Reply to Respondents' Proposed Findings;

RRF - Respondents' Rebuttal to Complainant's Proposed Findings.

FINDINGS OF FACT

I. JURISDICTION

1. The International Trade Commission has jurisdiction over the subject matter of and the parties to this investigation. (CX 214, Stipulation No. 1; RRF at 1).

II. THE PARTIES

2. Complainant, Beloit Corporation (hereafter Beloit), is incorporated in the state of Delaware and has its principal place of business at 1 Saint Lawrence Avenue, Beloit, Wisconsin 53511. Through its Paper Machinery Division it is engaged in, among other things, the manufacture and sale in the United States of machinery for the manufacture of paper, as well as the research and development of such machinery. (CX 214, Stipulation No. 2; RRF, at 76).

3. Respondent Valmet Oy (hereafter Valmet) is a Finnish manufacturer of papermaking machinery having an address at P. L. 155, SF00131, Helsinki 13, Finland. It manufactures and sells a wide range of papermaking machinery, including the Sym-Former R, one of the devices here in issue. It also offers for sale another device here in issue, the New Sym-Former, but no such former had yet been manufactured as of the close of the record herein. (CX 206, p.2; CX 190, p. 6; RRF at 76).

4. Respondent TVW Paper Machines, Inc. (hereafter TVW) is incorporated in the State of New York and has its principal place of business at 180 Interstate North, Atlanta, Georgia 30339. Forty percent of the stock of TVW is owned by Valmet; forty percent is owned by Tampella Oy; and 20 percent by Wartsila Oy. TVW is engaged in, among other things, the importation into the United States, and the promotion, marketing and sale in the United States, of papermaking products of Valmet. (CX 214, Stipulation No. 3; RRF, at 76).

III. PAPERMAKING - DEFINITIONS

5. The papermaking process is one in which a very dilute slurry or suspension of fibers in water, called "stock", is processed in such a fashion that the water is removed and a sheet of paper is produced. A typical papermaking machine consists of a forming section, where the greatest percentage of "dewatering" occurs; a press section, where more water is squeezed from the "web" or forming sheet; and a dryer section wherein more water is thermally evaporated. After achieving a final degree of dryness, the web is rolled for transport and for possible further processing. (CX 204, Waller direct, at 11-12; RX 409, Kallmes direct, at 3-4).

6. The "forming section" of the machine is the focus of this investigation. This portion of the machine begins at the headbox slice where the stock is first introduced into the machine for dewatering and ends where a web is transferred to the press section. (RX 250, Hujula direct at 5). The "headbox" is the device used for first

introducing stock into the papermaking machine. The "slice" is the outlet of the headbox through which the stock is introduced. (RX 50, Hujula direct, at 3).

7. "Stock" refers to the materials introduced into the papermaking machine for ultimate transformation into paper. It generally consists of a mixture having 98.5% to 99.5% water. The other .5% to 1.5% of the mixture is comprised of wood pulp fibers and fine particles. Fine particles are made up of small pieces of wood pulp fibers and fillers, which are mineral materials such as clay and talc. Fillers are used because they are inexpensive compared with wood pulp fibers, and also because they improve the surface qualities of the finished paper product, which enhances the "printability" of the paper, i.e., the ability to print on the paper. The stock, as it is introduced into the machine from the headbox slice, is characterized by the fact that the fibers are arranged randomly in three dimensions in the stock mixture. (RX 250, Hujula direct, at 3). As the stock is dewatered the fibers gradually arrange themselves into a two dimensional planar arrangement. By the end of the forming section a formed sheet, or "web," is transferred to the press section. (CX 204, Waller direct, at 12; RX 250, Hujula direct, at 4; RX 467, Stipulation No. 13).

8. The standard forming section of a papermaking machine for well over 100 years was the fourdrinier forming section, which was invented in France in 1799. The fourdrinier section includes

a continuously moving, substantially horizontal, looped belt made of wire or screen on which the stock is deposited from the headbox. As the woven wire moves along the fourdrinier table, the stock is dewatered through the wire mesh by gravity, which may be aided by the use of vacuum or suction devices. (CX-204, Waller direct, at 12; RX-409, Kallmes direct, at 3-4). Although improved many times over the years, the fourdrinier former suffers from several shortcomings, including speed limitations, lack of fine formation and sheet "two-sidedness." (CX-204, Waller direct, at 12; RX-409, Kallmes direct, at 4-5). "Two-sidedness" means that the surface quality on one side of a paper sheet is different from that of the other. "Two-sidedness" is undesirable in paper for some usages, as it results in a difference in the "printability" of the two sides. This problem is encountered with fourdriniers because all the drainage takes place through one side of the sheet. (RX-409, Kallmes direct, at 6).

9. Twin-wire forming machines offered a solution to the shortcomings of the fourdrinier. In such devices, two wires are used and the stock is sandwiched therebetween, for dewatering in both directions. Since the water is removed from both sides of the forming sheet this method tends to eliminate "two-sidedness" and produce a sheet which is "one-sided," i.e., a sheet having appearance and physical characteristics which are the same on each side. Although this concept had been recognized for some time, it was

rarely commercialized until after World War II. (RX-409, Kallmes direct, at 4-6; CX-204, Waller direct, at 14-15). Beginning in the early 1950's, the demand for higher speed machines and better formation led to the development of a number of commercial twin-wire machines. (RX-409, Kallmes direct, at 5-8; CX-204; Waller direct, at 14-15).

10. In true twin-wire formers, sometimes called "gap-formers," the stock is deposited directly into the area of convergence (the "nip") of the two wires. (Waller, Tr. 460; Kallmes, Tr. 1217).

11. Top-wire formers, sometimes called hybrid formers, are also sometimes referred to as twin-wire formers, since they utilize, in part, two wires to dewater the paper forming materials. (Kallmes, Tr. 1217; Waller, Tr. 459-61). In a typical top-wire former there is a fourdrinier table, with a top wire section (twin-wire section) situated upon it about half-way down the fourdrinier, followed by the rest of the fourdrinier table. Water is drained downward in the fourdrinier sections both before and after the top-wire section, with dewatering in both directions in the top-wire section. (Waller, Tr. 460-61).

12. In the development of twin-wire formers it was recognized that as the wire-stock-wire sandwich traveled over a curved surface, such as an arcuate shoe, or rotary cylinder, that centrifugal forces would be generated which could be employed to remove water. The portion of the curved surface or rotary cylinder over which the wire sandwich travels is sometimes referred to as the "wrap." (CX-204, Waller direct, at 16).

IV. THE ISSUE OF INFRINGEMENT

A. The Pertinent Claims of the '758 Patent

13. Claim 1 covers an apparatus for forming fibrous webs comprising:

(a) First and second continuous looped foraminous forming wires which are arranged to converge and provide an entrance nip for the reception of web-forming stock;

(b) A curved stationary surface positioned adjacent said entrance nip;

(c) Means for supporting said wires within their respective loops and moving said wires into said entrance nip;

(d) Said forming wires being arranged to travel over said stationary curved surface downstream of said entrance nip while having stock therebetween;

(e) A rotary cylinder;

(f) Said wires traveling around a part of the periphery of said rotary cylinder immediately following the stationary forming surface, with said surface and said cylinder being on the same side of said wires;

(g) Said stationary curved surface having a relatively large radius of curvature;

(h) The first wire being free of restraining means on its outer surface opposite said rotating cylinder;

(i) Said wires arranged for traveling at a speed so that the stock is dewatered centrifugally through the first wire. (CX-1, Col. 22).

14. Claim 2 covers an apparatus as defined in claim 1 wherein the first wire passes over a roll for guiding it into said entrance nip. (CX-1, Col. 22).

15. Claim 3 covers an apparatus as defined in claim 2 including means for adjusting said roll relative to the entrance nip. (CX-1, Col. 22).

16. Claim 4 covers an apparatus for forming a fibrous web as defined in claim 1 wherein said wires wrap a guide roll after leaving the rotary cylinder with the first wire engaging said guide roll. (CX-1, Col. 22).

17. Claim 7 covers an apparatus for forming fibrous webs as defined in claim 1 including means for separating the first wire from the second wire following the rotary cylinder with the web being carried on the second wire. (CX-1, Col. 23).

18. Claim 8 covers an apparatus for forming fibrous webs as defined in Claim 7 including a web transfer means positioned downstream of the rotary cylinder and in working relation with the second wire for transferring the web away from the second wire. (CX-1, Col. 23).

19. Claim 10 covers an apparatus for forming a fibrous web comprising:

(a) Those features described in sub-paragraphs (a) through (d),

(f), (h) and (i) of finding 13, above, in connection with claim 1; and

(b) A rotary cylinder positioned downstream in close-working relation with said curved stationary surface to define a continuous bi-radii curved path of wire travel having a first radius of curvature substantially larger than a second radius of curvature. (CX-1, Col. 23).

20. Claim 11 covers an apparatus for forming fibrous webs as defined in claim 10 wherein the curved stationary surface is a substantially water permeable surface defined by a plurality of longitudinally spaced generally transverse wire-contacting relatively thin edges, the longitudinal contour of said wire-contacting edges defining the curve of said surface. (CX-1, Col. 23).

21. Claim 12 covers an apparatus for forming fibrous webs comprising:

(a) A combination of those features described in sub-paragraphs (a) through (e), (h) and (i) of finding 13, above, in connection with claim 1, and the features of claim 11, as described in finding 20, above; and

(b) Said wires traveling around a part of the periphery of said rotary cylinder following the stationary surface with said stationary surface and said rotary cylinder being on the same side of said wires. (CX-1, Cols. 23-24).1/

1/ The only real difference between this latter feature of claim 12 and sub-paragraph (f) of finding 13, above, describing claim 1, is the elimination of the requirement that the wires travel over a part of the periphery of the rotary cylinder "immediately following" the stationary surface. (CX 1, Cols. 22 & 24). (Emphasis added).

22. The language of all of the claims in issue, therefore, requires, among other things; that:

(a) The first and second wires must be arranged "to converge and provide an entrance nip for the reception of web-forming stock"; and

(b) The device must include "a curved stationary surface positioned adjacent said entrance nip." (Findings 13-21, above). (Emphasis added).

B. The '758 Device

23. The devices covered by the '758 patent are described in its "Summary of the Invention" as follows:

> The '758 invention generally comprises a forming machine and system including a head box means for providing a ribbon-thin jet stream of web stock in a given direction (horizontal or vertical); two endless loop forming wires arranged to travel in the given direction so as to define a forming zone; a breast roll positioned within each of the looped wires to define a nip therebetween for receiving the stock and curved guide elements positioned downstream of the breast rolls and within the loop of one of the wires to dewater the stock sandwiched between the wires.

(CX-1, Col. 2, l. 15-25).

24. In all of the embodiments envisioned in the patent, the '758 invention is a true-twin wire former, that is, the nip which receives the stock is an "entrance" nip, into which the jet stream of stock is directly discharged. (Kallmes. Tr. 1217, CX-1, Col. 1, l. 15-16, 23-29; Col. 2, l. 52-59; Col. 8, l. 29, 39-43, 61-63; Col. 10, l. 35-45, 58-62; Col. 11, l. 11-29, 36-51; Col. 15. l. 5-9, 26-29, 46-49; Col. 16, l. 67-68; Col. 18, l. 13-37; Col. 21,

1. 65-70; Col 22 1. 3-17; Figs. 3-8). There is no fourdrinier section preceding the twin wire former, or upon which the top wire is imposed. (See Attachments I and II, Figure 8 from the suit patent and a slide of complainant's Bel Baie II, respectively).

25. Further, in each of the embodiments envisioned in the patent, a curved stationary surface can be said to be "adjacent" the entrance nip, in that at least some portion of the entrance nip lies directly upon the curved stationary surface. (CX-1, Col. 8, 1. 39-51, 63-68; Col. 10. 1. 17-25; Col. 17, 1. 65-68; Col. 15, 1. 63-66; Col. 17, 1. 2-8 Col. 18, 1. 42-48; Figs. 3-8).

26. Moreover, in each embodiment envisioned by the '758 patent, the curved stationary surface has a relatively large radius of curvature and is followed by a cylindrical roll with a substantially smaller radius of curvature. (CX-1, Figs. 3 - 8).

27. The basic purposes of twin-wire formers, including the '758 device, were to improve formation (especially through the elimination of two-sidedness) and allow increased machine capacity and speeds. (CX-204, Waller direct, at 12-15).

28. The principal claimed advantages of the '758 device, over predecessor twin-wire formers, were that it provided a gradual nip between the two wires so as to prevent the stock from being rejected or spewed. (Gustafson, Tr. 1501-02; CX-1, Col. 8, 1. 41-58; Col. 10, 1. 17-40; Col. 12, 1. 51-58; Col. 17, 1. 22-28; Col. 18, 1. 54-59; CX-205, Gustafson direct, at 5-7), as well as eliminating problems involving

formation (CX-1, Col. 12, l. 1-27), and it provided for free centrifugal dewatering through the outer or free wire (CX-204, Waller direct, at 16; CX-1, Col. 1, l. 1-2, 23-30).[2/]

C. Respondents' Accused Devices

29. The devices of respondents which are alleged to infringe the '758 patent are the Sym-Former R and the New Sym-Former. (CB, at 29 et seq.).

30. Both the Sym-Former R and the New Sym-Former are "top-wire formers" which sit atop fourdrinier tables. (Waller, Tr. 463). (See Attachments III and IV, drawings of the Sym-Former R and the New Sym-Former respectively).

31. In both the Sym-Former R and the New Sym-Former, the portion of the fourdrinier table preceding the top-wire (or twin-wire) section of the device is approximately 20 to 30 feet in length (RX-280, Hujula direct, at 13). Between the headbox and the forming roll, where the top-wire section begins, the bottom wire on these devices is supported by a plurality of dewatering elements. These dewatering devices serve to remove water from the stock along the path of travel between

2/ The term "spew" or "spewing" refers to the phenomenon of stock being squeezed out of the sides of the two converging wires due to the fact that more stock is being introduced between the wires than can be accomodated. (CX-205, Gustafson direct, at 3).

the headbox and the forming roll (the fourdrinier section) by draining water down through the bottom wire. These elements accomplish dewatering by establishing a vacuum beneath the wire. By controlling the amount of vacuum applied to each dewatering element, the amount of water removed thereby can be controlled. In the Sym-Former R, between 35% and 50% of the water initially in the stock is removed in this fourdrinier section. (RX 250, Hujula direct, at 14). A typical percentage of water removal in this section is 43%. (RX-250, Hujula direct at 15; CPX T).

32. In the top wire section of the accused devices there is a nip established in the vicinity of the forming roll between the top wire which wraps the forming roll and the bottom wire. (RX-105-106).

33. This nip is a rather abrupt nip which begins at a point where the wires approach each other and ends at about the six o'clock position on the forming roll. (RX-105-106; Hujula, Tr. 952; RX-409, Kallmes direct, at 12-13; RX-381, Chapman dep., at 26; RX-235-236, which are Chapman dep. Exs. 6JC and 7JC; RX 200, McKie dep., at 122-23; RX-177, which is McKie dep. Ex. W4; and RPX D).[3/]

3/ As the term "nip" is used in the claims of the suit patent, it begins where the wires approach each other to receive stock therebetween and ends where the wires are in general parallelism. (RX-79, Complainant's response to respondents' interrogatory No. 60 (i)). Thus, the nip in the accused devices begins where the wires approach each other to receive the material from the fourdrinier section and ends where they have reached general parallelism -- the point where the wires are spaced apart only by material therebetween. (CX-1- Col. 9, l. 18-23; Col. 12, l. 28-34).

34. The forming roll in the accused devices, as illustrated in RX-107, is an open or drilled hollow roll. By open or drilled is meant that the roll has a multiplicity of holes drilled through its shell, such that the holes occupy approximately 70% of the outer surface of the roll. The entire surface of the roll is covered by a fabric which is shrunk down for a close fit about the roll. The fabric reduces the possibility of unintended marking of the paper with impressions of the holes. (RX-250, Hujula direct, at 16).

35. Following the end of the nip, the twin wires, with materials therebetween, pass around (wrap) a portion of the periphery of the forming roll for a distance of about 40 degrees on the Sym-Former R and about 30 degrees on the New Sym-Former. In this section of the accused devices substantial additional de-watering occurs--about 30% of the original volume. (Hujula, Tr. 959; RX-250, Hujula direct, at 17; CX-7).

36. After the twin wires leave the forming roll they traverse a stationary shoe which has a relatively large radius of curvature. The top surface of this shoe is made up of a plurality of individual blades spaced about 3 inches apart. Each blade is slightly curved and about 2 inches wide. The shoe also contains hollow compartments into which water squeezed through the bottom wire can be drawn off. Water squeezed through the top wire is thrown off by centrifugal force and collected in a save-all. (RX-250, Hujula direct, at 21-22).

37. As the wires travel over the shoe, approximately 16% more of the water from the original stock is removed. About 12% is removed through the top wire and approximately 4% is removed throught the bottom wire at this point. (RX-250, Hujula direct, at 22).

38. As the twin wires with material therebetween pass over the shoe, the pressure applied on the material is not a continuous, uniform pressure, as would be the case if the shoe were a solid curved surface. Rather, there is a pressure pulse applied at each blade. Therefore, a series of pressure pulses is applied to the paperforming material as it passes over the shoe. These pressure pulses serve to redistribute the fibers and fine particles, thus serving to improve the formation of the finished sheet. (RX-250, Hujula direct, at 23).

39. After leaving the shoe, the twin wires in respondents' accused devices pass over a solid roll on the same side of the wires as the shoe and reverse their upward direction. On the Sym-Former R this wire sandwich wraps the solid roll around an arc of 20 to 40 degrees during this direction reversal. (RX-250, Hujula direct, at 24). In the New Sym-Former this wrap is somewhat less. (Compare RX-106 with RX-105). Due to the passage of the wires over this curved cylinder there is some additional dewatering. Three percent or less of the original water content is removed through the top wire over this roll. There is no dewatering through the bottom wire as it passes over the roll, since the roll is solid. (RX-250, Hujula direct, at 24).

40. Following passage over this solid cylinder the wire sandwich in the Sym-Former R is brought back into the horizontal path of the original fourdrinier machine by a reversing roll.[4/] As the sandwich passes

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4/ The Sym-Former R was designed to be retrofitted into an existing fourdrinier machine as part of its forming section. (RX-250, Hujula direct, at 11).

around this roll (which is on the opposite side of the wires from the preceding roll and shoe) a small additional amount of water is removed. (RX-250, Hujula direct, at 24). In the New Sym-Former this roll is not needed, as that device has a different configuration which does not require return to the horizontal path of a fourdrinier. (Compare RX-106 with RX-105).

41. In both the Sym-Former R and the New Sym-Former the upper wire is then separated from the first wire by another roll elevated slightly above the plane of the wire sandwich with the aid of suction boxes under the bottom wire. (RX-105 - 106). There is some additional de-watering before the web, which continues on the bottom wire, is passed on to the drying section of the paper making machine. (CPX T).

D. The Accused Devices of Respondent Do Not Infringe the '758 Patent

42. On the basis of findings 43-61 below, I find that the accused forming devices of respondents do not infringe the '758 patent, in that they do not have a curved stationary surface "adjacent" an entrance nip and, in fact, do not even have an "entrance nip," within the meaning of claims 1-4, 7-8, and 10-12 of the '758 patent.

E. The Question of Adjacency

43. The requirement that the curved stationary surface be positioned "adjacent" the "entrance nip" is an essential part of each and every claim of the '758 patent at issue in this proceeding. (Finding 22, above). In fact, it was only after the insertion of the phrase "adjacent said entrance nip" was made in connection with the "curved stationary surface"

that the examiner allowed the claims in complainant's application Serial No. 795,954 (an application in the chain leading to the suit patent). (RX 377, document entitled "Voluntary Amendment," pp. 1, 2, 4 - 5; RX-377, Examiner's Amendment, date-stamped May 4, 1971, p. 3). Thus, both through a literal reading of the claims of the suit patent and by way of "file wrapper estoppel," it is clear that "adjacency" between the curved stationary surface and the entrance nip is an essential element of the suit patent device.

44. The claims do not define adjacency in terms of distance, or other measurable indicia. However, it is clear that there must be some direct functional relationship between the curved stationary surface and the nip. (CX-1, Claims 1-4, 7-8, 10-12; Cols. 22-24; Findings 13-21, above).

45. There is no showing in this record that there is any functional relationship between the nip and the curved stationary surface in the accused devices of respondents. (Findings 46-48, below). Moreover, the evidence adduced by complainant at this hearing reveals no showing of such adjacency under any other indicia. (Findings 49-55, below).

46. The only reliable evidence of record establishes the end of the nip in the accused devices at about the six-o'clock position on the forming roll, which is upstream from (before) the curved stationary surface. (CPX A, S and I; RX-409, Kallmes direct, para. 32; Hujula, Tr. 952; RX-200, McKie dep. at 122-23; RX-177, Ex. W4 to McKie dep.; RX-

381, Chapman dep. at 26; RX-235 - 236, Exs. 6JC and 7JC to Chapman dep).[5/]

47. Between the downstream end of the nip and the forming shoe in the accused devices the two wires with material therebetween traverse the forming roll for an arc of approximately 40 degrees in the Sym-Former R and approximately 30 degrees in the New Sym-Former. (Hujula, Tr. 959; RX 250, Hujula direct, at 17; CRF, at 1).

48. As the wires wrap the forming roll in Sym-Former R and New Sym Former, between the nip and the stationary shoe, approximately 30% of the water originally present in the headbox is removed; about 20% being removed into the forming roll and the other 10% being pressed outward and removed centrifugally from the bottom wire. (CX T; Hujula, Tr. 958-59; Waller, Tr. 67, 72, 453). Functionally then, this 30 to 40 degree wrap of the forming roll on the accused devices removes about three-quarters as much water as the entire 20-30 foot fourdrinier section which precedes the forming roll on these devices. (Finding 31,

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5/ The only contrary testimony in the record is ambiguous and unreliable. Dr. Waller was unable to locate the end of the nip on the accused devices with any degree of accuracy. (Waller, Tr. 60, 453-57). Mr. Gustafson, one of the inventors of the suit patent, testified in a conflicting manner as to the location of the end of the nip on those devices. (RX-390, Gustafson dep. at 310-13, 315-16, 595, 612; RX-137, Ex. 24 to the Gustafson Dep.). Moreover, complainant agrees with respondents' proposed finding No. 82 which states that "between the downstream end of the nip and the forming shoe in Sym-Former R, the two wires with material therebetween traverse the forming roll ... for an arc of approximately 40 degrees." (CRF at 1) (Emphasis added). In order for the wire sandwich to wrap the forming roll for that distance it would be necessary for the wires to be in general or substantial parallelism and the nip would have to be near the six o'clock position on the forming roll. (See RX-105, 106; RPX D; CX-5).

above). Under these circumstances, there is obviously a functional gap between the nip and the stationary curved surface in respondents' devices. Certainly if a 15-20 foot fourdrinier section intervened between the nip and the shoe, they could not be considered "adjacent."[6/] (See Findings 165-166, below for further reasons why the nip and shoe do not have the required functional relationship in the accused devices).

49. This latter analysis is based on a purely literal reading of the claims in issue of the suit patent, without any reference to the drawings and specification. (Findings 46-48). In this instance, however, there is good cause for referring to the specification and drawings in order to interpret the meaning of "adjacency" in the '758 patent. As noted by Mr. Gustafson, one of the inventors, during his deposition, "adjacent ... can be relative." (RX-390 at 293). One of complainant's counsel, during that same deposition, also notes that "adjacent has different meanings and different connotations in different circumstances." (RX-390 at 292). Indeed, complainant has admitted in its Posthearing Brief that, "In the absence of any specific definition in the text of the patent, resort to the drawings of the '758 patent must be made to interpret the term 'adjacent' in the claims...." (CB at 8).

6/ 15-20 feet represents approximately three-fourths of the length of the fourdrinier section which precedes the forming roll in respondents' devices. (Finding 31).

50. When reference is made to the specification and drawings of the '758 patent, it becomes even clearer that the nip and the curved shoe of the accused devices are not "adjacent" within the meaning of the suit patent.

51. Even Mr. Gustafson, one of the inventors of the suit patent, agrees that in order to be "adjacent" within the intent and meaning of that patent, the curved stationary surface must partially shape one side of the nip in order to create a gradual nip and, further, that if the nip terminates before the shoe, the shoe cannot shape the nip. (RX-390, Gustafson dep., 296-99; CX-205, Gustafson direct, at 7).

52. The specification and figures of the suit patent also make it clear that the nip cannot end prior to the curved stationary surface. In each of Figs. 3 through 8 of the suit patent, the entrance nip lies directly upon the curved stationary surface, at least in part.[7/] The specification too, is quite uniform in placing the nip on the guide elements, i.e., the curved stationary surface and, in the case of Fig. 3, the following roll. Beginning in the "Abstract of the Disclosure" in Column 1 of the patent it is stated:

7/ Figs. 1 and 2 of the suit patent do not contain a curved stationary surface and it is conceded by complainant that these figures are not covered by any of the claims of the patent. (RX-390, Gustafson dep. at 381; RX-409, at 10).

> A twin-wire web making system for use in forming multi-ply or single-ply webs wherein a web stock is discharged into a nip between opposed forming wire runs arranged to converge with one another over guide elements. (Emphasis added).

and,

> At each sequence a head box means discharges web stock between twin wires supported by spaced breast rolls defining the nip therebetween and the wires gradually converge into general parallelism over curved guides by wrapping a portion of their surfaces so as to centrifugally dewater the stock sandwiched between the wires. (Emphasis added).

and, again,

> [A] stationary curved surface and a rotary cylinder are positioned on the same side of the wires to guide the wires into general parallelism. (Emphasis added).

Also, in the "Description of the Preferred Embodiments," in connection with the description of the features of Figs. 3 through 8, the specification of the patent, in each case, shows a portion of the nip resting upon the curved stationary surface, and ending either thereon, or on the following rotary cylinder. Thus, in connection with Fig. 3 it is stated:

> [T]he portions of the curved stationary surface and the cylindrical roll cooperate to provide a single wire guide having a relatively large diameter arcuate surface whereby the initial curvature of the nip between the converging wires is much less than would otherwise be available ... the cooperation of these elements to define a gradually converging path of wire travel is essential.... The curvature is such that as the wires are nipped together, they experience every [sic] increasing curvature up to that of the roll.... The wires ... gradually converge until they actually attain general parallelism, as by contacting the rotating peripheral surface of the roll.

(CX-1, Col. 8, l. 63-68, 71-73; Col. 9, l.4-7, 17-19).

Similarly, in connection with Fig 4, the specification states:

> The stationary arcuate plate or shoe ... increases the effective diameter of the roll ... and thereby allows a more gradual consolidation of the jet-stream between the two wires as they approach each other and the roll surface.

(CX 1, Col. 10, l. 35-40). (Emphasis added).

Again, in the description of the embodiment contained in Fig. 5, the specification says:

> The first curved guide surface encountered by the converging wires is wire guide 218 [the curved stationary surface] which comprises an essentially elongated, smooth, stationary generally convexly curved surface urging the wire F2 [the bottom wire] into general parallelism with wire F 1 [the top wire] ... It will be noted that the forming wires F 1 and F 2 do not come into actual parallelism with one another until some point 218a well beyond the lead edge of wire guide 218.

(CX-1, Col. 12, l. 41-45, 65-68). (Emphasis added).

Referring to Fig. 6, the specification provides:

> The wires actually tend to assume general paralellism at a point 318a along the surface of guide element 318 [the curved stationary surface] so that a gradual build-up of pressure occurs throughout the area of convergence.

(CX-1, Col. 15, l. 63-66).

In connection with Fig. 7, the specification describes the relationship between the nip and the curved stationary surface in the following language:

> [T]he wires continue to travel convergingly together into general parallelism over a curved wire guide 428 to attain such parallelism ... at a point 428a along the surface of the guide element 428.

(CX-1, Col. 17, l. 2-8).

Figure 8 is also shown to require a similar relationship between the nip and the curved stationary surface. CX-1 at Col. 18, lines 64-66, states:

> The wires F1 and F2 do not come into actual parallelism with one another until a point 517a well beyond the lead edge of the guide element 517.

53. It is clear from the above and other evidence of record that this relationship between the nip and the curved stationary surface is essential to the '758 patent device. Mr. Gustafson, in his witness statement, points out that:

> The provision of a curved shoe having a relatively large radius in the embodiments of Figures 3 through 8 of CX 1 is a unique way of providing an entrance nip for the papermaking stock wherein dewatering is initially done in a relatively gentle manner.

(CX-205, at 7). (Emphasis added).

Mr. Gustafson also noted that the purpose of the curved stationary surface was to reduce the initial drainage pressure on the stock so as to achieve "less abrupt or harsh initial drainage," so as to eliminate a "spewing problem" in a predecessor machine design. Such "spewing" was due to a lack of "sufficient capacity to accept the amount of stock being supplied to the entrance nip" in the predecessor design. (CX-205, Gustafson direct, at 5-6). Mr. Gustafson also admitted during his deposition that a part of his concept in the '758 patent was to "provide a gap for the reception of a jet stream of stock to move into a nip that has been shaped by an arcuate shoe so that the convergence of the two wires is gradual" and that this could not be achieved if the nip were not adjacent the shoe. (RX-390, at 297). He then admitted that if the nip reached essential or substantial or general parallelism in advance of the shoe, the nip would not be shaped by the shoe. (RX-390, at 297).

54. As found above in Findings 46 and 47, the nips in the Sym-Former R and the New Sym-Former end well before the beginning of the shoe (the stationary curved surface). Therefore, the nip in the Sym-Former R and the New Sym-Former is not "adjacent" the curved stationary surface or shoe. (See also, RX-409, Kallmes direct, at 8-16).

55. Since the requirement of "a curved stationary surface positioned adjacent said entrance nip" is an essential element of each and every suit patent claim here in issue (Finding 22), the accused devices of respondents can not literally infringe the '758 patent, as alleged by complainant.

F. The Absence of an "Entrance Nip" in the Accused Devices.

56. As noted in Finding 22 above, another essential element of each of the claims of the '758 patent which are here in issue, is that the first and second wires must be arranged to converge and provide an "entrance nip" for the reception of web-forming stock. I find that the term "entrance nip" is not self-explanatory. In fact, Mr. Gustafson could not recall any other usage of the term "entrance nip" outside its use in the suit patent. (RX 390, Gustafson dep., at 379). Its precise meaning, i.e., whether it refers to any convergence of wires in a twin-wire former, or only such convergence which receives stock directly from the head-box, cannot be determined without reference to the drawings and specification of the patent.

57. In all of the figures of the suit patent a substantially homogenous mixture of fibers and water (stock) is discharged directly into the nip formed between the two wires, in the form of a jet stream. (RX-390, Gustafson dep., at 133-37; Waller, Tr. 166-68; RX 409, Kallmes direct, at para. 34).

58. The language of the specification further bears this out to be the fact. With reference to the reception of stock by the nip, between the wires, it is clear that the patent speaks of a jet stream of such stock being deposited directly from the headbox into the nip. (CX-1, Col. 2, l. 52-59; Col. 4, l. 12-13; Col. 5, 30-41; Col. 8, l. 20-29; Col. 10, l. 17-21; Col. 11, l. 47-51, Col. 15, l. 27-29; Col. 16, l. 67-75; Col. 18, l. 24-37).[8/] Thus, the modifying word "entrance" as used in connection with the term "nip" in the

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8/ Mr. Waller claims that in at least one instance the specification indicates that the jet stream of stock is deposited on the bottom wire prior to the entrance nip. He refers to CX-1, Col. 8, line 51 as bearing this out. (Waller, Tr. 488). Even if this were so, the jet stream of stock would still contact the wire immediately before the nip and, therefore, this fact would not materially affect this finding. However, Mr. Waller has misread the specifications in this regard. The language to which he refers:

> The bottom wire 11 is trained over the arcuate stationary surface of the plate or shoe 71 as the jet stream is deposited thereon....

is followed two sentences later by the language

> It will thus be appreciated that the combination... of the plate or shoe 71 with a large diameter roll 52 provides a relatively large arcuate surface which more readily assumes the trajectory of the jet stream and allows for a more uniform application of pressure to the jet stream <u>as it is deposited between the wires</u>.

(CX-1, Col. 8, l. 51-63). (Emphasis added).
Therefore, although the jet stream first contacts the bottom wire in this instance, it does so <u>within</u> the entrance nip.

suit patent is meant to define a nip into which the stock is directly discharged from the headbox. (See Findings 165-166, below). Such an "entrance nip" could only be found in a true twin-wire former.

59. This is further borne out by the history of this invention. Its original purpose was to correct a deficiency in an earlier design wherein spewing occurred when stock was received in jet stream form directly from the headbox into the nip. The shaping of a gradual nip through use of an arcuate shoe was intended to eliminate that problem. (Finding 53, above).

60. The Sym-Former R and the New Sym-Former, on the other hand, have eliminated the problem of spewing by an entirely different means. In the latter devices the material issuing from the headbox is substantially dewatered before it even approaches the convergence between the two wires, i.e., the nip. This initial dewatering occurs on the single-wire fourdrinier section of these formers. (RX-409, Kallmes direct, at 14; Finding 31, above). Therefore, there is no concern with the problem of spewing at the nip in Sym-Former R and the New Sym-Former. (RX-409, at 14). This is further borne out by the fact that the nip in the accused devices is an abrupt nip, rather than a gradual one. (RX-409, at paras. 33 and 35; CX-1, Col. 17, l. 22 et seq; Finding 33). As such, the nip in these devices would not be suitable for the reception of a jet stream of stock directly from the headbox. (Waller, Tr. 174; RX-381, Chapman dep., at 27a; RX-392, Waller dep., at 350; CX-1, Col. 17, l. 22 et seq.).

61. Accordingly, I find that the accused devices do not contain an "entrance nip" within the meaning of that term as it is used in the '758 patent. Therefore, for this additional reason, they cannot be considered as infringing devices. (Findings 56-60, above).

G. Additional Differences Claimed by Respondents

62. Respondents also urge that the accused devices do not read on the the '758 patent as to one other essential element of the claims in issue. That is the limitation in such claims that "said forming wires [be] arranged to travel over said curved stationary surface downstream of said entrance nip while having stock therebetween." (RF 107 et. seq.; Findings 13-21).

63. It is respondents' position that the forming wires in the accused devices, as they pass over the stationary shoe, have web between them rather than stock. (RF 107-122).

64. The term "stock" as used in the claims of the suit patent is not clearly defined within the language of the claims. (CX-1, Cols. 22-24). The testimony of the experts as to whether the material in the wire sandwich of the accused devices, at the point in question, is "stock" or "web" is conflicting. (CX-204, Waller direct, at 20-22, 41-44; RX-409, Kallmes direct, at 16-17). I find that the specification of the suit patent supports the position that the material in the wire sandwich as it passes over the shoe on respondents' devices is "stock" within the broadest use of that term within the suit patent.

65. The language of the specification indicates that the suit patent often uses the term "stock" in a very broad, inclusive, sense. It is agreed between the parties that the patent treats the words "stock", "web stock" and "web forming stock" synonymously. (Waller, Tr. 94; RF 95). The patent also uses the term "newly forming web" interchangeably with these terms in some places. For instance, at Col. 15, lines 56-60, the specification speaks of the "newly forming web" at drainage points A1 and A2, which are within the nip and before the shoe. (See also, Col. 12, l. 65-71; Col. 18, l. 74 - Col. 19, l. 2). Other language of the specification calls the materials in this area of the former, and well beyond this point, "stock." (Col. 17, l. 22 et. seq.; Col. 18, l. 45-48). Also, in connection with Fig. 8 of the patent, the specification refers to the materials in the area of convergence of the wires (within the nip) first, as "stock," and then as "newly forming web." (Col. 18, l. 45-48, and Col. 18, l. 74 - Col. 19, l. 2). At the same time, however, the term "newly forming web" is also used interchangeably with "web" at other places in the specification. For example, Col. 17, lines 64 et seq., talks about a "sandwiched web" at the point of the beginning of the following roll. Also, Col. 19, lines 43 et. seq., states that the following roll receives the "wire-web-wire sandwich." Again, at Col. 20, lines 50-61, the specification refers to the "web" at the following roll. However, Col. 16, lines 7-12, speak of the sandwich arrangement at the point of the "de-

watering roll" as a "newly forming web" and Col. 13, lines 56-63, state, "Further, at this stage of the forming zone, the newly forming web will still be in a relatively fluid stage ... as [it travels] over the curvature of the roll 219 [the following roll] ...." (Emphasis added). Furthermore, the term "stock" is sometimes applied to the sandwiched materials found in areas of the former where other patent references speak of "web." For example, the specification, in at least two places, uses the term "stock," to describe the materials traveling over the "bi-radii path" or the "guide elements," which include both the curved stationary shoe and the following roll. (CX-1, Col. 21, l. 73 et seq.).9/

66. The deposition testimony of Mr. Gustafson, one of the inventors noted on the '758 patent, further reveals his tendency to use the term "stock" in a very broad sense. In testifying to the condition of the materials at the point of tangency with the "couch" roll (the following roll), after the shoe, he describes such materials as "stock." (RX-390, at 213). He admits that the materials at this point consist of a "top mat" and a "bottom mat" with a "slurry" in between. (RX-390, at 213). He also admits that the middle portion of this sandwich has thickened somewhat and may have some orientation of the fibers (RX-390, at 214, 218), but he maintains that it is still "stock" until it has a sheet structure which can support itself (RX-390, at 212-18).

9/ The only places where the specification clearly uses the term "stock" in a restrictive manner are those points where it speaks of the "jet stream" of stock being discharged into the entrance nip. There it is clear that "stock" refers to the substantially homogeneous mixture of water and fibers as it is discharged from the headbox. (Waller, Tr. 166-68; RX 390, Gustafson dep., at 133-37; RX-409, Kallmes direct, at para. 34).

67. In view of these facts, it appears that when the claims of the patent state that the forming wires shall be "arranged to travel over said curved stationary surface downstream of said entrance nip while having stock therebetween," the term "stock" is used at this point in a very broad sense to describe the condition of the paper forming materials before they are fully formed into a defined mat (one with no appreciable lack of formation in the middle, at which point the sheet structure can support itself). (Findings 64 - 66). As the materials reach the shoe in respondents' accused devices they have been dewatered of about 73% of the original water from the slurry in the headbox. (CPX T). At this point, though, such materials still consist of about 50 parts water to 1 part solids and still have a great deal of fluid in the middle portion. (Waller, Tr. 78-79, 478-80). I find, therefore, that such materials are still "stock" as that term is used in this portion of the claims relating to the state of the paper forming materials as they pass over the curved stationary surface.

68. Lastly, respondents argue that the accused devices do not infringe the '758 patent because the wires do not pass over surfaces of ever decreasing radius. This argument is based on the fact that in the accused devices the wires first wrap a portion of the forming roll (having a relatively small radius of curvature) then pass over, on the other side, the large radius curved stationary shoe followed by a relatively small radius roll. (CPX T; RF 129). In support of this argument, respondents cite to a portion of the specification of the suit patent which notes that it is an advantageous

feature of the patent device that there is no reverse wrap in the path of the wire travel. (RF 131). The lack of such a reverse wrap is not an element of the claims of the '758 patent. Therefore, this configuration of the accused devices would not distinguish them from the patent device were it not for the effect this configuration has on the requirement of "adjacency" of the nip and the shoe, which is an element of each of the claims in issue. As noted above, in Findings 43-55, the wrap of the wire sandwich around the forming roll in respondents' Sym-Former R and New Sym-Former necessarily destroys any relationship between the nip and the curved stationary surface in these devices. Therefore, such devices do not read on the suit patent.

H. Equivalency

69 Complainant maintains that even if literal infringement does not exist, respondents' accused devices infringe the '758 patent under the doctrine of equivalents. (CB at 33). To find infringement under that doctrine, as complainant admits, it is necessary to find that the accused product

> performs substantially the same function in substantially the same way to obtain the same result as the claimed product. (CB at 33, citing Hughes Aircraft Co. v. U.S., 219 U.S.P.Q. 473, 480 (C.A.F.C. 1983).

70. In view of Findings 71-75, below, I cannot find infringement herein under the doctrine of equivalents, since respondents' devices do not perform substantially the same functions in substantially the same way.

71. The suit patent herein provides for a "Twin-Wire Web Forming System With Dewatering by Centrifugal Forces." (CX-1, Col. 1, l. 2-3). Its principal components include a gradual "entrance nip" for receipt of the jet stream of stock, a large radius stationary curved surface adjacent the entrance nip which helps shape the nip and provide for gradual dewatering, and a smaller radius rotary cylinder following the stationary shoe and positioned on the same side of the wire as the shoe. (CX-1, Col. 22-24). The path of the twin wires "with stock sandwiched therebetween" is designed so as to provide for free centri-

fugal dewatering through the top wire as it passes over the curved stationary surface and following roll. (CX-1, Col. 22, l. 64-66; Col. 23, l. 64-66; Col. 24, l. 24-25; CX-204, Waller direct, at 16-18). The twin-wire formers covered by the suit patent, just as all twin-wire formers, were intended to provide better paper formation, including the elimination of two-sidedness of the paper. (CX-204, Waller direct, at 11, 18; RX-152-154; RX-409, Kallmes direct, at 5-6). The combination of the gradual entrance nip, the curved stationary surface "adjacent" the entrance nip, and the smaller radius cylinder following the shoe were the features which distinguished the patent devices from other twin-wire formers. (RX-152-154; CX-204, Waller direct, at 16-20).

72. In the suit patent devices, the curved stationary shoe and following roll represent the primary dewatering devices. In such formers, essentially all of the free water is removed from the stock by the end of the bi-radii path around the shoe and the following roll. (RX 390, Gustafson dep., at 211; Waller, Tr. 227). In fact, in the Bel Baie II, up to 90% of the water is removed as the wire-stock-wire sandwich travels over the curved stationary surface. (CPX D).

73. Also, in the suit patent devices it is important to avoid pumping, or pressure pulses, in the stock as it passes over the curved stationary surface. (CX-1, Col. 12, l. 3-26, 41-58). In fact,

even in embodiments where the curved stationary shoe is slotted, it is important that it be designed in such a manner so as to minimize pressure pulsation. (RX-390, Gustafson dep., at 419-20).

74. In the accused devices of respondents, dewatering and sheet formation take place in a substantially different manner. The curved stationary surface and the following roll are not the primary dewatering devices in the Sym-Former R and the New Sym-Former. Indeed, about 73% of the water in the stock is removed before the paper forming materials even reach the shoe. (CPX T; Waller, Tr. 195). Only 16% of such water is removed as the materials pass over the shoe in these devices, and only 3% is removed over the following roll. (CPX T).

75. Furthermore, in the Sym-Former R and the New Sym-Former, one of the principal purposes of the shoe (which is bladed) is to create pressure pulses in the newly forming web, so as to redistribute the fibers and fine particles therein, thus improving the formation of the finished sheet. (RX-250, Hujula direct, at 23; Finding 38, above). Such pressure pulses are in sharp contrast to the need to avoid such pulsing in the patent devices. (Finding 73, above). Thus, in this additional manner, the functions and performance of the accused devices differ from those of the suit patent device. (See Findings 165-166, below).

V. VALIDITY OF THE '758 PATENT

A. Background

76. The art of papermaking can be traced back several thousand years to the ancient Chinese. In the modern era, the most significant lasting innovation in papermaking was the development of the fourdrinier forming section in France in about 1799. This type of forming section was continuously used in some fashion for the succeeding one hundred and fifty years. (Waller, CX-204, pp. 11-12; Kallmes, RX-409, pp. 3-4).

77. The formation of paper begins with an extremely diluted slurry made up of water and fibers. In order to transform this slurry into paper, the water must be removed in such fashion that a consolidated web of fibers is created in the form of a sheet. A fourdrinier forming section achieves this objective by means of a continuously moving, slightly inclined, substantially flat looped belt made of woven wire or screen onto which stock is deposited from a headbox. Initially, water is drained downwardly through the wire by means of gravity, which may be aided by the use of vacuum or suction. After this first stage of dewatering, the resulting web is transferred to a press section and then to a dryer. (Waller, CX-204, pp. 11-12; Kallmes, RX-409, pp. 3-4).

78. The improvements made to fourdrinier forming sections were directed toward dewatering the stock more quickly so as to attain a higher speed of operation. Nevertheless, certain drawbacks were inherent in forming paper on a fourdrinier, particularly at high speeds. Above a certain speed on a fourdrinier former, the resulting paper was rough on the upper free surface due to waves generated by rapid movement of stock on the wire. In addition, paper made on a fourdrinier was characterized by sheet two-sidedness and lack of fine formation. Fines are shorter fibers in stock which tend to migrate with the moving water as it drains from the stock. Fillers are also added to pulp fibers in order to assist in web formation. In the production of printing grades of paper such as newsprint and bond it is important that the fines and fillers be evenly distributed throughout the thickness of the paper. On a fourdrinier forming section, the fines tend to gravitate toward the wire during dewatering, resulting in two-sided paper. Two-sidedness refers to the difference in two sides of a sheet of paper in terms of the distribution of fines and fillers. If fines and fillers are not evenly distributed, the paper will tend to lint, and one side of the paper will be more receptive to ink than the other. (Waller, CX-204, pp. 12-13; Kallmes, RX-409, pp. 4-5).

79. In order to overcome the limitations of the fourdrinier forming

section and to increase production speeds, a twin wire former was developed and put into commerical operation in England in the early 1950's. With a twin wire former, a jet stream of stock is deposited by the headbox between two converging wires which sandwich the stock and allow drainage in both directions through the wires. By dewatering the stock in two directions, the problem of sheet two-sidedness could be overcome by achieving an even distribution of fines and fillers throughout the sheet. When both sides of the sheet have comparable surface qualities, the sheet is referred to as being one-sided, and is suitable for printing purposes. (Waller, CX-204, pp. 14-15; Kallmes, RX-409, pp. 6-7).

80. The early development of twin wire formers still exhibited certain drawbacks in speed and paper quality. At certain speeds, the converging wires were unable to accept the volume of stock ejected from the headbox, which resulted in flooding and spewing. In addition, dewatering would be achieved so quickly that many of the fines particles in the stock would be drained through the wires with the water, resulting in poor paper quality. Thus, the objectives in the development of twin wire formers were to arrange the convergence of wires so as to accommodate high volumes of stock moving rapidly without flooding or spewing, and to control the rate of dewatering so as to retain the fines particles in the web. (Waller, CX-204, pp. 15-16; Kallmes, RX-409, p. 7).

B. Invention of the Suit Patent

81. U.S. Letters Patent 3,726,758 ('758 patent), entitled "Twin-Wire Web Forming System with Dewatering by Centrifugal Forces," issued on April 10, 1973 to the inventors Joseph D. Parker and David R. Gustafson, who in turn assigned this patent to complainant Beloit Corp. (CX-1, 2; RX 126).

82. Mr. Gustafson began to work for Beloit in 1958 at a time when Beloit was developing an early twin-wire former, the Inverform. In this type of twin-wire former, the slurry was deposited by the headbox onto a fourdrinier forming wire. Some distance down the fourdrinier wire from the headbox, the top wire Inverform unit was mounted above the bottom wire in such fashion that the top wire was guided around an open breast roll in convergence with the bottom wire. With this unit, the slurry would not only be dewatered through the bottom wire, but drainage would also occur upwardly through the top wire and breast roll. (Gustafson, Tr. 1487-89; CX-205, pp. 1-3; CPX NN).

83. In about 1961, Beloit began development of the Twinverform forming section, which was designed to be used with a high turbulence headbox. The Twinverform was arranged so that the top wire unit was mounted in close proximity to the headbox with the objective of maximizing fiber dispension and suppressing turbulence from the headbox. A slotted drainage element was placed near the headbox in the loop of the top wire. This convexly curved shoe was parabolically shaped to have a

short radius at the beginning following by a long radius at the end. Dewatering on this machine occurred very rapidly in both directions, so that approximately 60-70% of total drainage took place over about two feet in length. The shape of the curved shoe was designed to correlate to the natural drainage properties of the fiber suspension. (Gustafson, Tr. 1490-91, 1493-94; CPX NN). Beloit obtained several patents on the Twinverform configuration, including Canadian Patent No. 869,266 to Gustafson, which utilized a slotted curved stationary shoe, and British Patent No. 1,129,893 and French Patent No. 1,473,988 to Justus which utilized a solid curved stationary shoe. (RX-147, 148).

84. In 1967, Beloit was interested in designing formers to manufacture multi-ply board grades. An experimental machine having an Inverform configuration had been set up at Beloit's affiliate in England. Mr. Gustafson and Mr. Parker went to view Beloit's pilot machine in Bolton, England in late 1967. The machine which they saw was arranged on a wrap roll concept, in which the stock was discharged from the headbox directly into a nip formed by the convergence of two wires wrapping opposing rolls. The output from this machine was unsatisfactory because the capacity of the nip to receive stock was limited, resulting in rejection of stock and slow speeds. (Gustafson, Tr. 1496-99, CX-205, pp. 4-5; CPX NN).

85. To solve the problems of spewing and limited speed, Mr. Gustafson proposed installing a curved shoe leading up to the solid wrap roll in order to allow

a more gradual build-up of pressure to prevent spewing. Mr. Parker proposed that the curved shoe should be adjacent the roll so that there would be continuous support of the wires to prevent any separation. These proposed changes were carried out at Bolton with the assistance of George Sheldon, Mike McCormick and George Chapman. These changes were quite successful in overcoming the problem of spewing, because the large radius curved shoe followed by the smaller radius wrap roll allowed an initial small buildup of pressure between the wires at the entrance of the nip. Tension would then increase on the smaller radius of the roll, and drainage would occur at a point at which the mat strength was sufficient to withstand the pressure without rejection. (Gustafson, Tr. 1499-1502; CX-205, pp. 5-7; CPX NN).

86. Due to the initial success of the curved shoe at Bolton, further development work was done along these lines. A patent application for this development was filed in England on January 24, 1968. Figure 2 of the British patent application discloses the structure conceived by Mr. Gustafson and Mr. Parker in November 1967. (Gustafson, Tr. 1502-03; RX-135).

87. The British patent application was filed by Beloit's British patent agent, Mr. A.T. Ranson. Due to the fact that the inventors of the subject matter were not domiciled in Britain, Mr. Ranson filed the

application in his own name as communicatee of Beloit. In preparing this application, Mr. Ranson obtained necessary information from Mr. Chapman at Bolton, who had assisted in the construction of the structure conceived by Messrs. Parker and Gustafson. (CX 7; Ranson, CPX G, p. 14; RX-135).

C. Prosecution History of the '758 Patent

88. On January 21, 1969, Beloit filed an application in the United States Patent and Trademark Office (PTO) for a patent on multi-ply web formation, Serial No. 792,713 ('713 application). In this application it claimed the priority date of its British application of January 24, 1968. The drawing of Figure 3 in the '713 application corresponds in all material respects to Figure 2 of the British application. (Kallmes, Tr. 1117; RX-135, 378).

89. Figure 3 of the '713 application, which later matured into Figure 3 of the '758 patent, depicts a twin-wire former in which the wires are arranged to converge and provide an entrance nip for the reception of stock and in which a curved stationary shoe is positioned immediately adjacent to a rotary cylinder in such fashion that the wires converge over the curved stationary shoe to form an entrance nip. The curved stationary shoe has a larger radius than the adjacent rotary cylinder. Thus, the wires follow

a bi-radii path of travel as they move over the curved stationary shoe and the rotary cylinder. The top wire is free of restraining means as it travels over the rotary cylinder, and on this path of travel the stock sandwiched between the wires will be dewatered centrifigually through the top wire as it passes over the rotary cylinder. Figure 2 of the British application and Figure 3 of the '713 application contain every element of claims 1, 2, 3, 4, 7, 8 and 10 of the '758 patent. (CX 1; RX-135, 378).

90. In an Office Action of August 26, 1970, the patent examiner rejected all of the initial claims, citing several prior art references as rendering the claimed invention unpatentable under 35 U.S.C. 103. (RX-378).

91. U.S. Letters Patent No. 3,311,533, issued March 28, 1967 to de Montigny covers an apparatus for making formed fibrous webs. The examiner of the '713 application noted that the de Montigny patent discloses, particularly in Figure 2, an apparatus for producing fibrous webs which includes a headbox, forming wires, guide rolls, and forming cylinder. The headbox directs stock into the nip between the wires as they wrap around the cylinder. De Montigny further discloses that the wires are arranged to travel around part of the first rotary cylinder to provide a first zone through which water will be expressed outwardly through the first wire and

inwardly into the foraminous cylinder. The wires then travel around a significant portion of the periphery of a second foraminous rotary cylinder (approximately 180 degrees). The second cylinder applies a low pressure air flow outwardly on the wire. Thus, de Montigny accomplishes centrifugal dewatering of the stock by means of passing the wires in a reverse wrap around two rotary cylinders. (RX-267, 378).

92. In response to the examiner's rejection, Beloit filed an Amendment "B" on October 16, 1970, in which the claims were amended, and in which Beloit referenced an interview held between the examiners and applicant's attorneys. The invention of the '713 application was distinguished over de Montigny on the basis that it was "patentably distinct to provide a stationary shoe in combination with the roll wherein the shoe is an extension of the roll surface to provide a longer dewatering surface." (RX-378).

93. De Montigny teaches the configuration of a twin-wire former in which dewatering of the stock is accomplished through both wires, and in which the configuration of the rotary cylinders accomplishes centrifugal dewatering by means of a reverse wrap of the wires around the cylinders. This dewatering is also aided by the application of air pressure and suction on the wires as they travel around the rotary cylinders. There is no teaching in de Montiguy of the placement of a curved

stationary surface adjacent the entrance nip and in close working relation with a rotary cylinder on the same side of the wires, so as to define a continuous, bi-radii path of wire travel having a first radius of curvature substantially larger than a second radius of curvature. (RX-267).

94. In the Office Action of August 26, 1970, the examiner also rejected certain claims under 35 U.S.C. 103 as unpatentable over Graham I. (RX-378).

95. U.S. Letters Patent No. 3,400,045, entitled Pressure Forming Apparatus for Making Paper, issued on September 3, 1968 to J.B. Graham (Graham I). In the rejection of the claims of the '713 application, the examiner noted that Graham I discloses, particularly in Figure 2, a paper forming apparatus wherein a headbox discharges slurry between a forming wire and a felt, the wire and felt both wrapping the upper down-running quadrant of the rotary cylinder immediately following the headbox. In response to the examiner's rejection, Beloit set forth the same argument in its Amendment as it had with respect to de Montigny. (RX-367, 378).

96. The Graham '045 patent discloses a papermaking machine utilizing a wire and a felt to sandwich the stock in the forming section. The headbox discharges stock into the nip formed by the convergence of the wire and felt on the rotary cylinder. With the wire situated outermost, the wire and felt immediately travel

around at least 90 degrees of the rotary cylinder. Dewatering occurs around the cylinder outwardly through the wire due to tension and centrifugal force. However, in dewatering by centrifugal force, the wire-web-felt sandwich is not bent reversely from its curved configuration in passing around the slice roll. (RX-367., Col. 1, 1, 53-59). The Graham I patent does not disclose the placement of a curved stationary surface adjacent the entrance nip and in close working relation with a rotary cylinder so as to define a continuous, bi-radii path of wire travel having a first radius of curvature substantially larger than a second radius of curvature. (RX-367).

97. In the Office Action of August 26, 1970, the examiner also rejected original claims 23 and 25 as unpatentable over Graham II. (RX-378).

98. U.S. Letters Patent 3,326,745, entitled Apparatus for Forming Paper Between a Forming Wire and Felt, issued on June 20, 1967 to J.B. Graham (Graham II). The examiner of the '713 application noted that Graham II discloses a paper forming apparatus wherein a headbox discharges slurry between a forming wire and a forming fabric, the forming fabric wrapping an elongated curved plate, and the forming wire wrapping two guide rolls. In response to this rejection in Amendment B, applicant distinguished Graham II on the same basis as de Montigny and Graham I. (RX-268, 378).

99. Graham II discloses a paper making apparatus consisting of a wire and a felt situated in such fashion that the wire and the felt provide a tapering cavity between them into which paper stock is discharged. A supporting shoe is provided on the felt side of the tapering cavity. This shoe may either be a flat backing plate, or it may be a plate having a convex external surface of gradually decreasing radius. The curved plate is followed by a roll around which the wire and felt travel with the wire being outermost. Dewatering around the curved plate and the roll is accomplished by centrifugal force, as the pressure increases due to increased wire tension and decreased radius of curvature. (RX-268).

100. Although Graham II discloses gradual build up of pressure by means of a curved stationary plate of decreasing radius immediately followed by a roll, in Figures 2 and 3, the curved path of wire travel is defined by the curve of the plate, and not by a close working relationship between the plate and the cylinder. Thus, centrifugal dewatering will occur through the wire as it passes around the curved plate, and the following roll does not play any part in centrifugal dewatering. In addition, Graham II requires the use of a wire and a felt, thus dewatering occurs only in one direction, through the wire. (RX-268).

101. In the Office Action of August 26, 1970, the examiner also cited as prior art U.S. Letters Patent 2,881,678 to Thomas, and U.S.

Letters Patent 3,215,593 to Green. In distinguishing these patents from the invention disclosed in the '713 application, Beloit relied on the same arguments presented with respect to de Montigny and Graham.

102. U.S. Letters Patent 2,881,678 issued on April 14, 1959 to R.J. Thomas. This patent discloses a twin-wire forming apparatus substantially of the design of the Inverform, that is, a top wire mounted above a substantially horizontally inclined fourdrinier wire so that the convergence of the wires creates a nip near the headbox. As the top wire travels around the cylinder, suction is induced by the rotating roller, and a slice is positioned downstream of the rotary roller to remove water that is drained in an upward direction. The path of travel of both wires along the forming zone is essentially flat. Thus, there is no curved stationary element positioned adjacent the nip in close working relation with the rotary cylinder, and no centrifugal dewatering occurs. (RX-368).

103. U.S. Letters Patent 3,215,593, entitled Headbox for Twin Wire Papermaking Apparatus, issued November 2, 1965 to M.S.Green. In rejecting original claims 18-20 as obvious over Graham II in view of Thomas and Green, the examiner of the '713 application

noted that Green discloses the use of deflector blades on both sides of a twin-wire formation zone. The examiner considered that in light of Green it would be obvious to one of ordinary skill in the art that deflectors could be used in the Graham II environment adjacent both forming wires since they would merely enhance web formation. In Amendment B filed by applicants in response to this office Action, original claims 18-20 were cancelled. (RX-369, 378). The patent to Green primarily concerns the construction of headbox means, which are not at issue in this investigation.

104. Following applicant's filing of Amendment B on October 16, 1970, in response to the August 26, 1970 Office Action, and a telephone interview with applicants' counsel on November 16, 1970, the claims were considered to be allowable. On July 8, 1971, applicant filed an express abandonment of the '713 application, without abandoning the invention, in favor of the co-pending application for "Twin-Wire Paper Forming System with Dewatering by Centrifugal Forces," which ultimately issued as the '758 patent. This later application was a continuation-in-part of the '713 application. (RX-378).

105. On February 3, 1969, Messrs. Parker and Gustafson filed a patent application in the PTO for issuance of a patent designated as "Improved Paper Forming Arrangement," Serial Number 795,954 ('954 application).

This application contained fifteen claims and was accompanied by three drawings which later became Figures 5, 6, and 7 of the '758 patent. (RX-377).

106. In an office action of September 21, 1970, the examiner rejected all of the claims under 35 U.S.C. 103, citing as prior art Graham II, U.S. Letters Patent 3,382,143, to Justus and U.S. Letters Patent 2,688,276 to Showers. The rejection over Showers concerned claims relating to a headbox. These claims are not at issue in this investigation, thus the Showers patent will not be considered herein. (RX-371, 377).

107. The examiner of the '954 application noted that Graham II, particularly in Figure 2, discloses a paper forming apparatus which includes opposed rolls, a rigid plate, rolls, and a headbox which discharges stock into a cavity formed between a forming wire and a fabric as they wrap the rolls and pass over the plate. In addition, the plate is disclosed as being a curved surface. The examiner additionally rejected the claims as unpatentable over Graham in view of the Justus '143 patent because Justus discloses a paper forming apparatus in which a stock inlet discharges slurry into a formation zone between two forming wires as they pass along a curved surface of a foil suction box, which box functions

to aid dewatering of the web being formed between the wires. The examiner considered that it would be obvious to one of ordinary skill in the art that if additional dewatering capabilities were desired in the Graham II formation apparatus, the curved plate could be a water permeable surface as taught by Justus. (RX-268, 370, 377).

108. On February 19, 1971, applicants filed Amendment "A" in response to the examiner's rejections. The original fifteen claims were cancelled and eleven new claims were proposed in their place. Applicants further indicated that the '954 application was a continuation-in-part of the earlier '713 application. The new claims presented in this amendment were designated "Jepson-type" claims based on the allowed claims of the parent application. The subject invention was distinguished from Graham II on the basis that Graham II does not suggest or relate to twin-wire paper formation, since it requires the use of a wire and a felt, so that drainage is attainable only from one side. In addition, Graham II does not suggest using the combination of a curved plate or shoe and a roll to define a continuous bi-radii path of travel. (RX-377).

109. Graham II is entitled "Apparatus for Forming Paper Between a Forming Wire and Felt." In the abstract of the disclosure,

it is stated that the wire and felt are situated so as to provide a tapering cavity into which stock is discharged, "with a supporting shoe being provided for the portion of the felt forming one side of the tapering cavity to prevent undue flexing of the felt. The supporting shoe may be either in the form of a flat backing plate or a plate having a convex external surface of gradually decreasing radius." In Figure 2, it is shown that the wire and felt travel around the plate, which is initially straight and then defines a curve of gradually decreasing radius. The wire and felt then pass around a relatively small guide roll. As the web leaves the forming section and passes to the press section, the web remains on the underside of the felt when the wire and felt separate. The backing plate is impermeable and is provided behind the felt due to the fact that felt is more elastic than forming wire, and that less tension is maintained on the felt than on the wire. Thus, the backing plate prevents bowing of the felt. (RX-268, Col. 3, l. 39-53).

110. Of the art cited by the examiner, Graham II is the most pertinent, by reason of the fact that it teaches the use of a curved surface of gradually decreasing radius to effect a gradual build-up of pressure and to achieve centrifugal dewatering around the curvature of the shoe. Nevertheless, there are significant differences between Graham II and the suit patent.

Most importantly, Graham II is concerned with paper formation between a wire and a felt. Thus, it does not involve twin-wire paper formation. As a result, although dewatering is carried out by centrifugal force under a similar principle to that disclosed in the suit patent, dewatering only occurs in one direction through the wire. Graham II further discloses that the backing plate is provided to prevent bowing of the felt, due to the fact that felt is more elastic than wire and has less tension maintained on it. Thus, the backing plate must be solid to provide necessary support to the felt, and a permeable curved element or suction box would not be appropriate to the Graham II configuration. Finally, the placement of the cylinder following the backing plate is significantly different from the arrangement of the suit patent. In Figure 1A of Graham II, a relatively large cylinder immediately follows a straight backing plate, and the wire and felt converge on the roll rather than on the backing plate. In Figures 2 and 3 of Graham II, the curve of decreasing radius is defined only by the curved plate. The roll which follows this curved plate is of relatively small diameter, serving the function of a guide roll, rather than defining a continuation of the curve of the backing plate. Thus, in each embodiment disclosed in Graham II, the curved shoe and adjacent roll are not situated in close working relationship so

as to define a continuous bi-radii path of wire travel. (CX-1; RX-268).

111. U.S. Letters patent 3,382,143, issued May 7, 1968 to Justus and Gustafson, is entitled "Paper Forming Assembly and Method." In the abstract of the disclosure it is stated that the invention relates to a plural wire web forming device in which "a web forming zone is defined between converging forming wires by the use of curved, stationary, permeable guide means acting against one wire to urge such wire through an elongated substantially curved path and into convergence with the opposite wire under tension." Figure 1-B of the Justus '143 patent discloses that the top wire travels around a curved stationary shoe to converge with the bottom wire, which passes around a breast roll situated beneath the curved stationary shoe so as to define the entrance nip. The upstream end of the stationary shoe forms a parabolic curve defining the path of travel of the upper wire. The bottom wire does not travel around the curve of the stationary shoe. The stationary shoe is water permeable downstream of the curved portion, thereby allowing upward drainage through the top wire. The bottom wire is free of restraining means as it travels past the opposing stationary shoe. Following the convergence of the wires, the path of travel of both wires along the stationary shoe is flat. (RX-370).

112. Thus, there is no disclosure in the Justus '143 patent of a curved stationary shoe positioned in close working relationship with an adjacent rotary cylinder such that the wires follow a bi-radii path of travel with the first radius of curvature being substantially larger than the second radius of curvature. (CX-1; RX-370).

113. On April 2, 1971, applicants filed a Voluntary Amendment with the PTO in further response to the September 21, 1970 Office Action, an interview of January 12, 1971 and subsequent telephone conferences with the examiner. In this amendment, certain claims were amended, including claim 16, to indicate that the curved stationary surface is adjacent to the entrance nip; and claim 20 to include the improvement of arranging the stationary surface and a rotary cylinder so as to define a continuous bi-radii curved path of travel having a first radius of curvature substantially larger than a second radius of curvature. With respect to the positioning of the curved stationary surface and the rotary cylinder to define a continuous bi-radii path of travel, applicants indicated their belief that "[i]n circumstances where the principles of the invention are not altered dewatering elements might be positioned in the space between the curved surface and the rotary cylinder." (RX-377).

114. On May 4, 1971, the examiner issued certain changes to the application record prior to allowance of the claims. In this communication, the examiner amended the abstract of the disclosure and changed the title

of the invention to the title of the suit patent. In response to applicants' contention that dewatering elements could be positioned between the curved stationary shoe and the rotary cylinder, the examiner noted that the specification does not state that an additional structure may be so positioned, and that the specification uses the word "immediately" to denote the downstream positioning of the cylinder with respect to the curved surface. The examiner also cited as prior art references the patent to de Montigny and U.S. Letters Patent No. 3,262,841 to Embry as showing twin-wire papermaking systems wherein the wires partially wrap cylindrical forming rolls in order to dewater the sheet between the wires. However, these references were not considered to render the subject invention unpatentable because no elongated curved surface preceding the rolls was used in either patent.(RX-377).

115. On May 4, 1971, the examiner issued a notice of allowance of all claims. On May 27, 1971, applicants filed an Amendment Under Rule 312 to make certain minor corrections. In addition, with respect to the placement of dewatering elements between the stationary element and the rotary cylinder, applicants stated:

> It is to be noted that the specification does not state that additional dewatering structure can not be positioned between the curved surface and the rotary cylinder. ... [T]he invention is not limited to the specific form disclosed but covers all modifications changes and alternative constructions falling within the scope

> and principles of the invention. Positioning of additional dewatering elements between the curved surface and the cylinder without altering the continuous "bi-radii" path of travel is certainly within the scope and principles of the invention. The word "immediately" merely indicates a preferred location of the cylinder and implies that there are other arrangements possible. Additionally, the disclosure ... further states that the rotary cylinder is positioned in close running relationship with the curved wire guide surface so as to provide essentially continuous path of travel. Elements positioned between such curved surface and rotary cylinder which do alter this continuous path of travel are not excluded from the scope of the invention, particularly since all of the claims utilized "open" terminology. (Emphasis in original).

On June 11, 1971, the examiner entered the Amendment Under Rule 312 "as directed to matters of form not affecting the scope of the invention." (RX-377).

116. In an internal memorandum addressed to the file of the '954 application of January 20, 1971, it was stated by Mr. Munday of Beloit's patent department that the patent would cover the interposition of a flat suction box between the shoe and the rotary cylinder, on the theory that straightening out the latter part of the shoe would provide an infinite radius, which would be larger than the radius of the roll. (RX-458).

117. This theory is rejected on the basis of Mr. Gustafson's deposition testimony that he did not equate a flat surface with a curved

surface of infinite radius. This position is additionally inconsistent with applicants' initial statement in their application that the stationary curved surface should have a decreasing radius of curvature. Although, in their amendment of February 19, 1971 applicants indicated that they no longer placed this limitation on the curved element, "since the invention encompasses any type of curved surface," the prosecution history of the patent does not support the broad interpretation proposed by Mr. Munday. Thus, any dewatering element placed between the curved stationary surface and the rotary cylinder will come within the claims of the patent only if it does not disturb the continuous bi-radii path of travel between the stationary surface and the cylinder. (RX 377; Gustafson, RX-390, at 550-53).

118. In the Office Action of May 4, 1971, the examiner cited as prior art U.S. Letters Patent No. 3,262,841 to Embry, issued July 26, 1966. The purpose of this invention was to provide a high speed fourdrinier type machine in which effective drainage of water could be achieved without the use of suction boxes, and in which water could be removed from both sides of the sheet at a higher rate than was previously known. Under the configuration disclosed by Embry, substantial dewatering through both wires is effected by means of centrifugal force. In Figure 1 it is shown that stock is deposited from the headbox onto the bottom fourdrinier wire. The top wire wraps around a guide roll a short distance from the headbox and gradually converges

with the bottom wire along the flat fourdrinier table. Three relatively small deflector rolls are positioned to carry both wires around a 90 degree curve. The specification discloses that the three deflector rolls could be replaced by a single large cylinder. (RX-270, Col. 3, l. 8-14). As the wires travel around the 90 degree curve, the top wire is free of restraining means. Substantial dewatering by centrifugal force occurs through the top wire. At the end of the third guide roll the wires travel in a downward vertical direction and are guided around another cylinder of relatively large radius, traveling around 90 degrees of its periphery. As the wires travel around this cylinder, centrifugal dewatering occurs through the bottom wire. Thus, Embry achieves centrifugal dewatering by means of a reverse wrap. The Embry patent does not disclose a curved stationary survace in close working relation with a rotary cylinder to define a continuous bi-radii path of wire travel having a first radius of curvature substantially larger than a second radius of curvature within the meaning of the '758 patent. (CX-1; RX-270).

119. On July 8, 1971, applicants expressly abandoned the '954 application without abandoning the invention in favor of a co-pending application filed concurrently with the abandonment, which application was identified as a continuation-in-part of the '954 application. (RX-377).

120. On July 8, 1971, applicants filed an application for issuance

of a patent for "Twin-Wire Paper Forming System with Dewatering by Centrifugal Forces," Serial Number 160,879, ('879 application). This application was a continuation-in-part of both the '713 and '954 applications, and applicants claimed the priority date for the common subject matter. In the Voluntary Amendment accompanying the '879 application, it was pointed out that the single application combined the allowed claims of the '713 and '954 applications, and a complete description of the manner of combining the claims, together with changes and additions, was provided. (RX-376).

121. On November 3, 1972, the examiner issued an Office Action making certain minor corrections to the claims and specification. In addition, the examiner noted that some of the references cited by applicants in their Voluntary Amendment accompanying the '879 application were not considered. (RX-376).

122. In the Office Action of November 3, 1972, the examiner listed the following ten references which were considered pertinent to the claimed invention, but the claims deemed patentable thereover: (1) the '533 patent to de Montigny; (2) '045 patent to Graham; (3) '745 patent to Graham; (4) '678 patent to Thomas; (5) '593 patent to Green; (6) '841 patent to Embry; (7) '143 patent to Justus; (8) '276 patent to Showers; (9) U.S. Letters Patent 2,977,277 to Kelly, issued March 28, 1961; and (10) U.S. Letters Patent 3,582,467 to Gustafson issued June 1, 1971. (RX-267, 268, 270, 367-371, 373, 374).

123. For purposes of the present investigation, the most pertinent prior art cited by the examiner and relevant to the claims of the '758 patent at issue consist of the Graham '745 and '045 patents, de Montigny, Embry, and Justus. (RX-267, 268, 270, 367, 370; See Findings 91-100, 106-112, 118 supra).

124. On April 10, 1973, the '758 patent issued from the '713 and '954 applications, abandoned in favor of the continuation-in-part '879 application to Parker and Gustafson, containing eight drawing and twenty-three claims. (CX-1).

D. Priority Date of Invention

125. In the '713 application, Beloit claimed as its priority date the date of filing the British patent application. (See Findings 86-88). The '713 application contained four drawings which became Figures 1-4 in the '758 patent. Figure 3 of the '758 patent corresponds to Figure 2 of the British patent application. (CX-1; RX-135, 378).

126. Every claim of the '758 patent at issue--claims 1-4, 7, 8, 10, 11--includes the following limitation: "said forming wires being arranged to travel over said stationary curved surface downstream of said entrance nip while having stock therebetween." (CX 1, Col. 22, l. 52-24, Col. 23, l. 49-51). The entrance nip begins where the wires approach each other to receive stock therebetween and ends where the wires are in general parallelism. (RX-79, Complainant's response to respondents' interrogatory No. 60(i)). The term

"general parallelism" is synonymous with "substantial parallelism," and is defined in the suit patent as "describing a dynamic concept of two wires spaced apart by a moist web continuously moving closer to each other as water is removed from such a web." (CX-1, Col. 9, L. 19-24). In Figure 3 of the '758 patent, general parallelism of the wires is achieved on the surface of the rotary cylinder. (CX-1, Col. 9, 1. 17-19; Waller Tr. 457). Thus, the entrance nip as shown in Figure 3 begins on the curved stationary shoe, and ends on the rotary cylinder.

127. There is nothing in the suit patent which requires that the claim terminology "downstream of said entrance nip" be defined to mean downstream of the end of the entrance nip. Thus, as shown in Figure 3 of the '758 patent, "downstream of said entrance nip," is interpreted to mean downstream of any portion of the entrance nip, or downstream of the upstream end of the entrance nip. Therefore, as shown in Figure 3, the forming wires do travel over the stationary curved surface downstream of the entrance nip, while having stock therebetween. (CX-1, Fig. 3, Col. 22, 1. 52-54).

128. Figure 3 of the '758 patent embodies all of the claims asserted herein. Therefore, the '713 application described the invention which issued in the '758 patent, and the British patent application also disclosed the invention which matured into the '758 patent. Accordingly, complainant is entitled to claim the priority date

of the British patent application, i.e., January 24, 1968. (CX-1; RX-135, 378).

E. Level of Ordinary Skill in the Art

129. The person of ordinary skill in the art of papermaking technology at the time of the invention of the subject matter of the '758 patent would be an individual with an engineering or similar technical degree in fluid mechanics and mechanical engineering. In addition to this degree, such a person would also have several years of direct experience in the design, manufacture or servicing of headboxes and forming sections, including experience in day-to-day trouble-shooting of on-line machines. Alternatively, a person of ordinary skill in the art could be a paper mill superintendent with at least twenty years of experience. (Waller, CX-204, pp. 7-8; Kallmes, RX-409, pp. 24-25).

F. Prior Art Not Considered by the Examiner

130. U.S. Letters Patent 3,232,825, entitled "Dual Wire Type Paper-Forming Apparatus and Methods of Forming and Dewatering Paper," issued on February 1, 1966 to D.E. Robinson (Robinson patent). The stated object of this invention was "to provide means for gently removing large quantities of water from a paper stock substantially immediately after its discharge from a slice in such a way as to prevent malformation of the web or sheet."

(RX-146, Col. 1, l. 39-43).

131. Although Beloit cited the Robinson patent as prior art in the '954 application, and specifically requested that the examiner review Robinson in its May 27, 1971 Amendment Under Rule 312, there is nothing in the prosecution history of the '758 patent to establish that the examiner actually reviewed Robinson in allowing the claims of the '758 patent. (RX-377).

132. Figure 6 of the Robinson patent is alleged by respondents to anticipate claims 1, 2, and 10 of the '758 patent. (RB. pp. 11-13).

133. Figure 6 of Robinson shows two forming wires, 11' and 12', trained around two impervious breast rolls, 13' and 14' respectively. The breast rolls are adjustably elevated at approximately 15 degrees above the position of the wires at roll C in the plane of paper formation. Roll C is a cellular or other open roll. Stock is ejected from slice 108' and enters between rolls 13' and 14'. (RX-146, Col. 5, l. 65- Col. 6, l. 5; RPX K). The wires 11' and 12' pass through belt converging means 20' and 21' and thereafter partially wrap roll C. Roll C applies pressure to the web to further consolidate it. Openings in the roll surface of roll C conduct water away from the stock and contain the expressed water which cannot be rapidly handled and disposed by suction boxes or other disposal means. (RX-146,

Col. 6, l. 64-72). Cellular roll C is provided with suction means S adapted to remove water expressed from the web through wire 12' by the converging grating assemblies 20' and 21' and by wrapping of the wires 11' and 12' about roll C and to discharge the water into water disposal means 22'. (RX-146, col. 7, l. 7-12). The water expressed through lower wire 11' by the converging grating assemblies 20' and 21' is directed from the wires by gravity or inertia. (RX-146, Col. 7, l. 35-39).

134. The grating assemblies 20' and 21' are referred to by Robinson as belt converging means. The grating assemblies 20' and 21' are mounted between rolls 13' and 14' so as to establish a gradual and controlled convergence of wires 11' and 12'. (RX-146, Col. 3, l. 25-32, 39-42; RPX K). In all figures in which elements 20' and 21' appear, these grating assemblies are straight. (RX-146, Figs. 1, 4, 6, 7).

135. Robinson provides in one embodiment of the invention, "one or more novel belt-converging means such as the grating assemblies 20' and 21'. (RX-146, Col. 3, l. 28-29). Throughout the specification, grating assemblies 20' and 21' are referred to conjunctively, as an inseparable pair. (RX-146, Col. 3, l. 35, 39-42, 66-69, Col. 4, ll. 3-6, Col. 6, l. 14-49, Col. 6, ll. 9-10, ll. 35-37). The function of the belt-converging means 20' and 21'

is to provide a gradual and controlled convergence of the wires so as to express water from the stock sandwiched in between the wires. A common meaning of the term "converge" is "to incline toward each other." (Random House College Dictionary, Rev. Ed.). This meaning implicitly requires at least two elements in order to converge. Thus, in view of the ordinary meaning of converge, and the function of the grating assemblies 20' and 21', acting together, as belt converging means, Robinson requires that they appear as a pair on opposing sides of the converged wires--where grating assembly 20' appears, it must be paired with grating assembly 21'. Thus, the language cited above, "one or more novel belt converging means ..." simply states that one or more pairs of such "belt converging means" may be used, in series, to express water from the sandwiched stock. (RX-146, Figs. 1, 2, 6, 7).

136. Figure 4 of Robinson discloses the construction of grating assemblies 20' and 21'. (RX-146, Col. 4, l. 10-16, 53-56). Robinson discloses that the edges 30 and 31 of the belt converging means 20' and 21' may "be contoured so that the rate of belt convergence is not constant along their length. For example, a slight convexity of the edges 30 and 31 towards the belts 11 and 12 may be desirable in many cases, so that the belts converge somewhat more rapidly in the vicinity of the upstream portions of the blades 26 and 28 than in the vicinity of the downstream portions." (RX-146, Col. 4, l. 70- Col. 5, l. 2; Fig. 4). Professor Waller interpreted this to mean that the shape of the surface of the blades would

be slightly rounded at the leading edge, and then straight in the downstream direction of the grating assemblies. (Waller, Tr. 245). The foregoing language, read together with Figure 4, suggests that the leading edges of the grating assemblies may both be slightly convexly curved toward each other and toward the wires 11 and 12, but that the grating assemblies themselves are straight.

137. The arrangement disclosed in Figure 6 of Robinson as described in the specification does not have a curved stationary surface positioned adjacent the entrance nip, the first wire is not free of restraining means on its outer surface opposite the rotating cylinder, and there is no close working relation of a curved stationary surface with a rotary cylinder positioned downstream to define a continuous bi-radii curved path of wire travel having a first radius of curvature substantially larger than a second radius of curvature. (CX-1; RX-146).

138. On the basis of the foregoing findings, Figure 6 of Robinson does not anticipate any claims of the '758 patent. In the event that centrifugal dewatering around roll C, with the assistance of gravity, may be inherent from the structure disclosed in Figure 6, the patent specification does not expressly teach centrifugal dewatering, and it is not an objective of the disclosed invention to accomplish dewatering by this means. Thus, Robinson is no more pertinent than the prior art cited by the examiner, particularly the patents to de Montigny, Graham, Embry and Justus.

(Finding 123, RX-146, 267, 268, 270, 367, 370).

139. U.S. Letters Patent 3,438,854, entitled "Dual Wire Paper Forming Apparatus and Suction Box Therefor," issued on April 15, 1969 to John A. Means. This patent was an improvement over the Robinson patent, and together with Robinson, resulted from work done at Time, Inc. Springdale Laboratories. (RX-145; Means Tr. 759-760). A commercial installation of the invention of the Means patent was the PM 2 built at St. Francisville Paper Co. in St. Francisville, Louisiana, which was a joint venture of Crown-Zellerbach and Time, Inc. (Means, Tr. 761). The machine developed at Springdale Laboratories was built at St. Francisville, and manufactured by Beloit. The first contact between Beloit and Springdale Labs occurred in 1963. (Means, Tr. 770-72). The pilot machine at Springdale Labs in 1966 was substantially configured as shown in Figure 1 of the Means patent. (Means, Tr. 786-88; RX-145).

140. Figure 1 of the Means patent discloses a twin-wire forming apparatus in which the stock is directed from a slice between lower and upper breast rolls 22 and 24 rotatably mounted in spaced apart relation with respect to each other. Lower and upper foraminous wires 26 and 28 are trained respectively around the lower and upper breast rolls. A curved, stationary forming box 32 is mounted in closely-spaced apart relation to the lower breast roll 22. The wires 26 and 28 are trained about the open, curved surface 33 of the forming box 32 in

such a way that the forming box assists in the establishment of a convergence between forming wires 26 and 28. The curve described by the surface 33 may be part of a circle, parabola, hyperbola, sine wave, or some other curve, but it will preferably curve through an arc of about 20 degrees. This curvature of surface 33 facilitates the imposition of progressively increasing pressure on the web sandwich between the wires as it traverses the surface. In order to maintain optimum pressure on the web and sufficient tension on upper wire 28, in a preferred embodiment, surface 33 is curved cylindrically through an arc of 20 degrees and about a five foot radius. (RX-145, Fig. 1, Col. 2, l. 63- Col. 3, l. 73; RPX H).

141. Downstream of the curved forming box 32 are situated four suction boxes, 38, 40, 42, and 44 beneath bottom wire 26, and a top scraper 46 above top wire 28. These elements are provided to dewater the web between the wires in both directions. The suction boxes are arranged with their tops sloping in the direction of web movement at an angle 3 degrees above the horizontal. Similarly, the scraper blade 48 for the top scraper 46 slopes upwardly in the direction of movement at an angle of about 3 degrees (RX 145, Col. 4, l. 19-29; RPX H).

142. Downstream of suction box 44 is positioned rotary vacuum roll 50, which is positioned so that the wires 26 and 28 move in substantially a straight line from the downstream end 36 of the curved forming box 32 to roll 50 upwardly in the direction of web movement at an angle of about 3 degrees. The upper wire 28 travels around tail roll 54,

which is mounted above and slightly downstream of roll 50. The upper wire then loops back to the upper breast roll 24. Thus, the bottom wire 26 is separated from the top wire at the point of contact with the vacuum roll 50, and bottom wire 26 continues downstream toward roll 72, passing suction boxes 56, 58, 60 and 62, which are downwardly inclined in the direction of web travel at an angle of about 3 degrees. The suction box 52 positioned within vacuum roll 50 ensures separation of the web from the top wire and that the web continues to travel with bottom wire 26. In this configuration the bottom wire wraps approximately 6 degrees around roll 50. (RX-145, Col. 4, l. 30-65; RPX H).

143. As the stock sandwiched between the wires travels over the curved grating, it is dewatered symmetrically through both the top and bottom wires. Dewatering through the bottom wire occurs as a result of pressure between the wires, suction and gravity. Dewatering through the top wire occurs as a result of pressure between the wires and centrifugal force. (Means, Tr. 788-89).

144. Although centrifugal dewatering through the top wire over the curved grating may be inherent from the structure disclosed in Figure 1 of the Means patent, and as put into operation at St. Francisville, this type of dewatering was not the subject of the invention and there is no express teaching in Means with respect to centrifugal dewatering. (Means, Tr. 832-33; RX-145).

145. As previously indicated, in the configuration of Figure 1 of the Means patent, after the wires travel over the curved grating, they follow a substantially flat horizontal path over the suction boxes, and wrap approximately 6 degrees of the vacuum roll. (Findings 140-142). Thus, there is essentially no relationship between the curved grating 32 and the vacuum roll 50 defining a bi-radii path of travel. In addition, the path of travel of the wires, to the extent it follows a curved path in the direction of web travel, describes a path of increasing radius, in view of the arc of 20 degrees over the curved grating followed by a straight path over the suction boxes and a 6 degree wrap around the vacuum roll. By contrast, the claims of the '758 patent require a continuous bi-radii curved path of wire travel having a first radius of curvature substantially larger than a second radius of curvature. In the embodiments disclosed in the specification of the '758 patent, the wires travel around a periphery of about 90 degrees of the rotary cylinder following the curved stationary shoe. (CX-1, col. 13, l. 41-44, col. 19, l. 62 - Col. 20 l. 14, Figs. 5, 8).

146. Figure 1 of the Means patent, and PM2 at St. Francisville do not comprise a twin-wire forming apparatus in which the forming wires are arranged to travel over a stationary curved surface downstream of the entrance nip while having stock therebetween, said wires traveling around a part of the periphery of a rotary cylinder immediately following the stationary forming surface,

with said surface and said cylinder being on the same side of said wires, the rotary cylinder being positioned downstream in close-working relationship with said curved stationary surface to define a continuous, bi-radii curved path of wire travel having a first radius of curvature substantially larger than a second radius of curvature. (CX 1; RX 145).

147. On the basis of the foregoing findings the Means patent and PM2 at St. Francisville do not anticipate claims 1, 2, 3, 7, 8, 10 and 11 of the '758 patent. (Findings 139-146).

148. Although Beloit cited the Means patent in its list of prior art contained in its Voluntary Amendment Accompanying Application of July 8, 1971, in connection with the '879 application, there is no indication from the file history that the examiner actually considered it in passing on the claims which matured into the '758 patent. It also appears that complainant did not disclose the existence of the PM2 machine at St. Francisville to the examiner. (RX-376). In view of the configuration and teachings of Means and St. Francisville, these items of prior art are equally pertinent but no more pertinent as the prior art cited by the examiner. (Findings 122, 123).

149. The operation of the PM2 at St. Francisville was characterized as a "colossal disaster by ordinary standards." The objective of the PM2 was to achieve a specific weight of paper for four-color printing, and to attain a relatively high machine speed and volume of production. Although a certain amount of saleable paper has been produced, the machine has fallen short of

expectations over essentially its entire term of operation, beginning in 1967, with respect to volume, speed and quality of production. The term "mountains of St. Francisville" was coined to denote the mounds of unsaleable paper produced from 1967-1969 which was stored outside the mill under black plastic. The engineers at Springdale Labs and Beloit devoted long hours to troubleshooting the problems that arose in the operation of the machine, with the result that the machine was frequently shut down. The PM2 is the only machine of this type that Time, Inc. and Crown-Zellerbach ever built, and it is unlikely that they would ever build another. (Elliot, Tr. 925-36; CX-209).

150. Since the development and commercialization of Beloit's Bel Baie twin-wire formers, approximately 75-100 have been sold worldwide of which approximately fourteen have been sold in the United States. (See Finding 196, below). In Japan, the Bel Baie has become virtually a requirement for the manufacture of newsprint. This is so because the quality of Japanese newsprint must be high due to the fact that any deformation of Japanese characters can alter the meaning of the character. Newsprint manufactured on a Bel Baie has good formation and a low degree of linting, which makes it highly suitable to the Japanese. In the United States, the Bel Baie is also well received for newsprint. The reason for the success of the Bel Baie in manufacturing newsprint is that it solved the long-term problem of sheet two-sidedness and

achieved commercially acceptable speeds of production. The problem of two-sidedness was solved by the gentle draining characteristics of the Bel Baie, which is accomplished by the dewatering process over the large radius shoe followed by a roll. Although forming sections manufactured by other companies, such as the Vertiformer, produced an acceptable quality of paper, the configuration of the machine resulted in greater wear on the wires, and it has proved to be difficult and uneconomical to operate. (Roell, Tr. 631-37).

151. On April 27, 1971, Candian Patent 869,266 issued to David R. Gustafson. The priority date shown for this invention is May 20, 1968. In view of the priority date of the '758 patent of January 24, 1968, based on the British application, the Canadian patent to Gustafson is not prior art to the '758 patent. (RX-148; Finding 128).

152. Figure 2 of the Canadian patent discloses a structure in which a convexly curved shoe is placed adjacent the entrance nip inside the top wire immediately upstream of a large rotary cylinder, on the same side of the wire as the rotary cylinder. The curved stationary shoe is shaped as a parabola, having a small initial radius of curvature followed by a large radius of curvature. The curvature of this stationary element is designed to match the natural drainage curve of a particular stock, thus the curvature cannot be arbitrarily varied.

(RX 148; Waller, CX-204, p. 36; Kallmes, Tr. 1202-05).

153. The configuration shown in Figure 2 of the Canadian patent, in which a small radius of curvature is followed by a large radius curvature, would not allow a gradual build up of pressure in the dirction of wire travel, as required by the '758 patent. (Kallmes, Tr. 1205).

154. On the basis of the foregoing findings, even if the Canadian patent were prior art to the '758 patent, it would not anticipate claims 1, 2, 7, 10 and 11 of the '758 patent. (Findings 150-152).

155. French Patent No. 1,473,988, applied for in the name of Mr. Edgar Justus, issued February 15, 1967. This patent is comparable to British Patent No. 1,129,893. The invention of the Justus French patent is directed to production of light weight tissue paper. Thus the patent describes the use of a wire and a felt. Figure 2 of the French patent discloses a curved solid shoe positioned inside the top felt to define a small radius of curvature at the entrance nip, followed downstream by a flat run, then the wire-web-felt sandwich travels around a cylinder. The curved shoe inside the top wire is parabolic in shape, and is specifically designed to meet the drainage curve of the stock. The bottom wire does not travel

around the curved portion of the solid shoe, thus it converges with the top felt on the flat portion of the shoe. In view of the fact that the top belt is a felt, dewatering will occur primarily in one direction, through the wire. (RX-100, 147; Waller, CX 204, p. 33; Kallmes, Tr. 1213; RPX I).

156. In addition to the fact that the Justus French patent discloses the use of a wire and a felt, the structure shown in Figure 2 does not recite a rotary cylinder positioned downstream in close working relation with a curved stationary surface to define a continuous bi-radii curved path of wire travel having a first radius of curvature substantially larger than a second radius of curvature. (CX-1; RX-147).

157. U.S. Letters Patent 3,150,037, entitled "Papermaking Machine Utilizing Centrifugal Dewatering," issued on September 23, 1964 to Lee. This patent concerns dewatering stock by centrifugal force using a reverse wrap configuration, and combining it with air flow and suction. With respect to the type of foraminous carriers used under the Lee configuration, it is stated that "[t]he foraminous carriers which are employed must be capable of draining water from the web carried thereby at a substantial rate. This distinguishes them from felts and canvases which are often used in connection

with dewatering a paper web." A typical forming wire is capable of draining over fifty times as much water as a top felt. (RX 101, Col. 5, l. 18-29).

158. Dr. Kallmes indicated that in his opinion it would have been obvious to one of ordinary skill in the art of papermaking in 1968-1969 to substitute a wire for a felt in appropriate circumstances to achieve desired drainage characteristics, particularly in view of the Justus French patent and Lee patent. In spite of this claimed obviousness, Dr. Kallmes has never actually seen such a substitution made by a paper-maker. (Kallmes, RX-409, p. 40, Tr. 1208-09). This alleged substitutability is not corroborated by the record. The Lee patent indicates that wires are capable of draining about fifty times more water than felts, and suggests that a felt could not be used effectively in a configuration which provides centrifugal dewatering by means of a reverse wrap, in which dewatering is effected in both directions by centrifugal force. (Findings 118, 157). In addition, in the prosecution history of the '758 patent, the examiner initially rejected the claims over the Graham '745 patent, which utilized a felt and a wire. Over and above the different drainage capabilities of felt, Graham taught the use of a solid plate behind the felt to prevent the felt from bowing and pointed out the degree of elasticity

of a felt and the level of tension to which it could be subjected, as opposed to a wire. In the configuration set forth in the Graham '745 patent, centrifugal dewatering of the stock was only accomplished through the top wire. Further, in overcoming the examiner's rejection over Graham, Beloit successfully indicated the important differences between wires and felts. The examiner subsequently allowed the claims over Graham. (Findings 98-100, 107-110). Thus, Dr. Kallmes' opinion with respect to the obviousness of the claims of the '758 patent is found to be based on impermissable hindsight and is not adequately supported by the evidence of record.

159. Of the prior art cited by the patent examiner in the prosecution of the '758 patent, the Graham '745 patent disclosed an appparatus for forming paper between a forming wire and a felt. In the configuration of this patent, Graham suggested placing a curved stationary plate behind the felt, followed by a guide roll. The examiner initially rejected the claims of the '758 patent as obvious over Graham '745, but complainant distinguished its claims over the rejection, and the examiner allowed the claims as patentable over the prior art cited. (Findings 107, 108).

160. The Justus French patent and the Lee patent are not more pertinent than the prior art cited by the examiner in allowing the claims of the '758 patent. In view of the patent examiner's initial rejection on grounds comparable to those suggested by the

combination of the Justus French patent and Lee, which rejection was overcome, Justus and Lee combined, with or without Means do not render the claims of the '758 patent obvious. (Findings 107, 108).

161. As stated in Finding 138, the Robinsion patent is not more pertinent than the prior art cited by the examiner during the prosecution of the '758 patent. Although Means may be equally pertinent as th art cited by the examiner, it does not anticipate the claims of the '758 patent. (Findings 147, 148). Neither Means nor Robinson discloses a structure in which a rotary cylinder is positioned downstream in close working relation with a curved stationary surface to define a continuous bi-radii curved path of wire travel having a first radius of curvature substantially larger than a second radius of curvature. (Findings 130-146). Thus, Means and Robinson in combination will not render the claims of the '758 patent obvious.

162. Although Beloit was aware of the existence of the PM2 at St. Francisville, and its relation to the Means patent, it did not disclose this machine to the examiner during the prosecution of the '758 patent. (Finding 139, 148). In view of the limited relevance found herein of the Means configuration as embodied in PM2 at St. Francisville to the claims of the '758 patent, such nondisclosure by Beloit does not rise to the level of a breach of the duty of candor to the PTO.

VI. COMPLAINANT'S FORMERS AND THE SUIT PATENT

163 Complainant maintains that it sells and/or offers for sale various formers which embody the features of the '758 patent. It includes in this assertion its Bel Baie I, Bel Baie II, Bel Baie III, and modified Bel Roll formers. (CX-194, Roell direct, at 5-6, 28-30).

A. The Bel Baie Formers

164. Mr. Waller has described how the Bel Baie formers embody each of the elements stated in the claims of the suit patent. (Waller, Tr. 45-53).[10/] Respondents have offered no evidence in opposition to this testimony and, indeed, do not contest the fact that the Bel Baie formers of complainant read on the suit patent. (RF 1-727; RRF 728-736). Moreover, a comparison of the features of the Bel Baie II as revealed in CPX C and CPX D, with the elements of the claims in issue (Findings 13-21), supports Mr. Waller's testimony. Although a suction box is interposed between the shoe and the following roll in the Bel Baie II, this element is curved so as to conform to the general radius of the shoe and, therefore, does not interfere with the cooperation between the shoe and the following roll. The specification

10/ Mr. Waller's testimony covered only claims 1, 2, 3, 4, 7, 8, 10 and 11 of the suit patent, since complainant did not offer evidence as to claim 12 in the presentation of its case. (Waller, Tr. 45-53).

indicates that such an intervening device is within the scope of the claims. (CX-1, Col. 8, l. 68-75).

B. The Modified Bel Roll

165. Mr. Waller has also testified that the modified Bel Roll (Bel Roll with the shoe) embodies all of the features of the '758 patent. (Waller, Tr. 54-57). Respondents did not directly oppose such testimony, as it is respondents' position that no industry involving a modified Bel Roll exists. (RF 511-559). The modified Bel Roll design is not that of a true twin-wire former. If one were built, it would be a top-wire former similar to the Sym-Former R, although it would contain an extended, gradual nip which would end on the curved stationary surface, i.e. the nip and shoe would be "adjacent." (CPX B; Waller, Tr. 55). However, since the stock is not deposited into an "entrance nip" it does not read on the claims of the suit patent. (See Findings 56-60, concerning the lack of an "entrance nip" in respondents' accused devices).

166. Indeed, complainant's experience with an experimental model of the modified Bel Roll provides explicit proof that it is essential to the claims of the suit patent that the nip be an "entrance nip" which receives the jet stream of stock directly from the headbox slice. The record evidence reveals only one test which was

run by complainant on a Bel Roll former modified by the addition of a forming shoe. (RX-38). That test concluded that the only difference between the standard Bel Roll and the modified Bel Roll was that, with the shoe, the machine required more power to operate. There were no apparent improvements in retention or formation. (RX 38; Roell, Tr. 578-80).[11/] Therefore, the shoe serves no apparent purpose in the modified Bel Roll. This highlights the different purpose the shoe serves in respondents' devices, as compared to the suit patent device. The principal purpose of the shoe in the accused devices is that the particular design thereof causes pulsations which tend to redistribute some of the fibers and fine particles in the web, or stock, thereby serving to improve the formation of the finished sheet. (Finding 38, above). This is in contradiction to the teachings of the suit patent which attempts to minimize any disturbances or pulsations as the wire sandwich passes over the shoe. (Finding 73). The lack of any effect from insertion of complainant's shoe in the top-wire Bel Roll indicates that a shoe of such design is only useful in a true twin-wire former, where it helps to shape a gradual entrance nip and serves as a primary dewatering device. (Compare Findings 23-28 with 29-61).

11/ There is unsupported testimony that the modified Bel Roll does offer improvement over the standard Bel Roll (Roell, Tr. 678-79), but in the absence of support and, in view of the test embodied in RX-38, I cannot credit such testimony.

VII. IMPORTATION AND SALE

167. Respondents are engaged in the importation into, promotion, marketing and sale in the United States of forming sections alleged to infringe the patent in suit. (CX-214, Stipulation No. 12). As of the close of the record herein, however, no New Sym-Former had been sold or imported into the United States; only Sym-Former R's and a "modified" New Sym-Former had been so imported or sold. (CPX II, Hautamaki dep. at 74, 91-102, 383-84; RRF RR-B1 and RR-B2).

168. Since the beginning of 1982, respondents have to date sold three accused forming sections to paper mills in the United States. (CX-214, Stipulation No. 13).

169. In 1981, respondent Valmet through respondent TVW, sold a Sym-Former N (not an acused device) to Abitibi/Augusta (Augusta Newsprint Company, Augusta, Georgia) for its PM2 paper machine. In mid-1982, the unit which was nearly completed in Finland, was changed to receive a Sym-Former R modification (thus becoming an accused device). Since it was delivered to Augusta as a new paper machine it can be called a "modified" New Sym-Former, but it is of a different design than a true New Sym-Former. The machine, as modified, was delivered in the summer of 1983 and started up October 1, 1983. (CPX II, Hautamaki dep., at 91-102, 202; CPX GG, Parviainen dep., at 150-52; RRF RR-B3).

170. In 1983, respondents sold a Sym-Former R to Abitibi/Augusta as a former section rebuild for its PM1 paper machine. This unit is scheduled for delivery in the United States in April 1984. (CX-215, Stipulation No. 14; RRF RR-B4).

171. In June 1983, respondents sold a Sym-Former R to FSC Corp. (FSC), delivery of which was scheduled for December 1983. (CPX FF, Parviainen dep., at 83-84; RRF RR-B5).

VIII. DOMESTIC INDUSTRY

A. Beloit Operations

172. Complainant Beloit is a privately held corporation engaged in the manufacture of papermaking machines and associated equipment, with corporate headquarters in Beloit, Wisconsin. (RX-467, Stipulation No. 1).

173. Beloit's Paper Machinery Group consists of the Paper Machinery Division in Beloit, Wisconsin (PMD), and Beloit subsidiaries and facilities in Great Britain, Canada, Italy and Brazil. All of those facilities are capable of building papermaking machinery. (Roell, Tr. 546-48).

174. Beloit's domestic facilities dedicated to the research, design and manufacture of papermaking machines are located at the Paper Machinery Division, Beloit, Wisconsin and Roscoe, Illinois, and at Beloit's Rocton, Illinois research center. (RX-467, Stipulation No. 2).

175. Beloit's Paper Machinery Division (PMD) has manufacturing facilities at Beloit, Wisconsin and Rocton, Illinois comprising approximately square feet. Research and development for the forming sections is conducted at the research facility at Rocton. Sales offices for the forming sections are located at Mobile, Alabama and Portland, Oregon. (Jenkins, CX 196, p. 3).

176. PMD currently has employees; of these employees are directly involved in manufacturing and the balance are divided between engineering and sales. (Jenkins, CX 196, p. 5). Production of forming sections has been completed in calendar 1983 and are currently in production at PMD; of these units, were sold in calendar 1983.

. (Jenkins, Tr. 327-28; Roell, Tr. 544-45).

177. All the components and raw materials that PMD uses for the manufacture of forming sections in the United States come from sources in the United States. (Jenkins, CX 196, p. 7).

178. Complainant Beloit seeks to make all of its forming sections which are sold in the U.S. at PMD. Subcontracting to Beloit's overseas affiliates occurs

(Roell, Tr. 543-44; Roell, SX 2, pp. 51-53; McKie, SX 3, pp. 142-44).

179. At present, Beloit is centralizing its engineering systems so that all of the detailed engineering drawings will be made in

Wisconsin no matter where in the world the machine is located or is being constructed. (Roell, Tr. 643-44).

180. Planning engineering involves the overall design concept of the forming section and includes all but the shop drawings. This work is done for each order to ensure that the forming section will be tailored for the mill to which it is destined. (Roell, Tr. 643).

181. Detailed engineering are those drawings which are given to the shop for the forming section's manufacture. (Roell, Tr. 643).

182. It is estimated that on those projects that are subcontracted C abroad, approximately percent of the total job is furnished out of the United States by PMD. (Roell, Tr. 646).

183. In addition to manufacture of original equipment, PMD is engaged in the manufacture of replacement and repair parts for forming sections. PMD also performs maintenance work on forming sections at the millsite. (Jenkins, CX 196, p. 6).

184. The manufacture of replacement and repair parts by PMD constitutes C a part of PMD's total business. It constitutes approximately percent of PMD's total volume of business in a normal year and C accounts for percent of its profit. (Roell, CX 194, pp. 16-17).

185. More repair and replacement parts for forming sections are generated than for other segments of a paper machine due to the wet corrosive atmosphere in which the forming section parts have to operate. Thus, they tend to wear out sooner and are replaced more often than are parts for the rest of the machine. (Roell, CX 194, pp. 16-17).

186. The manufacture of repair parts, since they are on an individual one-at-a-time basis, are more labor intensive than the manufacture of new parts, especially when the rolls and assemblies come back to PMD for rebuilding. (Roell, CX 194, p. 17).

187. Customers in the industry routinely purchase from the vendor an engineering start-up package which covers all labor and other activities attendent to the start-up of the machinery. This phase can last several months depending on the complexity of the particular machinery. After the start-up of the machinery, the supplier continues to monitor closely its operation through approximately the first year of its performance. (Hoover, SX 4, pp. 152-54; Parviainen, CPX GG, pp. 246-47).

188. When PMD replaces a forming section in an existing mill with a new forming section, it must be installed as quickly as possible to get the machine running again; therefore, PMD sends erectors from its shop to the millsite approximately three to four weeks in advance of the machinery shutdown. The erectors remain there for the shutdown, which can last from 14 to 20 days,

and then are there for approximately one week after start-up. Start-up engineers from PMD's engineering department are sent to the millsite during the installation and at the start-up to train new crews and take care of any problems that might arise. (Jenkins, Tr. 367-68).

189. When a forming section is being installed as part of a new paper machine, usually erectors from PMD are used (for the entire machine) on 10 to 12 hour shifts at the millsite for approximately a year. At start-up, approximately PMD engineers are sent to the mill site three to four weeks in advance of start-up and remain two to three weeks after start-up, with engineers remaining there for three to four months or even a year after start-up, depending on the complexity of the mill. (Jenkins, Tr. 368-69).

190. The actual manufacture of a forming section begins upon release of the engineering drawings when Beloit industrial engineers prepare detailed "routings" describing how to manufacture the forming section. A routing is a road map directing the former through the various stages of production. Routings are updated and revised during the manufacturing process. (Jenkins, CX 196, p. 4; Jenkins, Tr. 362-63).

191. Because a forming section is a custom built machine, planning engineering, detailing engineering drawings, specifications, and design features are developed on an order-by-order basis. (Roell, Tr. 643).

B. The Bel Baie Formers

192. Beloit does not have employees dedicated solely to the manufacture of Bel Baie formers. (Complainant's response to First Set of Interrogatories propounded by respondents. RX 79, p. 33).

193. There are no separate plants or separate facilities at PMD used to manufacture Bel Baie formers as opposed to use for other manufacturing purposes. The equipment that would be used to make Bel Baies is also used to make other parts of papermaking machines. (Jenkins, Tr. 346; Roell, RX 201, p. 133).

194. The manufacture of a Bel Baie forming section requires, on the average, C hours of direct manufacturing labor. (Jenkins, CX 196, pp. 5-6; Jenkins, Tr. 371).

195. Although the Bel Baie has been sold and is available for rebuilds, it is sold predominantly as an integral part of a new papermaking machine. The cost of a new papermaking machine is roughly twice as expensive as the cost of a rebuild. As a result of this cost differential and the generally depressed state of the paper making industry in recent years, the domestic industry defined by the Bel Baie has experienced sporadic and sometimes lengthy intervals between sales. (Gustafson, RX 390, pp. 393-94; Roell, CX 194, pp. 29-30; Roell, RX 202, pp. 202-03; CX 200, pp. 10; 27-28; Roell, Tr. 648; Roell, RX 201, p. 69, SX 12).

196. For the period 1976-83, Beloit has produced Bel Baie forming sections in the United States which have been installed in the United States. The last one sold (of these was 1978, (SX 13).

C

197. The last Bel Baie manufactured by Beloit in the United States was for of Taiwan in 1981-82. (Roell, RX 201, pp. 45-46).

C

198. Since the time of the last U.S. sale of a U.S. made Bel Baie, Beloit has sold and installed a Bel Baie II former at Washington. This forming section was manufactured at in Japan. (SX 12).

C

199. ordered its paper machine for the , Washington mill from Beloit on May 12, 1981. (RX 466). under its subcontract agreement with Beloit, was to manufacture the Bel Baie forming section, for a total of was also to manufacture for and for (RX 57, Bates Nos. 102193-97).

C

200. The domestic activities of Beloit involved in the sale, manufacture and installation at included, specifically, all research and development, portions of the engineering, and all sales and general administration activities. (SX 12; Regnier, SX 14, pp. 93-129).

C

201. Of the total manufacturing cost of the forming section of the
C project, set forth as complainant has calculated the U.S. value added for the project to be roughly (SX 14F).

202. The manufacturing cost of the Bel Baie forming section, i.e.,
C is comprised of Beloit PMD's manufacturing costs, plus the amount charged to Beloit by (SX 14F, 14G, pp. 138900, 138902; Regnier, SX 14, pp. 106-09).

C 203. The amount charged to Beloit by for the job, is the sum of (SX 14G, pp. 138900, 138902; Regnier, SX 14, p. 107).

C 204. Beloit PMD's total manufacturing costs for the Bel Baie can be attributed to the stages of the manufacturing process as follows:

(Regnier, SX 14, pp. 106-09; SX 14F, 14G, pp. 138900-138902).

C 205. The domestic value-added to the Bel Baie, totaling is the sum of PMD manufacture, a corporate surchange, a warranty cost, and sales, general, and administrative (SG & A) expenses. (Regnier, SX 14, pp. 106-16; SX 14E, 14F).

206. PMD personnel in the United States, in consultation with the customer, made numerous amendments and modifications to the engineering specifications for the Bel Baie, which changes were then transmitted by PMD to Beloit personnel purchased and manufactured in the United States spare parts and components for the forming section. (SX 27-46; Jenkins, Tr. 377-80).

207. All erection and start-up activities in connection with the Bel Baie former for the project were conducted by PMD personnel.[12/] This activity is not included in the U.S. value-added computations Beloit calculated for the project. (Jenkins, Tr. 377; SX 14F, 14G).

208. The corporate "surcharge," which comprises one element of the domestic value-added in the transaction, is a royalty charged on the price of a "proprietary" (Beloit-designed) product to cover research and development and other domestic corporate activities in support of PMD. (Regnier, SX 14, pp. 110-11, 127-28; SX 14E).

209. The warranty cost, which comprises one element of the domestic value-added in the transaction, is an estimate of the costs that will be incurred through domestic activities carried out in performance of warranty obligations at the start-up of the forming section. (Regnier, SX 14, pp. 111-112, 125-26).

12/ One engineer from participated as an observer.

210. The prorated SG&A burden, which constitutes one element of the domestic value-added in the transaction,

represents bona fide domestic activities attributable to the transaction and carried out in the United States, irrespective of where the equipment is manufactured. (Regnier, SX 14, pp. 112-16, 118-9; SX 14E).

211. The domestic value-added figure of does not include field erection, start-up engineering and post-installation maintenance and manufacture of repair and replacement parts in connection with the transaction, which are activities carried out in the United States by PMD. (SX 14E and 14F; Roell, CX 194, p. 16; Roell, Tr. 545, 676-77).

212. Given the sporadic nature of demand for new papermaking machines in recent years, the fact that a Bel Baie has been manufactured at PMD as recently as 1981-82 is sufficient evidence to establish the existence of a domestic industry for the Bel Baie, as required by Section 337. Additionally, evidence of the Bel Baie's availability for use in rebuilds and the fact that Beloit's domestic operations contribute a significant "value-added" portion to the total cost of Bel Baies manufactured for sale in this country by Beloit's foreign subsidiaries and licensees, also establish the existence of a domestic industry for the Bel Baies.

C. The Modified Bel Roll

213. The "modified" Bel Roll, as noted above, is a modification of Beloit's Bel Roll former (a top-wire former which is admittedly not covered by the suit patent), wherein a curved stationary shoe is inserted in the top-wire section between the breast rolls and the following cylinder. (Findings 165-166, above).

214.

C (Roell, Tr. 552-53; Jenkins, Tr. 358).

215. No evidence exists which would indicate that the conception of a Bel Roll with a forming shoe, also known as a "modified" Bel

C Roll, existed prior to (RX 90).

216. Sym-Former R has been on sale since 1981. The design was finalized in November 1981, the first in the world was sold in September 1982, and more than twenty Sym-Former R's have been sold since that time (RX 250, Hujula W.S. para. 17). The Sym-Former R was first offered in the United States in May 1982. (CX 85).

217. As of June 6, 1983, when Beloit answered respondent's First Set of Interrogatories, Beloit claimed that only the Bel Baie Formers I, II and III were covered by one or more claims of the suit patent. (RX 79, p. 11).

218. As of July 20, 1983, when Beloit supplemented its answers to respondent's First Set of Interrogatories, Beloit still contended that only the Bel Baie formers were covered by the claims of the suit patent. (RX 79, pp. 2-3).

219. Beloit did not allege that the "modified" Bel Roll forming section fell within the scope of the suit patent until it further supplemented its response on September 21, 1983, to respondent's First Set of Interrogatories, served in June, with a one paragraph statement with respect to the "modified" Bel Roll. (RX 79, p. 1).

220. In order to manufacture a Bel Roll with provision for the insertion
C of a forming shoe in the future,

Beloit's Vice-President for Sales acknowledged, both at trial and in his deposition testimony, that

(Roell, Tr. 553-56, Roell, RX 202, p. 160).

221. During the summer of 1983, Beloit sold a Bel Roll former (without a
C forming shoe) to

(RX 75).

C 222. The forming section supplied by Beloit to was a standard Bel Roll without a forming shoe, but with provision for the addition of a forming shoe in the future should the customer desire one. (RX 75, Bates No. 137023).

223. The provision for future insertion of a forming shoe on paper machine

C No. 3 was done

(Roell, Tr. 531, 593-95).

C 224.

(Roell, Tr. 657).

225. In 1983, Beloit sold a Bel Roll former (without a forming shoe) to

C

. (Roell, CX 194, p. 22).

C 226.

. (Roell, RX 202, p. 128).

C 227.

(Roell, RX 202, pp. 50, 54).

C 228.

(Roell, RX 202, pp. 35-36).

C 229. chose to proceed with a Bel Roll which included a single blade water deflector,

(Roell, RX 202, p. 52).

230. Although Mr. Roell claims to have talked about the addition of a C forming shoe to the Bel Roll shortly after

he cannot recall

(Roell, RX 202, pp. 51-52).

231. Mr. Roell, Vice-President of Sales for the Paper Machinery Group,

C

until after one of his salesmen independently offered to insert a forming shoe in a Bel Roll for FSC Paper Corporation in Alsip, Illinois. (Roell, RX 202, pp. 53; 56-57; RX 90).

232. Mr. Roell admits that one reason his salesman may have proposed C inserting a forming shoe in the Bel Roll offered to FSC was

(Roell, RX 202, p. 207).

C 233.

(Roell, RX 202, p. 54).

234. After having a discussion with Mr. Bal about Mr. Bal's offer of a

C Bel Roll containing a multi-foil shoe to FSC,

(Roell, RX 202, pp. 59-60).

C 235.

. (Roell, RX 202, p. 119).

C 236.

. (McKie, RX 200, pp. 72-74, 199).

C 237. The Bel Roll, with or without a shoe,

(McKie, RX 200, p. 196).

C 238.

(Jenkins, Tr. 338).

C 239.

(Macklem, Tr. 1360).

240. Beloit engineers make presentations and give papers on Beloit products as part of Beloit's sales promotion activity. A paper presented publicly in May 1983, by a Beloit product engineer involved with both Bel Bond and Bel Roll formers titled "Top Wire Formers by Beloit" did not mention that Beloit had offered or planned to offer a Bel Roll containing a forming shoe. (CX 11).

241. As of the date Beloit answered respondent's First Set of Inter-
C rogatories (June 6, 1983),

(RX 79, p. 8).

242. The first written offer by Beloit to anyone to supply a Bel Roll
C with a forming shoe was made on

(RX 90; Roell, Tr. 558-59).

(RX 39; SX 47, pp. 53, 65-66).

243. A Bel Roll former without any forming shoe was initially offered
C to in July 1983. (Roell, Tr. 590-91, RX 410, Bates No. 138821).

C 244. did Beloit offer a "modified" Bel Roll.

(Roell, Tr. 588; RX 94, p. 1; RX 410).

C 245. has delayed reaching any decision as to what unit to purchase for its mill at (Roell, Tr. 655).

C 246. Beloit's primary offer of a forming section to the as reflected in a September 29, 1983 letter, was for a standard Bel Roll without a forming shoe. The forming shoe was offered as "an option."

(RX 93, p. 1; Roell, Tr. 568-69, 610-11).

247. The only written offers of a Bel Roll by Beloit, with what might
C be deemed a forming shoe, are contained in:

C 248. In view of the above facts, it is clear that

Therefore, aside from the question as to whether a "modified" Bel Roll is covered by the suit patent (Findings 165-166, above), complainant has not shown that a "domestic industry" exists, as is required by Section 337, insofar as the "modified" Bel Roll is concerned.

C 249. PMD has spent approximately since 1979 in acquiring new equipment or rebuilding existing equipment to increase productivity, efficiency and quality. Of this amount, PMD has expended approximately on new equipment since 1979 and approximately on major rebuilds of machine tools since 1981. (Jenkins, CX 196, Exh. 1; Jenkins, Tr. 365).

250. The decision to make each acquisition or rebuild is based on a MAPI analysis, a standard analysis used in the industry to determine the return on investment. (Jenkins, CX 196, p. 8).

251. As one example of how Beloit's machining projects have improved

C efficiency, the greatly reduces

(Jenkins, CX 196, pp. 8-9).

252. In rebuilding some of its machine tools, PMD has either

C or The majority of the rebuilding has been done

(Jenkins, Tr. 366).

C 253. In fiscal 1984, of capital expansion was budgeted for the Beloit Paper Group, which includes PMD. of this amount is targeted for PMD in Beloit, Wisconsin. Over

C of this amount was approved by the board of directors in October of 1983 for a major capital improvement of existing facilities and for acquisition of a new machining center. (Jenkins, Tr. 326, 335).

254. In addition to capital investments in plant and facilities, PMD has made the following improvements in its systems and procedures to improve productivity for the manufacture of its forming sections:

C (a)

C (b)

C (c)

C (d)

C (e)

C (f)

and

C (g)

(Jenkins, CX 196, Exh. 2).

255. Internal management documents at Beloit indicate that Beloit was able to make on-time deliveries, based on internal measures

C on percent of its orders in 1983. (RX 404, p. 11, Bates No. 136573). The record evidence does not establish an industry-wide norm with which this can be compared.

256. On the other hand, Beloit management has recently found that

C A 1983 internal management report found that Beloit's

It was further urged that

and that some customers found

Additionally, it was stated that customers considered

(RX 404, Bates No. 136579). Such internal self-criticism, however, does not detract from the more positive facts noted in the preceding findings. Indeed, management's ability to look critically at its own operations is, in itself, the mark of an efficiently run operation.

257. The over-all picture of the domestic industry revealed by this record is that it is an efficient and economic operation within the meaning of section 337.

X. INJURY

A. The Domestic Market for Forming Sections

258. The industry relating to the production and sale of forming sections consists of both rebuilds (where only the forming section of a machine is replaced or rebuilt) and the installation of a new forming section as part of the installation of an entirely new papermaking machine. (Hoover, SX 4, p. 155).

C 259. The price of a new paper making machine can be as much as million or more, of which the forming section may represent only percent of the value of the total machine. The price of a rebuild is less than that of a new machine, but the exact amount depends on the extent of the particular rebuild. (SX 14F, 16; Roell, Tr. 664-65).

260. Paper making machines, including forming sections, both new and rebuild, are generally sold directly by sales representatives employed by the manufacturing companies. When a paper mill decides to purchase new equipment, it usually invites bids or inquiries from some or all paper machinery suppliers. Occasionally, an unsolicited quotation is received. The buyer may retain an engineering consulting firm to assist in determining engineering specifications as well as to serve "middleman" functions. (Hoover, SX 4, p. 156; McLenaghan, SX 5, pp. 15-18; Thompson, SX 47, pp. 10-12).

261. Each vendor, in submitting its bid for the subject equipment, makes a presentation to the buyer, which can be a formal, extensive proceeding. The buyer may visit the manufacturer's facilities and other paper mills containing the supplier's product. Before a final decision is reached, the buyer and vendor may negotiate specific terms, such as price, delivery or financing. (Thompson, SX 47, pp. 12-13; McLenaghan, SX 5, pp. 20-21).

262. Those factors which seem to be considered in determining to whom the sale is given vary and include: price, technology, delivery, financing, service, and the number of a supplier's machines in operation. (Thompson, SX 47, pp. 16-17; McLenaghan, SX 5, pp. 22-23).

263. The primary bidders for the sale of forming sections, whether for new paper machines or as part of a rebuild, usually include: Beloit (U.S.); Valmet (Finland); KMW (Sweden); Voith (Germany); Dominion (Canada); Escher-Wyss (Germany); and Black-Clawson (Canada). (SX 15; Hautamaki, CX II, pp. 303-04).

B. Substantial Injury

264. Beloit and Valmet were the only bidders for the new paper machine to be installed at the Augusta Newsprint Co. in Augusta, Georgia (also sometimes referred to as Abitibi/Augusta) for its Augusta PM2 machine. Beloit offered a Bel Baie II forming section while Valmet offered a Sym-Former N forming section, a machine not alleged to infringe the patent in issue. (McLenaghan, SX 5, pp. 4-5, 7).

265. At the time that Beloit and Valmet bid for the PM2 sale, FSC already owned a Valmet Sym-Former N, which was installed at FSC's Stevenville plant. FSC was "entirely happy" with the Sym-Former N's performance at Stevenville, and, thus, favored the Sym-Former N in the PM2 sale. (McLenaghan; SX 5, p. 7-8).

266. Augusta selected the Sym-Former N for its PM2 machine in head-to-head competition with the Bel Baie II, but, after the order was placed, Augusta agreed to change its choice to a Sym-Former R at Valmet's suggestion. A change order reflecting the purchase of a Sym-Former R was implemented. (McLenaghan, SX 5, pp. 4-5, 7, 11-12, 26).

267. The Senior Vice-President of Abitibi/Augusta testified that there was no reason to reconsider Beloit's Bel Baie II at the time that his company decided to purchase the Sym-Former R rather than the Sym-Former N. (McLenaghan, SX 5, p. 11).

268. Augusta has purchased another Sym-Former R for the rebuild of its fourdrinier, PM1, to be installed in 1984. Augusta did not solicit bids for this transaction but made its decision based on its experience with the Sym-Former R it had previously purchased for the PM2 and the desire that both machines utilize the same equipment as well as be serviced by the same technicians. (McLenaghan, SX 5, pp. 13-14).

269 FSC Paper Corp., Alsip, Illinois, made a decision to purchase a top wire forming section for the rebuild of its existing fourdrinier in February 1983. (Thompson, SX 47, p. 18).

270. FSC was interested in the lowest price possible for its rebuild and wanted to install the machine when the mill was shut down between Christmas and New Year's Day. (Thompson, SX 47, pp. 23-24).

271. The following companies were bidding for the FSC rebuild: Beloit, Valmet, Escher-Wyss, Voith, Dominion, and Black-Clawson. (Thompson, SX 47, pp. 24-25; SX 15).

272. The number of running units or a company's track record was an important consideration for FSC. (Thompson, SX 47, p. 28).

273. In a letter dated April 13, 1983, from T.J. Bal to Harry Thompson, Beloit offered FSC a standard Bel Roll forming section at a price of

C (SX 16). (The standard Bel Roll is not covered by the suit patent).

274. On the basis of initial proposals from all bidders, FSC favored Voith, Dominion, Valmet, and Escher-Wyss for its rebuild. (Thompson, SX 47, p. 25; SX 15).

275. By letter of June 17, 1983, from T.J. Bal to Harry Thompson, Beloit offered FSC a standard Bel Roll forming section at a reduced price of

C $1.3 million, with detailed engineering to be completed by (SX 17).

C 276. The June 17 offer by Beloit included shipment by This shipment date was unacceptable to FSC. (SX 17; Thompson, SX 47, pp. 44-45).

277. On June 21-22, 1983, FSC met with Voith, Dominion, Valmet, and Escher-Wyss to negotiate a final position. At these meetings, each competitor was asked to lower its price. (Thompson, SX 47, pp. 45, 47-51).

278. In a letter dated June 24, 1983, FSC denoted its intent to purchase a Valmet Sym-Former R and enclosed a payment on the order. (Thompson, SX 47, p. 53; SX 18).

279.

(Roell, RX 202, p. 84).

280. By a letter dated June 28, 1983, from T.J. Bal to Harry Thompson, Beloit offered to FSC a Bel Roll former with a curved ceramic shoe between the forming roll and center roll. (SX 19).

281. FSC received Beloit's letter of June 28 after it had placed its order with Valmet. (Thompson, SX 47, p. 55).

282. Complainant Beloit has failed to establish any causal nexus between Valmet's sale of accused devices to Abitibi/Augusta (for PM1 and PM 2) and FSC, and any loss of sales or customers experienced by Beloit, as is required by §337. Therefore, Beloit has failed to meet is burden of proof that it has been substantially injured due to Valmet's importation and sale in the United States of the allegedly infringing forming sections in these instances.

C. Tendency To Substantially Injure

283. Only Beloit and Valmet offer the so called "forming shoe" technology for forming sections. These machines are promoted by both Valmet and Beloit as most suitable for newsprint and fine paper. (Roell, CX 194, pp. 27-28; Roell, Tr. 633; Parviainen, CPX GG, p. 248).

284. The technology of better known suppliers, such as Valmet and Beloit, is considered to be stronger than that of their competitors, such as Voith, Dominion, Escher-Wyss, KMW and Black-Clawson. These latter companies are not really accepted as suppliers for the U.S. paper industry. (Hautamaki, CPX KK, p. 305).

285. A total rebuild of a paper machine entails rebuilding all of the sections down through the machine. A major rebuild on a machine may
C come to a total of million, with the forming section being million dollars. Most paper companies like to purchase the total rebuild from one source. If the sale of the forming section is lost, it is likely that the sale of the total paper machine rebuild is lost as well. (Roell, CX 194, pp. 32-33).

286. Valmet's current costs of manufacturing the accused forming sections
C are

(Stipulation No. 1, filed October 31, 1983).

287. Valmet presently does not expect its current costs of manufacturing the accused forming section to increase significantly in the foreseeable future, except as might be required by changes in currency exchange rates and inflation. (Stipulation No. 2, filed October 31, 1983).

288. With a reasonable mix of product orders, Valmet has the capacity

C to manufacture approximately Sym-Former R's or New Sym-Formers in a calendar year in which the plant is working at or near capacity. (Hautamaki, CPX JJ, p. 171). The New Sym-Former is the standard former respondents offer for a new paper machine. (Parviainen, CPX HH, p. 5).

289. Valmet intends to increase its sales of forming sections in the United States market and possesses the capacity to maintain its present market share in the U.S. and to increase that market share in 1984. (Hautamaki, CPX KK, pp. 392-94).

290. It is estimated that there is a potential in the market for sales of

C units per year. Valmet has projected a market share of percent in 1984 and 1985. In 1982 and 1983 Valmet's market share was (Hautamaki, CPX KK, pp. 379, 382).

291. The sales department for paper machines and forming sections is one of the departments in Valmet's Paper Machine Division and has its own separate budget. Within the sales department are eight different groups, one of which is responsible for sales in North America. (Hautamaki, CPX JJ, pp. 174-75).

C 292. TVW employs approximately people, of whom are employed in the Valmet Product Group. (Parviainen, CPX GG, p. 233).

293. There is a great deal of communication between TVW and Valmet in Finland -- approximately 20 telexes per day -- especially when negotiations for a bid with a customer are in progress.

(Parviainen, CPX GG, pp. 236-37).

294. The advertisements and brochures for the Sym-Former R are largely developed by Valmet and then distributed by TVW to potential customers who are on TVW's mailing list. TVW personnel, and often Valmet personnel as well, participate regularly in trade meetings and shows. (Parviainen, CPX GG, p. 237).

295. Valmet, in the sale of its forming sections, seeks to realize a profit of at least on top of its direct costs.

(Hautamaki, CPX JJ, pp. 154-55).

296.

(Hautamaki, CPX JJ, p. 161).

297. Beloit PMD has reduced its total work force and is presently operating at approximately percent of its capacity. Prior to respondents' alleged unfair acts in the United States, only percent of the PMD work force was involved in the manufacture of the product in issue. (McKie, SX 3, pp. 247-51).

C 298.

(Jenkins, Tr. 336).

C 299.

(McKie, SX 3, pp. 263-65).

300. In a typical sale of a Bel Baie forming section, Beloit hopes to realize a profit of percent or applied to the total costs. If the sale of a Bel Baie former is lost, it is this amount of profit that would be lost by Beloit. In addition, if, by losing the order, a space of normal capacity is created that could not be filled by any other order at the time, then Beloit would also lose its recovery of the fixed costs or Furthermore, the loss of the sale of a Bel Baie would result in the loss of approximately man years in employment at PMD. (Regnier, CX 195, pp. 10, 13, Exhs. 1, 3).

C

C

C 301.

(Roell, Tr. 540-41).

302. Manufacture of other forming sections in the U.S. does not in and of itself establish a domestic industry since such other forming sections are not part of the domestic industry. However, since the same principles

apply to them, insofar as manufacture by foreign subsidiaries and licensees is concerned, the manufacture of these formers reveals that if the Bel Baie is sold in the future in the U.S. there is a good chance it will be manufactured at PMD. (As stated previously in Finding 176, PMD manufactured forming sections in 1983,

C

C 303. The is one of several instances in which customers have specifically requested or demanded that Beloit quote on the basis of manufacture at PMD; another recent instance was

C which advised Beloit that it would consider buying from Beloit only if the equipment was made at PMD, which the customer perceived to be Beloit's center of technology. (Roell, Tr. 539-40.

304. Beloit and Valmet's market projections indicate that bookings will increase within the next year, with greater activity concentrated in the rebuild market, although some growth is predicted in sales of new machines. (McKie, SX 3, pp. 265-66; Roell, SX 2, p. 168; Parviainen, CPX FF, pp. 122-24, 169).

305. The newsprint manufacturing industry is currently operating at excess capacity. (Pesonen, CPX LL, pp. 89-90).

C 306. Beloit has offered a Bel Baie III for the new paper machine at (SX 20, 23; Roell, Tr. 669). (SX 21; Parviainen, CPX HH, pp. 36-37; CX 153). A decision concerning the machine is not expected in the near future. (Parviainen, CPX HH, p. 36; Roell, Tr. 670).

C 307. The record demonstrates that respondents

and that they possess the manufacturing capacity and intent to penetrate further the United States market. One instance of current direct competition between Beloit and Valmet in the forming sections at issue (Finding 306), exemplifies a conceivable lost sale by complainant. The record further indicates that Beloit and Valmet will be competing for other future business in like manner. (Findings 283-84, 286-90, 301-04). In view of the large dollar value of a forming section, the loss of a single sale by Beloit to Valmet would respresent substantial injury.

D. If the Domestic Industry includes the Modified Bel Roll Former

308. If the modified Bel Roll former were to be found to embody all of the features of the suit patent and to be within the domestic industry, as defined in §337, there would exist a tendency to injure this domestic industry based on Findings 283-299, 301, 303-305.

309. The following instances of direct competition between the modified Bel Roll former and the Sym-Former R former represent potential lost sales and customers to complainant and additional evidence of a tendency to injure the domestic industry, if defined so as to include the modified Bel Roll former:

(a) Beloit offered a standard Bel Roll former to

C on

approximately October 19, 1983. (RX 44, p. 4;

RX 453). Beloit might quote the modified Bel Roll as an optional modification. (RX 453). Valmet has offered a Sym-Former R to (SX 21; Parviainen, CPX HH, p. 33; CX 156).

C (b) Beloit offered a standard Bel Roll for on July 7, 1983 and again on July 9, 1983.

In a letter sent to and dated October 4, 1983, Beloit mentioned the modified Bel Roll as an option for the (RX 44, p. 3; RX 94; Roell, CX 194, pp. 22-25; Roell, Tr. 654-55). Valmet has offered a Sym-Former R (SX 21; Parviainen, CPX HH, pp. 38-40).

(c) On September 29, 1983, Beloit offered a standard

C Bel Roll to Beloit proposed the and the modified Bel Roll as alternative options for the Valmet is likely to offer the Sym-Former R to (Roell, Tr. 537-39).

C (d) On November 4, 1983, requested quotes for the forming section for at the mill. Vendors

must submit two quotes: (1) one quote utilizing the existing fourdrinier; and (2) one quote of a new twin-wire forming section with the existing fourdrinier being removed. (CX 200, p. 3). Beloit bid a for the fourdrinier rebuild at (RX 44, p. 2; RX 453). Beloit may submit an alternative bid and offer the modified Bel Roll or the Bel Baie II. (Roell, Tr. 534-35, 671-72). Valmet submitted a quotation for the which includes a Sym-Former R. (CX 106; Parviainen, CPX GG, p. 145-46; CPX GG, pp. 43-44).

OPINION

VALIDITY OF THE '758 PATENT

A. Presumption of Validity

As with all duly issued United States patents, the '758 patent is entitled to the statutory presumption of validity. Thus, respondents bear the burden of proving the alleged invalidity of the suit patent. 35 U.S.C. 282. The presumption of validity can only be overcome by the presentation of clear and convincing evidence. Astra-Sjuco A.B. v. U.S. International Trade Commission, 207 U.S.P.Q. 1, 6-7 (C.C.P.A. 1980).

In this investigation, respondents have alleged the invalidity of the suit patent principally on the grounds of anticipation and obviousness, and have relied heavily on prior art not considered by the examiner during prosecution of the suit patent. Introduction of prior art more pertinent than art cited by the examiner does not, in and of itself, weaken or destroy the presumption, nor does it shift the burden of proof. Rather, evidence concerning such art may facilitate respondents' ability to meet its burden. Stratoflex, Inc. v. Aeroquip Corp., 218 U.S.P.Q. 871, 875-76 (C.A.F.C. 1983); Kalman v. Kimberly-Clark Corp., 218 U.S.P.Q. 781, 790 (C.A.F.C. 1983). Nevertheless, whether rebuttal will be achieved "requires careful consideration of whether the prior art relied upon does in truth render the claimed invention anticipated or obvious. Until that question is answered in the affirmative, the presumption is not rebutted and continues alive and well." Solder Removal Co. v. United States International Trade Commission, 199 U.S.P.Q. 129, 132 (C.C.P.A. 1978).

As more fully stated hereinafter, respondents have not met their burden of proof on this issue, and I find that the '758 patent is valid and enforceable.

B. Anticipation

Under 35 U.S.C. §102:

> A person shall be entitled to a patent unless -
> ...
> (b) the invention was patented or described in a printed publication in this or a foregin country or in public use or on sale in this country, more than one year prior to the date of the application for patent in the United States, or
> ...
> (e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent ....

On the basis of my finding that both Beloit's British patent application and its first U.S. application, the '713 application, embody the invention disclosed in the claims of the '758 patent, the suit patent is entitled to the priority date of the British patent application of January 24, 1968. (Findings 125-128). Respondents' allegations with respect to anticipation of the suit patent are based on four items of prior art, namely the Robinson patent, the Means patent, the St. Francisville PM2, and Gustafson's Canadian patent. In view of the fact that St. Francisville PM2 is an embodiment of Figure 1 of the Means patent, they will be considered concurrently. (Finding 139). The date of invention of the Gustafson Canadian patent is later than the priority date of the '758 patent. Thus, the Gustafson Canadian patent is not prior art to the suit patent. (Findings 151-154).

In order to sustain a finding of invalidity under §102, "all material elements recited in a claim must be found in one unit of prior art." In re Marshall, 198 U.S.P.Q. 344, 346 (C.C.P.A. 1978). There must be a showing "that each element of the claim in issue is found, either expressly described or under principles of inherency, in a single prior art reference, or that the claimed invention was previously known or embodied in a single prior art device or practice." Kalman v. Kimberly-Clark Corp., 218 U.S.P.Q. at 789. Thus, in order for there to be anticipation, "[a] prior art reference must teach the very invention of the patent." Grefco, Inc. v. Kewanee Industries, Inc , 208 U.S.P.Q. 218, 224 (D. Del. 1980) aff'd 671 F.2d 495 (3d Cir.), cert. denied 213 U.S.P.Q. 888 (1981), quoting Tokyo Shibaura Electric Co., Ltd. v. Zenith Radio Corp., 188 U.S.P.Q. 55 (D. Del. 1975), aff'd 193 U.S.P.Q. 73 (3d Cir. 1977). The Third Circuit has set forth the following standard of anticipation:

> For a prior publication to be sufficient to defeat a patent it must exhibit a substantial representation of the invention in such full, clear, and exact terms that one skilled in the art may make, construct and practice the invention without having to depend on either the patent or on his own inventive skills.

Grefco, Inc. v. Kewanee Industries, Inc., 208 U.S.P.Q. at 224. (Citations omitted). The standard of anticipation is, therefore, very strict, and requires that a determination of anticipation by a single item of prior art be made without benefit of the teachings of the suit patent.

1. Figure 6 of the Robinson Patent

Respondents allege that Figure 6 of the Robinson patent anticipates claims 1, 2, and 10 of the '758 patent. On the basis of my findings that

the grating assemblies in Figure 6 of Robinson as described in the specification can only be found in pairs on either side of the converging wires, and that these so called "belt-converging means" are not disclosed as being convexly shaped in Robinsion, Figure 6 falls far short of anticipating claims 1, 2, and 10 of the '758 patent. (Findings 135, 136). In particular, Figure 6 of Robinson at a minimum does not disclose a curved stationary surface positioned adjacent the entrance nip, the stationary curved surface having a relatively large radius of curvature, the first wire being free of restraining means on its outer surface opposite the rotating cylinder, as required in claims 1 and 10, nor does it disclose a rotary cylinder positioned downstream in close working relation with the curved stationary surface to define a continuous bi-radii curved path of wire travel having a first radius of curvature substantially larger than a second radius of curvature. (Findings 137, 138). Thus, the Robinson patent does not anticipate any of the asserted claims of the suit patent.

2. The Means Patent and PM2 at St. Francisville

Respondents allege that the Means patent and the PM2 at St. Francisville anticipate claims 1, 2, 3, 7, 8, 10, 11 and 12 of the '758 patent. It is clear from the record that PM2 at St. Francisville is essentially an embodiment of Figure 1 of the Means patent. (Finding 139). It is respondents' position that a finding of anticipation by the Means configuration requires an affirmative determination that there is centrifugal dewatering around the curved grating, that both wires travel around a part of the periphery

of the rotary cylinder and that the rotary cylinder immediately follows the curved stationary forming surface.

The specification and claims of the Means patent teach nothing with respect to centrifugal dewatering. This is so because the subject matter of the patent is directed to dewatering by means of suction. (Findings 139,144). Nevertheless, it appears from the actual operation of the PM2 at St. Francisville, that the structure described in Means will inherently accomplish a certain amount of centrifugal dewatering. (Findings 140, 143).

This fact, in and of itself does not decide the matter, since the concept of dewatering by centrifugal force was not new in the art. The subsequent path of wire travel beyond the curved grating is crucial. In the Means configuration, after the curved grating, the wires travel over a straight line passing over several suction boxes, and then wrap approximately 6 degrees around the rotary cylinder. (Findings 141, 142, 145). I find that the path over the suction boxes totally defeats any possible close working relationship between the curved grating and the rotary cylinder. Further, a wrap of 6 degrees around the rotary cylinder does not constitute travel "around a part of the periphery" of the rotary cylinder as required in the suit patent. Although the claims of the '758 patent do not specify the number of degrees of the rotary cylinder around which the wires must travel, the specification and drawings indicate a path of approximately 90 degrees or more around the rotary cylinder. (Finding 145). The wires must, of necessity, pass around a significant portion of the rotary cylinder by reason of the fact that the purpose of this path of travel is to define a decreasing radius of curvature beyond the curved stationary

surface, which has the effect of increasing pressure on the stock between the wires, resulting in greater centrifugal dewatering. Herein lies a critical aspect of the invention. A wrap of 6 degrees around the rotary cylinder in Means does not achieve the necessary decreasing radius required in the '758 patent.

In construing the claims of the '758 patent, it is necessary to consider the specification. The claims and the specification, read together, define the invention. Grefco, Inc. v. Kewanee Industries, Inc., 208 U.S.P.Q. at 225, quoting United States v. Adams, 383 U.S. 39 (1966). In the Means configuration, the only significant radius of curvature over which the wires pass together is the curved grating. To the extent that centrifugal dewatering occurs at all, it can only occur over the curved grating. Thereafter, the path of wire travel is essentially straight. This structure is not that required by the '758 patent. The rotary cylinder in Means is positioned to ensure that the web will stay with the bottom wire at the point of separation of the top and bottom wires. It is not designed to accomplish centrifugal dewatering, and the wires do not pass around a sufficient portion of the cylinder for there to be any appreciable centrifugal force.

Finally, the rotary cylinder is not positioned "immediately following the stationary forming surface" within the meaning of claims 1 and 10 or "following the stationary forming surface" within the meaning of claim 12 of the suit patent. In the prosecution of the '758 patent, complainant indicated that it believed that the insertion of a dewatering element between the curved

stationary surface and the rotary cylinder would fall within the meaning of "immediately following" in the claims. It is not clear whether the examiner agreed with this interpretation. (Findings 113-115). Irrespective of the position of the examiner or complainant on this issue, I have found that in order for a dewatering element positioned between the curved stationary surface and the rotary cylinder to fall within the claims of the '758 patent, it must also be curved and positioned in such fashion that it does not disturb the continuous bi-radii curved path of wire travel having a first radius of curvature substantially larger than a second radius of curvature. Thus, I have specifically rejected the statement of Mr. Munday of Beloit's patent department that the interposition of a flat suction box between the curved stationary surface and the rotary cylinder would fall within the claims of the patent. (Findings 116-117).

The structure of the Means patent does not define a "continuous bi-radii curved path of wire travel," and the rotary cylinder is not positioned "immediately following" or "following the stationary surface" within the meaning of the '758 patent. Therefore, I find that neither the Means patent nor the PM2 at St. Francisville anticipates claims 1, 2, 3, 7, 8, 10, 11 and 12 of the suit patent.13/

13/ On January 13, 1984, complainant filed a motion to strike the last sentence of Section VIII of respondents' reply brief together with a printout of a British decision attached to the brief. (Motion Docket No. 147-12). Respondents oppose this motion.

The British decision at issue from the Chancery Division, Patents Court dismisses a motion for an interlocutory injuction in an infringement action brought by Beloit against Valmet. Respondents allege that the motion was dismissed, in part, because Beloit's patent issued without consideration by the examiner of Robinson and Means. In their opposition to Motion 147-12, respondents suggest that this British opinion should be accorded precedential consideration by this forum.

C. Obviousness

Under the provisions of 35 U.S.C. (103:

> A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

The Supreme Court has set forth the factual inquiries which will lead to a determination of obviousness or nonobviousness:

> [T]he 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 commerical success, long-felt but unsolved needs, failure of others, etc., might be utilized to give light to the circumstances surrounding the origin of the subject matter sought to be patented.

Graham v. John Deere Co., 383 U.S. 1, 17-18, 148 U.S.P.Q. 459, 467 (1966). It is implicit from the foregoing that obviousness "is a legal conclusion based on factual determinations and not a factual determination itself." Aktiebolaget Karlstads Mekaniska Werkstad v. United States International Trade Commission, 217 U.S.P.Q. 865, 872 (C.A.F.C. 1983).

In reaching a determination of obviousness or nonobviousness, "it is critical to the analysis to deliberately guard against using the teaching

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FN 13 con't :

It is clear from the opinion that it concerns only a motion for interlocutory injunction and is not a decision on the merits. Thus, there is no final decision from the judge on the issues of infringement or validity. Further, it is a matter of total speculation about the evidence on which this opinion is based. The rather cryptic references to what are apparently the Robinson and Means patents do not shed any useful light on the validity issues in this opinion. Under these circumstances, it is difficult to imagine what precedential value this opinion could conceivably be accorded.

Although I will not strike respondents' statement, nor the copy of the opinion, it should be apparent from my findings and opinion that the British opinion played no role in my determination. Accordingly, as stated herein, Motion 147-12 is denied.

of the patent in suit in arriving at the conclusions." General Electric Co. v. United States, 198 U.S.P.Q. 65, 80 (Ct. Cl. 1978). The issue to be determined, therefore, is "whether the teachings of the prior art would, in and of themselves and without the benefits of [complainant's] disclosure, make the invention as a whole, obvious." In re Nomiya, Kohisa, and Matsumura, 184 U.S.P.Q. 607, 612 (C.C.P.A. 1975), quoting In re Sponnoble, 160 U.S.P.Q. 237, 243 (C.C P.A. 1969) (citations omitted; emphasis in original).

1. Level of Skill in the Art

The hypothetical person of ordinary skill in the art is presumed to be familiar with all of the pertinent prior art. In re Sernacker, 217 U.S.P.Q. 1, 5 (C.A.F.C. 1983). It is also critical to determine the level of skill in the art at the time of the invention. This requires a conscious effort to avoid the temptation to rely on hindsight in making this analysis.

> It is wrong to use the patent in suit as a guide through the maze of prior art references, combining the right references in the right way so as to achieve the result of the claims in suit. Monday morning quarterbacking is quite improper when resolving the question of nonobviousness in a court of law.

Orthopedic Equipment Co., Inc. v. United States, 217 U.S.P.Q. 193, 199 (C.A.F.C. 1983). Finally, the level of skill in the art is stated in §103 to be "ordinary." Thus, the question is not whether the subject matter would have been obvious "to the rare genius in the art, or to a judge or other layman after learning all about the invention." Stratoflex, Inc. v. Aeroquip Corp., 218 U.S.P.Q. at 879.

The time of the invention in this particular case has been found to be January 24, 1968. (Finding 128). Complainant's and respondents' experts

were in relatively close agreement that the person of ordinary skill in the art in 1968-1969 had a degree in engineering and several years of hands-on experience in the field of papermaking, or alternatively, approximately twenty years' experience as a paper mill superintendant. (Finding 129).

2. Scope and Content of the Prior Art

The scope of the prior art is that "reasonably pertinent to the particular problem with which the inventor was involved." Id. at 876. In broad terms, the objective in the papermaking art at the time of the invention of the suit patent was to achieve higher machine speeds and an improved quality of web as compared to that which was previously attainable on fourdrinier forming sections. (Findings 77, 78). The development of twin-wire formers in the 1950's addressed this problem with formers that rapidly dewatered the stock in both directions through the forming wires. (Finding 79). By the time of the invention of the suit patent, those working in the art were concerned with solving the problems that had arisen with twin-wire formers. These problems included loss of fines with too rapid dewatering, resulting in poor quality web, spewing at the nip when the wires were unable to accommodate the volume of stock deposited by the headbox, resulting in lower machine speeds, and alternatively damage to the wires from excessive suction in dewatering, or damage to the web from certain types of centrifugal dewatering. (Finding 80).

During the course of prosecution of the '758 patent, the examiner cited ten prior art references over which he allowed the claims. Of the references cited, the patents most pertinent to the claims at issue in the present investigation

include the Graham '745 and '045 patents, de Montigny, Embry and Justus. (Finding 123). Respondents assert combinations of four additional prior art patents which they allege render the invention of the '758 patent obvious, namely Robinson, Means, the Justus French patent and Lee. Although these patents are relevant to the subject matter of the suit patent, I have found that none are more pertinent than the art cited by the examiner. (Findings 138, 148, 160).

In the process of assessing the scope and content of the prior art and combining certain references, several points are important. First,

> [i]t is impermissible within the framework of section 103 to pick and choose from any one reference only so much of it as will support a given position, to the exclusion of other parts necessary to the full appreciation of what such reference fairly suggests to one of ordinary skill in the art.

In re Wesslau, 147 U.S.P.Q. 391, 393 (C.C.P.A. 1965). Second, the mere fact that certain prior art references can be combined "does not make the combination obvious unless the art also contains something to suggest the desirability of the combination." In re Imperato, 179 U.S.P.Q. 730, 732 (C.C.P.A. 1973). Thus, the issue of patentability is to be considered

> in terms of what would have been obvious to one of ordinary skill in the art at the time the invention was made in view of the sum of all of the relevant teachings in the art, not in view of first one and then another of the isolated teachings in the art. (Emphasis in original).

In re Ehrreich and Avery, 200 U.S.P.Q. 504, 510 (C.C.P.A. 1979), quoting In re Kuderna, 165 U.S.P.Q. 575, 578-79 (C.C.P.A. 1970).

The prior art considered by the examiner as well as the additional art of record in this investigation is all concerned with optimizing methods of de-watering stock. This is seen to be done by varying means, including pressure,

tension, gravity, suction, air flow, and centrifugal force. Several prior art patents concern the use of a wire and a felt.

The Justus French patent discloses a system which uses a wire and a felt. A stationary surface is placed inside the felt at the point of convergence of the wire and felt. This shoe is curved to conform with the parabolic curve representative of the drainage curve of the stock. After passing the stationary shoe, the wires pass around a smaller radius roll which results in centrifugal dewatering through the wire. (Finding 155).

The Graham I patent also describes an apparatus using a wire and a felt. Its objective is to facilitate dewatering by applying tension on the stock as it passes around a curved surface while sandwiched between the wire and felt. It is also designed to avoid damage to the web by eliminating the reverse bend often used in the prior art to effect dewatering. (Finding 95-96).

The Graham II patent discloses a system which again utilizes a wire and a felt. The objective of the patent is to provide a tapering cavity into which stock is deposited from the headbox so as to allow gradual dewatering before passing the roll. A backing plate is provided behind the felt to prevent the felt from bowing. This plate may be curved with gradually decreasing radius so as to facilitate centrifugal dewatering. (Findings 98-100, 107-110).

The Justus '143 patent is similar to the Justus French patent with respect to the shoe on the upper wire, which shoe is a parabolic curve. This patent uses two wires, rather than a felt and a wire, and also discloses a

shoe which allows upward dewatering. (Findings 111, 112).

The patent to Lee is directed to dewatering stock by means of directional changes, including methods of protecting the stock from damage as it changes direction. Thus, dewatering is accomplished by means of centrifugal force through both wires by a reverse wrap. Centrifugal dewatering is also accompanied by suction and air flow. Lee uses two wires, and points out the difference in drainage characteristics between wire and felt. (Finding 157).

The patent to Embry discloses a system which modifies a fourdrinier forming section. The objective of the invention is to dewater stock through both wires at high speed without the use of suction boxes, which tend to produce drag and abrasive friction on the wires. This dewatering is accomplished by means of centrifugal force through both wires by a reverse wrap. (Finding 118).

The patent to de Montigny recognized that two significant problems to be overcome were the loss of fines and wire marks on the web that often resulted from rapid dewatering. The method of dewatering disclosed by de Montigny occurs through both wires by centrifugal force aided by application of air flow. Dewatering through both wires is accomplished by a reverse wrap. (Findings 91-93).

The Robinson patent is directed to dewatering stock without removing fines and without disrupting the web. The objective is to remove large

amounts of water from the stock substantially immediately after it is discharged from a slice, and to dispose of the water quickly. This is accomplished by controlling the convergence of the wires over an appreciable length after the slice, and gently, smoothly, and continuously expressing water from the stock through both wires. The dewatering that occurs in a downward direction is aided also by gravity. (Findings 130-138).

The Means patent is directed to solving several problems inherent in twin-wire formers, namely controlling the convergence of the wires while allowing lumps in the stock and snags in the wires to pass, providing inexpensive, but effective suction boxes, and separating the wires without damaging the web. The convergence of the wires is controlled by a curved forming box, which is designed to gradually increase the pressure on the web as it passes over the curved surface. Dewatering occurs as a result of tension on the wires, suction, gravity and some centrifugal force. (Findings 139-146).

From the foregoing prior art, a picture emerges of the nature of the problems to be solved, and the results of attempts to resolve them. First, it appears that use of a wire and a felt involved several considerations not present in twin-wire formers. These differences included such things as the elasticity of felt, the amount of tension that could be exerted on it, and its drainage properties. Dewatering by centrifugal force is used in each of Graham I, Graham II and the Justus French patent. (Findings 96, 99, 110, 155, 157).

However, due to the use of a felt, the configuration used to accomplish centrifugal dewatering had to be arranged so as to occur only through the wire.

Second, the prior inventions sought to achieve a balance in dewatering, so that it could be accomplished rapidly, but not so rapidly as to lose the fines and diminish the quality of the resulting paper. Although centrifugal force was an effective way to dewater stock, a reverse wrap in particular appeared to result in damage to the web. By contrast, the use of suction was apparently more expensive, but not commensurately effective, resulting in drag and abrasive friction on the wires.

Another frequent problem to be solved in twin-wire formers was flooding and spewing at the nip when the converging wires were unable to accomodate the volume of stock ejected from the headbox. This was the specific problem that led to the invention of the suit patent. (Findings 84-85).

Essentially all of the material elements of the '758 patent can be located in the prior art. In particular, it was known in the art that centrifugal force was an effective means of dewatering stock. (Graham I, Graham II, Justus French patent, Lee, De Montigny, and Embry). Further, it was known that a reverse wrap could damage the web, without compensating forces. (Graham I). Also, it was known that a curve of decreasing radius would increase the amount of centrifugal force. (Graham II). The prior art also disclosed varying means of accomplishing a gradual nip or a gradual build-up of pressure between the converging wires. (Graham II, Robinson, Means).

The presence of virtually all of the material elements of the '758 patent in the cited prior art is not dispositive of an obviousness determination.

> That all elements of an invention may have been old (the normal situation), or some old and some new, or all new, is however, simply irrelevant. Virtually all inventions are combinations and virtually all are combinations of old elements. A court must consider what the prior art as a whole would have suggested to one skilled in the art.

Environmental Designs, Ltd. v. Union Oil Co. of California, 210 U.S.P.Q. 865, 870 (C.A.F.C. 1983) (Citation omitted).

3. Differences Between the Prior Art and the '758 Patent

Although many elements from the prior art are present in the invention of the '758 patent, there are also several differences between the claimed subject matter of the suit patent and the prior art patents. Unlike the patents which disclose the use of a wire and felt, the '758 patent accomplishes dewatering through both wires. There are other differences in the use of felts in the forming section which are not fully developed on this record. In contrast to several patents which disclose the use of centrifugal force to dewater stock through both wires, the suit patent centrifugally dewaters only through one wire, and does not employ a reverse wrap.

The primary feature of the invention of the '758 patent is the positioning of the curved stationary surface immediately followed by a rotary cylinder of smaller radius, with both in close working relation so as to define a continuous bi-radii curved path of wire travel having a first radius of curvature substantially

larger than a second radius of curvature. This configuration results in a gradual build-up of pressure, preventing spewing at the nip and allowing initial gentle dewatering. Further, it provides ever increasing centrifugal dewatering due to the declining radius of curvature, while avoiding damage to the web that could be caused by a reverse wrap. This combination of elements is nowhere specifically disclosed or suggested in the cited prior art. Thus, I find the invention disclosed in claims 1, 2, 3, 4, 7, 8, 10 and 11 to be nonobvious over the prior art as a whole, and over the specific combinations suggested by respondents.

4. Secondary Considerations

The reviewing court of this Commission has mandated that when evidence of secondary considerations of nonobviousness are of record, they must be considered in reaching a determination on this issue. Stratoflex, Inc. v. Aeroquip Corp., 218 U.S.P.Q. at 879; Stevenson v. International Trade Commission, 204 U.S.P.Q. 276, 282 (C.C.P.A. 1979). However, there must be a nexus shown between the merits of the claimed invention and the evidence of secondary considerations under Graham. Stratoflex, Inc. v. Aeroquip Corp., 218 U.S.P.Q. at 879, citing Solder Removal Co. v. U.S. International Trade Commission, 199 U.S.P.Q. at 137.

The evidence on this record of commercial success and satisfaction of a long-felt, but unsolved need in the industry by Beloit's Bel Baie forming sections (which embody the claims of the suit patent), tend to strongly support a finding of nonobviousness. Paper produced on the Bel Baie has become the standard in the industry in the United States and Japan, and Beloit has sold a large number of Bel Baies worldwide. (Finding 150). This degree of commercial success

has been attributed to the ability of the Bel Baie to reach high levels of production while manufacturing a high quality of printing grade paper. The quality of the paper is a result of the even distribution of fines and fillers within the web, which is accomplished by the manner of dewatering carried out by the configuration of the suit patent. (Finding 150). In addition, the Bel Baie has proved to be economical to operate. (Finding 150).

By contrast, other types of forming sections have not experienced the degree of success of the Bel Baie. Notably the PM2 at St. Francisville, which is an embodiment of the Means patent, has consistently fallen short of expectations, both in terms of speed of production and quality of paper produced. The St. Francisville machine has required a substantial amount of down time due to problems in its operation. It appears to be the only machine of its kind ever built, and it is highly unlikely that it will ever be duplicated. (Finding 149). Other types of forming sections have produced an acceptable quality of paper, but have been more expensive to operate. (Finding 150).

On the basis of the foregoing, I find the invention of the '758 patent to be nonobvious under §103. In addition, I find that respondents have not met their burden of rebutting the presumptive validity of the suit patent under either section 102 or 103.

D. Duty of Candor

In the prosecution of a patent before the PTO, patent applicants are held to a high standard of candor and good faith. The standard of conduct is set forth in the PTO's Rules of Practice, Rule 56:

> (a) A duty of candor and good faith toward the Patent and Trademark Office rests on the inventor, on each attorney or agent who prepares or prosecutes the application and on every other individual who is substantively involved in the preparation or prosecution of the application .... All such individuals have a duty to disclose to the office information they are aware of which is material to the examination of the application. Such information is material where there is a substantial likelihood that a reasonable examiner would consider it important in deciding whether to allow the application to issue as a patent....

37 C.F.R. §1.56 (1982).

Although this obligation was not incorporated expressly in the PTO's Rules of Practice until 1977, it was merely a codification of a patent applicant's duty as it already existed in pertinent case law. True Temper Corp. v. C.F. & I. Steel Corp., 202 U.S.P.Q. 412, 419 n. 9 (10th Cir. 1979), citing Hazel-Atlas Glass v. Hartford-Empire Co., 61 U.S.P.Q. 241 (S. Ct. 1944), Admiral Corp. v. Zenith Radio Corp., 131 U.S.P.Q. 456 (10th Cir. 1961); and U.S. Industries, Inc. v. Norton Co., 210 U.S.P.Q. 94, 108 n.8 (N.D.N.Y. 1980).

To sustain a finding that complainant has breached its duty of candor toward the PTO in the prosecution of the suit patent, several elements must be found to exist:

1. a representation of a material fact;
2. the falsity of that representation;
3. the intent to deceive or, at least, a state of mind so reckless as to the consequences that it is held to be the equivalent of intent (scienter);
4. a justifiable reliance upon the misrepresentation by the party deceived which induces him to act thereon; and
5. injury to the party deceived as a result of his reliance on the misrepresentation.

Norton v. Curtiss, 167 U.S.P.Q. 532, 543 (C.C.P.A. 1970).

In view of the seriousness of the allegation that a patent applicant has engaged in fraudulent or inequitable conduct in the prosecution of a patent before the PTO, the party asserting such conduct bears a heavy burden of proof. Thus, in this case, respondents must prove the existence of fraud or inequitable conduct by complainant by clear, unequivocal, and convincing evidence. Pfizer, Inc. v. International Rectifier Corp., 190 U.S.P.Q. 273, 278-79 (8th Cir. 1976), cert. denied 429 U.S. 1070 (1977); Norton v. Curtiss, 167 U.S.P.Q. at 107; Corning Glass Works v. Anchor Hocking Glass Corp., 149 U.S.P.Q. 99, 107 (D. Del. 1966).

Respondents allege that the failure of Beloit to bring to the attention of the examiner the existence of PM2 at St. Francisville amounted to a breach of its duty of disclosure. This contention is based on the idea that although complainant cited the Means patent to the examiner, there is no teaching of centifugal dewatering in the patent, but the embodiment of Means in the St. Francisville machine expressly disclosed the existence of centifugal dewatering over the curved grating. (RB at 29-30).

The record demonstrates a sharp difference of opinion on this point. It was complainant's position throughout the hearing that the PM2 at St. Francisville did not show centrifugal dewatering. There is ample evidence that at the time of construction of the PM2, centrifugal dewatering was not a major issue. (Finding 144; CB at 21-23).

Notwithstanding my finding that there is a certain amount of centrifugal dewatering inherent in the structure of the Means patent, patent applicants are entitled "to exercise good faith judgment in deciding what matters are and are not of sufficient relevance and materiality to require disclosure." Xerox Corp. v. Dennison Mfg. Co., 168 U.S.P.Q. 700, 705 (S.D.N.Y. 1971); Certain

Limited-Charge Cell Culture Microcarriers, Inv. No. 337-TA-129, ID at 187 (1983). In view of the fact that complainant did cite the Means patent as a prior reference, and considering my findings that Means and PM2 at St. Francisville are not more pertinent than the prior art cited by the examiner and that they do not anticipate or render obvious the claims of the patent, the judgment exercised by complainant in this matter cannot be said to have been faulty. (Findings 147, 148, 161).

Respondents have not met their burden of establishing the materiality of the alleged omission. Thus, I find that complainant fulfilled its duty of disclosure to the PTO in the prosecution of the suit patent, and that the patent is enforceable.

INFRINGEMENT OF THE '758 PATENT

Complainant has the burden of proving that the accused devices infringe the claims of the '758 patent. That burden requires proving that the accused devices include each and every element recited in the claims at issue. Wolens v. F. W. Woolworth Co., 218 U.S.P.Q. 100 (7th Cir. 1983). SSIH Equipment S.A. v. U.S. International Trade Commission, 218 U.S.P.Q. 679 (C.F.A.C. 1983); Vekamaf Holland B.V. v. Pepe Benders Inc., 211 U.S.P.Q. 955 (D. Minn 1981). As noted in Findings 43-61, above, the evidence reveals that the accused devices lack at least two important elements recited in the claims of the '758 patent.

Nor can I find infringement under the doctrine of equivalents. As noted by complainant itself,

> Under the doctrine of equivalents, an accused product that does not literally infringe a structural claim may yet be found in infringement "if it performs substantially the same function in substantially the way to obtain the same result" as the claimed product or process.

Hughes Aircraft Co. v. United States, 19 U.S.P.Q. 473, 480 (C.A.F.C. 1983). (Emphasis added).

The record evidence herein shows that respondents' accused devices do not perform the same function in the same manner as the suit patent device. (Findings 69-75, above).

Since I find that there is no direct infringement, there can be no contributory or induced infringement.

IMPORTATION AND SALE

Evidence of record shows that there has been importation and sale in the United States of accused forming sections. A "modified" New Sym-Former was delivered to Abitibi/Augusta in the summer of 1983 and has been operating since October 1, 1983, and two Sym-Former R's have been sold for delivery to plants in the United States. (Findings 167-171). Therefore, the statutory requirement of importation and sale of the accused articles is satisfied.

DOMESTIC INDUSTRY

Definition

In patent-based §337 investigations, the Commission has customarily defined the domestic industry as the domestic operations of the patent owner 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) (Plastic 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, H. Rep. No. 93-571 at 78, (93d Cong., 1st Sess. (1973). (Trade Reform Act). Since the term "domestic industry" is not precisely defined in §337, the Commission does not adhere to any rigid formula in determining the scope of the domestic industry, but will examine each case in light of the realities of the marketplace. Certain Apparatus for the Continuous Production of Copper Rod, Inv. No. 337-TA-52, 206 U.S.P.Q. 138, (1979) (Copper Rod); Slide Fastener Stringers, supra.

Exploitation of patent rights may include domestic production and manufacture, development, servicing, licensing, and sale of the patented product. Plastic Tubing; supra; Certain Molded-In Sandwich Panel Inserts and Methods for Their Installation, Inv. No. 337-TA-99, 218 U.S.P.Q. 832 (1982) (Sandwich Panels); Certain Spring Assemblies and Components Thereof and Methods for Their Manufacture, Inv. No. 337-TA-88, 216 U.S.P.Q. 225 (1981) (Spring Assemblies); Certain Automatic Crankpin Grinders, Inv. No. 337-TA-60, 205 U.S.P.Q. 71 (1979) (Crankpin Grinders); Copper Rod, supra. When some of the manufacturing of the patented product occurs outside of the geographic boundaries of the United States, analysis of the nature and scope of the domestic industry must also consider the nature and significance of the operations occurring within the

the United States, compared to those which occur abroad, and assess the relative importance of the value added domestically. Certain Cube Puzzles, Inv. No. 337-TA-112, 219 U.S.P.Q. 322 (1982) (Cube Puzzles); Certain Miniature, Battery-Operated, All-Terrain, Wheeled Vehicles, Inv. No. 337-TA-122, (Toy Vehicles), aff'd sub nom, Schaper Manufacturing Co. v. U.S. International Trade Commission, Slip Opinion, Ap. No. 83-713, (C.A.F.C. September 22, 1983) (Schaper); Certain Airtight Cast-Iron Stoves, Inv. No. 337-TA-69, 215 U.S.P.Q. 963 (1981) (Stoves).

The nature and scope of the domestic industry in the present investigation must be determined in view of the patent alleged to have been infringed, and the exploitation within the United States of the rights afforded by that patent. Complainant maintains that the domestic industry is defined by those activities related to the manufacture, sale, and servicing of various formers which embody the features of the '758 patent. It includes in this assertion its Bel Baie I, Bel Baie II, Bel Baie III, and modified Bel Roll formers. (Finding 163).

A. The Bel Baie Formers

The threshold inquiry in determining the existence of a domestic industry for the Bel Baie formers is whether said formers are designed in accordance with the teachings of the '758 patent. Certain Roller Units, Inv. No. 337-TA-44, 208 U.S.P.Q. 141 (1979) (Roller Units); Certain Combination Locks, Inv. No. 337-TA-45, 205 U.S.P.Q. 1124 (1979) (Combination Locks). Complainant's expert witness, Mr. Waller, has described how the Bel Baie formers embody each of the elements stated in the claims of the suit patent. Respondents have offered no evidence in opposition to this testimony and, indeed, do not contest the fact that the Bel Baie formers of complainant read on the suit patent. Moreover, a comparison of the features of the Bel Baie II as revealed in CPX C and CPX D, with the elements of the claims in issue, supports Mr. Waller's testimony. (Finding 164). The Bel Baie I and Bel Baie III forming sections likewise embody the elements of the suit patent at issue in this investigation. (RX 98; RX 153, p. 28). Thus, I find that the Bel Baie formers are manufactured in accordance with the teachings of the '758 patent.

The relevant domestic industry in this investigation must be defined as that portion of complainant's resources that are devoted to the manufacture, sale and servicing of the Bel Baie forming sections. Sandwich Panels, supra; Spring Assemblies, supra. Respondents contend that no domestic industry exists for the Bel Baie forming sections because the Bel Baie formers have not been manufactured at Beloit PMD for sale in the United states since 1978. The legislative intent and the Commission's precedents with respect to the "definition" of the domestic industry evince no support for respondents' restrictive "definition" of the domestic industry, which recognizes only those instances of the Bel Baie's domestic manufacture in which such Bel Baies are sold in

the United States. Respondents appear to have confused the domestic industry's definition, which is based on manufacture or production of the subject product, Plastic Tubing, supra, with injury analysis of said domestic industry, which must be based on lost sales in the United States. Respondents' "definition" of the domestic industry contravenes the Commission mandate that the injury requirement under §337 represent a separate inquiry which requires independent proof. See, e.g., In the Ear Hearing Aids, T.C. Pub. 182, at 28 (1966) Statement of Commissioners Sutton and Thunberg; Spring Assemblies, supra at 43-44. Consequently, for the purposes of establishing the existence and definition of the domestic industry, the last Bel Baie produced in the United States was C for sale to of Taiwan in 1981-82. (Finding 197).

Beloit continues to maintain manufacturing facilities at PMD, which C comprise approximately square feet, and has employees who are directly involved in manufacturing papermaking machines. While there exist no separate plants or separate facilities at PMD used to manufacture Bel Baie formers as opposed to use for other manufacturing purposes, the equipment that would be used to make Bel Baies is also used to make other parts C of papermaking machines. Additionally, PMD has spent approximately since 1979 in acquiring new equipment or rebuilding existing equipment to C increase productivity, efficiency and quality. In fiscal 1984, over C of capital expansion has been targeted for Beloit PMD. (Findings 175-176, 193, 249, 253). Beloit's inability to identify specific resources that are dedicated exclusively to the production of the Bel Baie formers, be they plant facilities labor or capital equipment, does not bar the inclusion of activities related to the manufacture of Bel Baies from the definition of domestic industry. See, e.g., Certain Headboxes and Papermaking Machine Forming

for the Continuous Production of Paper and Components Thereof, Inv. No. 337-TA-82, RD at 109 (1981). (Headboxes).

In view of the sporadic nature of demand for new papermaking machines in recent years,[14/] the fact that a Bel Baie has been manufactured at PMD as recently as 1981-82 and the capital investments cited above which reveal PMD's continued commitment to the manufacture of forming sections at PMD since that time, are sufficient evidence to establish the existence of a domestic industry for the Bel Baie, as required by Section 337. (Finding 212).

Additionally, the fact that Beloit's domestic operations contribute a significant "value-added" portion to the total cost of Bel Baies manufactured for sale in this country by Beloit's foreign subsidiaries and licensees, also establishes the existence of a domestic industry for the Bel Baies. (Finding 212).

Beloit's United States activities in connection with foreign manufacture of the Bel Baie are of an appropriate nature and of sufficient amount as to constitute a domestic industry. When a forming section is manufactured outside the United States, all planning engineering and detailed engineering drawings are developed at PMD. (Findings 179-181, 191-192). Also, certain parts and fabrications will be manufactured and/or purchased in Wisconsin and shipped to the site of manufacture, where they are installed and made operational by PMD personnel. (Findings 187-189, 207). Once the machine is operating, all future maintenance and repair parts are furnished

14/ While predominantly used as part of a new paper machine, the Bel Baie former also has been used as part of a rebuild. (See Finding 195).

by PMD. (Finding 183). The manufacture of replacement and repair parts by PMD constitutes a major part of PMD's total volume of business in a normal year and accounts for at least of its profits. (Finding 184).

Since the time of the last U.S. sale of a U.S.-made Bel Baie, Beloit has sold and installed a Bel Baie II former at in Washington (hereinafter referred to as). This forming section was manufactured in Japan. (Finding 198). All of the above-mentioned Beloit domestic activities occurred in the sale, manufacture and installation of the Bel Baie former at Specifically, all research and development, certain manufacturing portions of the engineering, sales and general adminstrative activities, and field erection and start-up activities were performed by PMD. (Findings 200, 202, 204-207). PMD personnel in the United States, in consultation with the customer, made numerous amendments and modifications to the engineering specifications for the Bel Baie, which changes were then transmitted by PMD to Beloit personnel also purchased and manufactured in the United States spare parts and components for the forming section. (Finding 206).

Of the total manufacturing cost of the forming section for the project, set forth as complainant has calculated the U.S. valued-added for the project to be or roughly (Finding 201).

Although respondents have questioned the manner and accounting methods by which complainant calculated the domestic value-added for the project, they have failed to introduce any substantive evidence which refutes their accuracy. In addition, several activities applicable and quite significant to the U.S. value-added calculation were excluded from complainant's figure. These

include all erection and startup activities in connection with the Bel Baie former for the project. Also, future replacement and repair parts for the Bel Baie, exclusive of those covered by the warranty costs, will be provided by PMD. (Findings 183-187, 207, 211).

The foregoing activities qualify for inclusion in this domestic industry analysis. Although research and development alone do not constitute the basis for an "industry" under §337, Schaper, supra, Slip Opinion at 9 n.7, Beloit's activities in the United States related to manufacture, sale and servicing of forming sections is not limited solely to research and development. Because the Bel Baie forming section is a custom-built machine, specific drawings and detailed specifications must be developed for each order. (Findings 190-191). The nature of PMD's research and development with respect to the manufacture, sale and installation of the Bel Baie former cannot be equated with the patentee's activities in Schaper, supra, which were described by the Court of Appeals for the Federal Circuit as a "general business of designing and inventing many kinds of toys ... for many firms, but most of this activity is ... unrelated in any way to the [product in issue]." Id.

Moreover, the extensive start-up and servicing activity conducted by Beloit with respect to the Bel Baie forming section (Findings 183-189) is appropriately part of the domestic industry. Stoves, supra; Toy Vehicles, supra, at 6 n.9. The repair and maintenance work performed by Beloit with respect to the Bel Baie forming section is quite similar to the repair and testing activities of complainant in Stoves, supra, which tasks were included in the domestic industry because the nature of these activities are "integrally related" to the product sold. Toy Vehicles, supra, at 6 n.9; Stoves, supra, at 10-11; see also Certain Airless Spray Paint Pumps and

Components Thereof, Inv. No. 337-TA-90, 216 U.S.P.Q. 465 (1981). PMD's repair and maintanence activities stand in sharp contrast to complainant's repackaging and manufacturing design activities as an importer in Toy Vehicles, which the Commission described as "more akin to an 'assist' which are often provided by a buyer of imported merchandise." Id. at 6 n.9.

C Thus, Beloit's domestic operations in connection with the sale, although numerically a smaller percentage than the value-added in Cube

C Puzzles (rather than 50%), are sufficient to constitute a domestic industry when field erection, start-up engineering, post-installation maintenance and the manufacture of repair and replacement parts by PMD are included, thus increasing the domestic value-added figure arrived at by complainant. (Findings 201-202, 204, 207-212).

B. The Modified Bel Roll Former

As heretofore mentioned with respect to the Bel Baie formers, the threshold inquiry in determining the existence of a domestic industry for the modified Bel Roll former is whether said former is designed in accordance with the teachings of the '758 patent. Roller Units, supra; Combination Locks, supra. Complainant's expert witness, Mr. Waller, has testified that the modified Bel Roll (Bel Roll with the shoe) embodies all of the features of the '758 patent. Respondents did not directly oppose such testimony as it is respondents' position that no industry involving a modified Bel Roll exists. For the reasons stated in Finding 165, the modified Bel Roll is not designed in accordance with the teachings of the suit patent. Accordingly, I find that the modified Bel Roll cannot be included in the domestic industry, as defined by Section 337. (Findings 165-166).

If the modified Bel Roll were found to be designed in accordance with the teachings of the suit patent it would, nevertheless, not be included in the domestic industry in this investigation for the further reasons set forth below. (Finding 247).

No "modified" Bel Roll containing a forming shoe has ever been manufactured by Beloit (Finding 214). Additionally, there exists no convincing evidence of record which would indicate that the conception of a Bel Roll with a forming shoe, also known as the modified Bel Roll, existed prior to (Finding 215).

performance test of the modified Bel Roll has been carried out by Beloit's technicians at Beloit's pilot machine site. Their conclusion

was that the addition of a shoe to the regular Bel Roll

(Finding 166).

Beloit has offered the modified Bel Roll former as an "option" in each of several potential sales. In each case, the modified Bel Roll was not Beloit's main offer and was one of several formers presented to the customer. No modified Bel Rolls have been sold as a result of these offers

Beloit has developed another former, the Bel Blade, which, in Beloit's own opinion, combines the advantages of both the Bel Roll and the Bel Bond. Beloit sold four Bel Blade formers in 1983. (Findings 221-229, 231-234, 242-247).

(Finding 238).

In view of the above facts, it is clear that no "modified" Bel Roll has ever been produced or sold by Beloit,

Therefore, aside from the question as to whether a "modified" Bel Roll is covered by the suit patent, complainant has not shown that a "domestic industry" exists, as is required by Section 337, insofar as the "modified" Bel Roll is concerned. (Finding 248).

EFFICIENT AND ECONOMIC OPERATION

In order to prevail under Section 337, complainant must establish that the domestic industry, as defined, is efficiently and economically operated. The criteria established by the Commission to be indicative of efficient and economic operation include: (1) use of modern equipment and procedures; (2) substantial investment in research and development; (3) profitable operations; (4) competent, highly trained, technical work force; (5) effective quality control program. Plastic Tubing, supra; Slide Fastener Stringers, supra; Certain Stabilized Hull Units and Components Thereof and Sonar Units Utilizing Said Stabilized Hull Units, Inv. No. 337-TA-103, 218 U.S.P.Q. 752 (1982) Certain Coin-Operated Audiovisual Games and Components Thereof, Inv. No. 337-TA-105, 214 U.S.P.Q. 217 (1982); Headboxes, supra, Crankpin Grinders, supra.

Respondents contend that, if there is a domestic industry, it is not efficiently and economically operated. Respondents further allege that C PMD's sales of Bel Baie formers and that PMD has C In view of the nature of this industry, and in the context of all of the foregoing indicia of economy and efficiency of operation, I find that PMD's operations do not warrant the adverse inferences asserted by Valmet.

C Since 1979, Beloit has directed approximately in capital expenditures toward the replacement and rebuilding of equipment devoted to the manufacture of papermaking machines. Of this amount, PMD has expended C approximately on new equipment and approximately on major machine tools since 1981. Additionally, in fiscal 1984, of C capital expansion was budgeted for the Beloit Paper Group. Over of this amount has been targeted for PMD. (Findings 249, 253).

As a result of its capital expenditures on machinery projects, Beloit has been able to improve the efficiency of its operations at PMD. An example of this improved efficiency is found in the operations of the

C which greatly reduces in the manufacture of a Bel Baie, thus resulting in the completion of the machining process for a Bel Baie in less time. (Finding 251).

The Paper Machinery Division (PMD) manufacturing facilities at Beloit,

C Wisconsin, and Rocton, Illinois comprise approximately square feet. Research and development for the forming sections is conducted at Beloit's research facility at Rocton, Illinois. Sales offices for the forming sections are located at Mobile, Alabama and Portland, Oregon. PMD

C currently has employees, of whom are directly involved in manufacturing and the balance are divided between engineering and sales. (Findings 175, 176).

In addition to capital investments in its manufacturing facilities, PMD has made improvements in its systems and procedures to increase productivity

C in the manufacture of its forming sections. PMD has implemented the

C in order to produce more accurate and less costly designs and drawings. PMD has also changed its labor reporting

C procedures

C (Finding 254).

Mr. Jenkins, the Manager of Manufacturing at PMD, estimated that PMD has

C the capacity to manufacture between and forming sections per year.

C forming sections were delivered during 1983 and forming sections are presently in production. (Finding 176).

Valmet asserts that the profit level at which Beloit has sold PMD manufactured Bel Baie formers to date compels the conclusion that Beloit's PMD facilities are not economically and efficiently operated. Respondents' allegations unnecessarily denigrate Beloit's manufacturing operations. Respondents base their assertion on the fact that PMD's profit margin on its sale of
C Bel Baies since 1976 has been (RX-466). Yet, no evidence exists on the record to establish an industry standard by which to evaluate PMD's profit percentage. PMD's profit, in absolute terms, on the sale of Bel Baie formers has been substantial. The last Bel Baie (Bel Baie II) produced at PMD in 1981-82 for Chung Hsing Paper Corp. of Taiwan resulted in a profit
C of (RX-466).

Valmet also asserts that Beloit's ability to make on-time deliveries on
C only percent of its orders is further evidence of PMD's inefficient and uneconomic operation. Once again, no evidence exists on the record of an industry standard for on-time deliveries against which to compare and evaluate PMD's record concerning on-time delivery of its orders. Further,
C internal self-criticisms by Beloit's management concerning
C of Beloit's products, does not negate the many positive factors about this company's operations which are revealed in the record. (Findings 249-254).

Therefore, on the basis of the evidence of record, I have found that the domestic industry, as defined herein, is efficiently and economically operated within the meaning of Section 337.

INJURY

To prev il under §337, complainant must prove not only that respondents engaged in the unfair methods of competition and unfair acts alleged, but that respondents' unfair methods of competition and unfair acts have had the effect or tendency to destroy or substantially injure the domestic industry. The Commission has frequently emphasized that the unfair act and injury requirements under Section 337 are separate and require independent proof. See e.g., In the Ear Hearing Aids, supra, at 28; Spring Assemblies, supra, at 43-44, 216 U.S.P.Q. at 242.

Although the Commission has recognized that a patentee is entitled to a monopoly on sales of the patented product and lawful exploitation of patent rights in the United States, "[t]he complainant is not released from the burden of establishing substantial injury, or of showing the requisite causal connection between the imports and injury." Spring Assemblies, supra, at 44. As stated by Commissioner Stern:

> This Commission has the obligation to make a judgement as to the causal relationship between the subject imports and any substantial injury to a domestic industry based on the reality demonstrated by the facts on the record and not on a per se analysis based on the same facts establishing the unfair act.

Id. at 44 n.37. Therefore it will be necessary to determine both whether there is injury to the domestic industry and whether such injury is caused by respondents.

The Commission has enumerated several guidelines for determining injury to the domestic industry. Relevant factors include declining sales, lost customers, decreased employment, decreased production, and decreased profitability combined with excess capacity. Furazolidone, T.C. Pub. 299, at 19-21 (1969) Statement of Commissioners Sutton and Newsom; Lightweight Luggage, T.C. Pub. 463, at 7 (1972); Convertible Game Tables, T.C. Pub. 705, at 16-17 (1974); Reclosable Plastic Bags, Inv. No. 337-TA-22, 192 U.S.P.Q. 674; Roller Units, supra; Certain Flexible Foam Sandals, Inv. No. 337-TA-47, RD at 4 (1979); Spring Assemblies, supra, at 42-49; Certain Drill Point Screws for Drywall Construction, Inv. No. 337-TA-116 (1983) (Drill Point Screws).

A. Substantial Injury

Complainant alleges that it has experienced declining sales and lost customers due to respondents' sales of the allegedly infringing forming sections. Specifically, complainant alleges three sales lost to respondents as follows: (1) Augusta PM2; (2) Augusta PM1, and (3) FSC Paper Corp. (Findings 264-282). Consequently, complainant contends that it has experienced decreased employment, production and profitability as a result of these lost sales.

Respondents and the Commission investigative attorney contend that

any past injury to the domestic industry has not been caused by respondents' sales of the Sym-former R. On the basis of the evidence adduced in this investigation, it is found that there exists no substantial injury to the domestic industry.

The only bidders for Abitibi's new Augusta PM 2 paper machine were Beloit and Valmet. Beloit offered a Bel Baie II forming section to Augusta while Valmet offered a Sym-Former N forming section, a machine no alleged by complainant to infringe the suit patent. Augusta selected the Sym-Former N for PM2 rather than the Bel Baie II. After Augusta placed its order with Valmet for the Sym-Former N, respondents proposed that the Sym-Former R be installed in place of the Sym-Former N. Augusta accepted this proposal and proceeded to purchase the Sym-Former R. (Findings 264-266).

The Augusta PM2 transaction does not represent a lost sale to Beloit based upon direct competition between the products involved in this investigation. Augusta chose to purchase Valmet's Sym-Former N rather than Beloit's Bel Baie II. Augusta's decision to switch to the Sym-Former R rather than the Sym-Former N occurred after Valmet received Augusta's order and had constructed a significant portion of the papermaking machine. Abitibi's Senior Vice President testified that there was no reason to reconsider the Bel Baie II at the time that Augusta decided to purchase the Sym-Former R rather than the Sym-Former N. (Findings 266-267). It is clear that had the Sym-Former R not been selected by Augusta for PM2 that Augusta would have purchased the Sym-Former N, as was evidenced by Augusta's initial decision to select the Sym-Former N as a result of direct competition

between the Sym-Former N and the Bel Baie II.

Following its purchase of a papermaking machine from Valmet for PM2, Augusta chose to purchase a rebuild from Valmet for its already existing PM1 fourdrinier, to be installed in 1984. Augusta did not solicit bids for the PM1 sale, but rather chose to purchase a Valmet rebuild (a Sym-Former R) in order to ensure that both machines utilize the same equipment as well as were serviced by the same technicians. (Finding 268).

Although Augusta purchased a rebuild from respondents for PM1 which included a Sym-Former R, Beloit's loss of the PM1 sale was not caused by Valmet's sale of this allegedly infringing forming section. In making its previous purchasing decision for PM2, Augusta displayed a clear preference for the Valmet Sym-Former N forming section over the Bel Baie II forming section. (McLenaghan, SX 5, p. 7, 10). Based on Augusta's preference for the Sym-Former N over the Beloit Bel Baie II in the PM2 sale, it is reasonable to infer that, had Augusta not selected the Sym-Former R for PM1, it would have selected the Sym-Former N. (Findings 264-266).

Augusta's selection with respect to PM1 was motivated by a desire to maintain the same product quality on both PM2 and PM1, as well as to utilize the same service technicians. (Finding 268). Given Augusta's preference for the Sym-Former N over Beloit forming sections and its above-mentioned criteria for selection for the PM1 rebuild, a Beloit forming section would not have been selected for the PM1 rebuild had the Sym-Former R not been purchased by Augusta.

Additionally, there is no evidence of record that Beloit would have offered a forming section for the PM1 rebuild which would fall within the definition of the domestic industry in this investigation. (See Finding 309, concerning Beloit offers of units not covered by the suit patent where "rebuilds" are involved).

The only other sale in this country by respondents, up to this time, was the sale of a Sym-Former R to FSC Paper Corporation. FSC made the decision to purchase a top wire forming section for the rebuild of its existing fourdrinier in February 1983. Among the vendors competing or this sale were Beloit and Valmet. In April 1983, Beloit offered a Bel Roll forming section, a former not manufactured in accordance with the '758 patent, and Valmet offered the Sym-Former R forming section. On June 24, 1983, FSC indicated in a letter to TVW (Valmet's U.S. subsidiary) its intention to purchase a Valmet Sym-Former R and enclosed a payment on the order. By June 27, 1983, Beloit was aware that FSC had eliminated all suppliers except Escher-Wyss and Valmet. Nevertheless, in a letter to FSC dated June 28, 1983, Beloit offered a "Bel Roll former ... with a curved ceramic shoe between the forming roll and center roll." (Findings 269-281). Even if such a former were covered by the suit patent, such offer came well after Beloit had been eliminated as a potential supplier.

No domestic industry has been found to exist for the modified Bel

Roll (Finding 248). Thus, the FSC transaction could not injure the domestic industry involved herein. Even if a domestic industry were found to exist for the modified Bel Roll, FSC's purchase of a Sym-Former R forming section does not constitute a lost sale within the meaning of Section 337. FSC's Vice President and General Manager testified that FSC had reached its final decision in this matter prior to the receipt of Beloit's letter. (Finding 281). Thus, there existed no direct competition between the products in issue. Hence, there is no causation linking respondents' successful bid for a Sym-Former R and complainant's failure to sell FSC a forming section.

Consequently, complainant has failed to prove by a preponderance of the record evidence that its domestic industry devoted to the subject forming sections has been substantially injured by respondents' importation and sale of the allegedly infringing forming sections. (Finding 282).

B. Tendency To Substantially Injure

As stated in the legislative history of §337, "[w]here unfair methods and acts have resulted in conceivable loss of sales, a tendency to substantially injure such an industry has been established." Trade Reform Act, supra, at 78, citing In re Von Clemm, 168 U.S.P.Q. 371 (C.C.P.A. 1955) (Von Clemm). Commission precedent indicates that a tendency to

substantially injure also may be found where the respondent has substantial capacity to manufacture and export, together with the intention to export and undersell the domestic product, resulting in the inability of complainant to compete effectively. Plastic Tubing, supra, at 13-18.

To support its contention that respondents' activities in the United States establish a tendency to substantially injure the domestic industry, complainant points to respondents' level of market penetration, C by respondents, and respondents' apparent capacity and intent to increase its sales of the allegedly infringing formers in the United States. Additionally, complainant cites instances of current direct competition between Beloit's Bel Baie and Valmet's accused formers as representing future sales and customers which are potentially lost to the domestic industry.

Respondents counter these contentions by alleging that complainant, despite the depressed market, has been able to make a profit. Respondents also contend that competition between Beloit's Bel Baie and Valmet's Sym-Former concept is based on technologies different from that found in the suit patent.

Valmet has stipulated that its current costs of manufacturing the C accused forming sections C (Finding 286). Valmet also concedes that it does not expect such current costs of manufacture to increase significantly in the future, except as may be

required by fluctuations in currency exchange rates and inflation. (Finding 287).

Presently, Valmet has the capacity to manufacture approximately C Sym-Former R's or new Sym-Formers in a calendar year. Valmet intends to increase its sales of forming sections in the U.S. market. It also possesses the capacity to maintain its present market share in C the U.S. and to increase its market share in 1984 to percent. (Findings 288-90).

Valmet's commitment to the United States market is evidenced further by the existence of outstanding orders or offers to sell New Sym-Former and Sym-Former R forming sections in this market. Combination Locks, supra, at 11. (Finding 306). While complainant has established no actual loss of sales, potential lost sales are sufficient to establish a tendency to injure the domestic industry, as defined herein. Von Clemm, supra.

Furthermore, if the modified Bel Roll former were found to embody all of the features of the suit patent and to be within the domestic industry, as defined in Section 337, there would be further evidence of a tendency to injure the domestic industry, based on the analysis C of Valmet's foreign capacity and intent with respect to future sales of the Sym-Former R. The record shows that in several current negotiations for forming section rebuilds, respondents are offering the Sym-Former R in direct competition with Beloit offers which include the modified Bel Roll, among other alternatives. (Finding 309). If the modified Bel Roll were a part of the domestic industry, such evidence would further support the finding herein of a tendency to injure the domestic industry.

Both Beloit and Valmet project that bookings will increase within the next year, with greater activity concentrated in the rebuild market, although some growth is predicted in sales of new machines. (Finding 304). The Bel Baie is available to compete in the rebuild market, although this is not its primary usage. (Finding 307). In any event, even the rebuild market is necessarily limited by the number of papermaking machines for which rebuilds are being sought at any particular time. This fact combined with the limited projected growth in the demand for new machines highlights the nature of Beloit's potential injury, for only a finite number of sales of Bel Baies can be made to these customers. In this respect, the instant investigation is distinguishable from those Section 337 investigations involving mass-merchandised products with a potentially unlimited market. See, e.g., Certain Vacuum Bottles and Components Thereof, Inv. No. 337-TA-108 (1981); Cubes, supra; Schaper, supra.

The record demonstrates that respondents enjoy a foreign

C and that they possess the manufacturing capacity and intent to penetrate further the United States market. Additionally the limited number of potential future sales of forming sections and specific instances of current direct competition between Beloit and Valmet establish the strong potential for future lost sales and customers by Beloit. The record also demonstrates that, but for the loss to Valmet of such future sales, Beloit would probably produce the Bel Baie formers for such potential customers in the United States at PMD. (Finding 178, 302). In view of the infrequency

of sales in this market, and the substantial dollar value of a single former, the loss of even one sale by the domestic industry would represent substantial injury. Certain Large Video Matrix Display Systems and Components Thereof, Inv. No. 337-TA-75, at 22-23, 213 U.S.P.Q. 475 (1981).

In view of these facts, I find that respondents' present activities, capacity and intent demonstrate a tendency to substantially injure the domestic industry, as the domestic industry is defined herein.

CONCLUSIONS OF LAW

1. The Commission has jurisdiction over the subject matter of this investigation.

2. U.S. Letters Patent 3,726,758 is valid and enforceable.

3. The accused devices of respondents, the Sym-Former R and New Sym-Former forming sections, do not directly infringe claims 1, 2, 3, 4, 7, 8, 10, 11 or 12 of the '758 patent, thus there is likewise no contributory or induced infringement of these claims of the '758 patent.

4. The domestic industry in this investigation consists of those portions of complainant Beloit's Paper Machinery Division located in the United States which are devoted, in part, to the manufacture, sale and service of twin-wire forming sections covered by the claims of the '758 patent, that is, the Bel Baie I, II and III models of complainant's forming sections.

5. Such domestic industry is efficiently and economically operated.

6. If the respondents had committed unfair acts, as alleged in this investigation, such acts would not substantially injure, but would have the tendency to substantially injure the domestic industry defined by the claims of the '758 patent.

7. Complainant has not established the existence of a violation of 19 U.S.C. 1337 by respondents.

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 of the pleadings and arguments presented orally and in briefs, as well as proposed findings of fact and conclusions of law, it is the Presiding Officer's DETERMINATION that there is no violation of Section 337 in the unauthorized importation into and sale in the United States of the accused papermaking machine forming sections for the continuous production of paper and components thereof.

The Presiding Officer hereby CERTIFIES to the Commission this 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 Presiding Officer; and further,

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 in camera for reasons of business, financial and marketing data found by the Presiding Officer to be cognizable as confidential business information under

Rule 201.6(a) is to be given five-year in camera treatment from the date this investigation is terminated;

2. As provided herein, Motion No. 147-12 is denied;

3. The Secretary shall serve a 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 Presiding Officer in this investigation; and further,

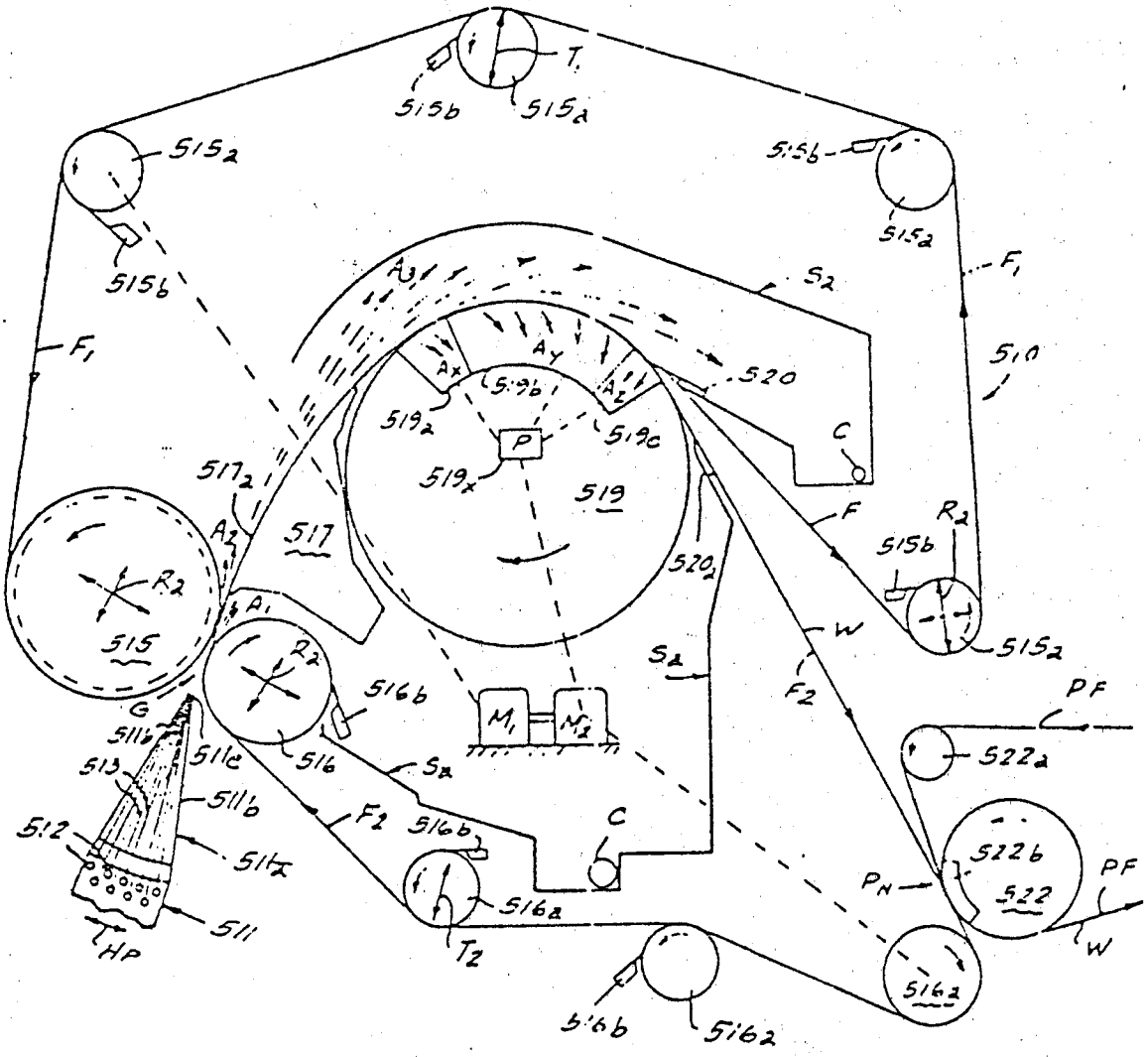
4. This Initial Determination shall become the determination of the Commission thirty (30) days after the service thereof, unless the Commission, within thirty (30) days after the date of filing of the Initial Determination shall have ordered review of the Initial Determination or certain issues therein, pursuant to 19 C.F.R. 210.54(b) or 210.55 or by order shall have changed the effective date of this Initial Determination.

John J. Mathias

Judge John J. Mathias
Presiding Officer

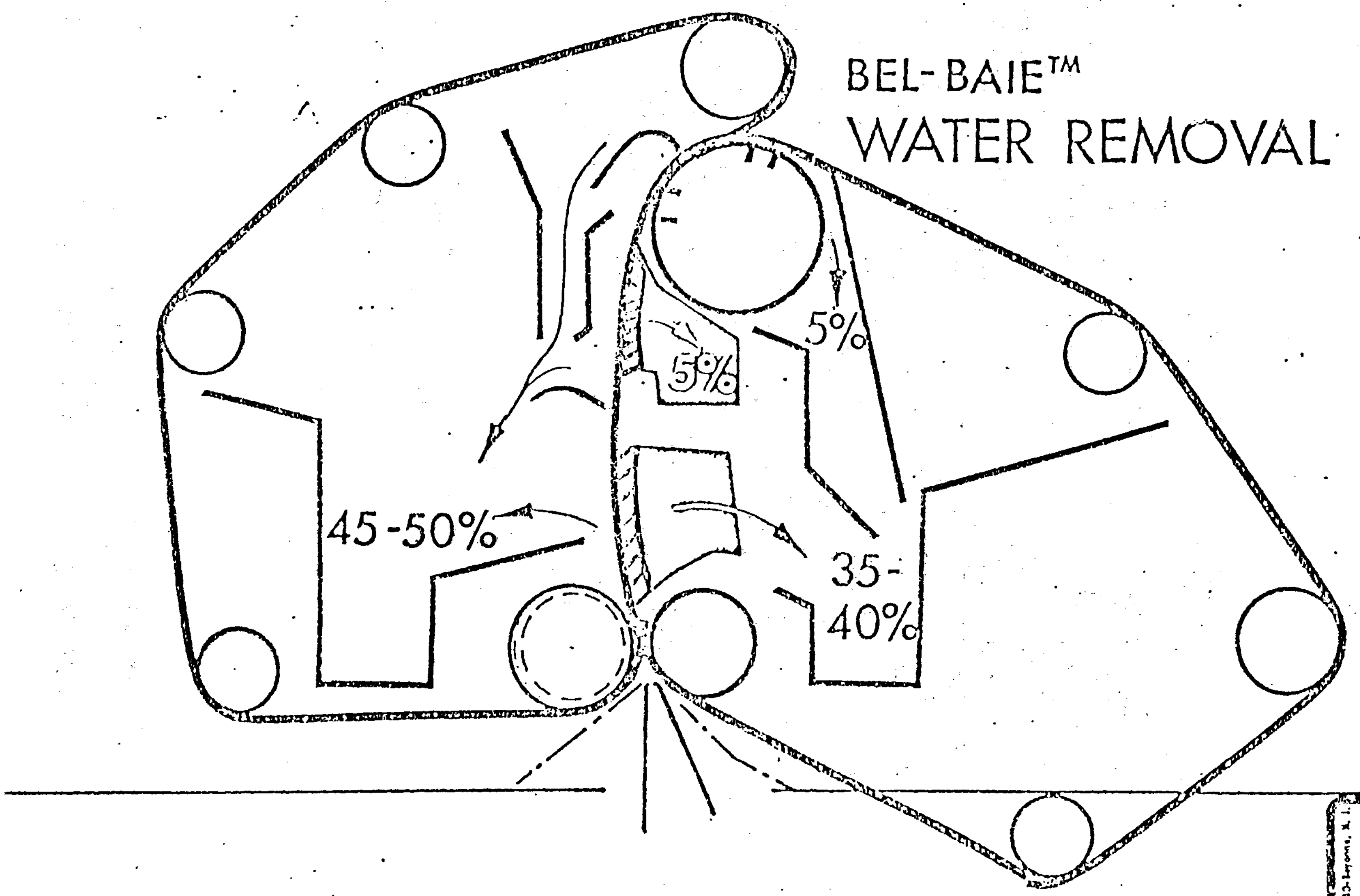
Issued: February 13, 1984

Fig. 8

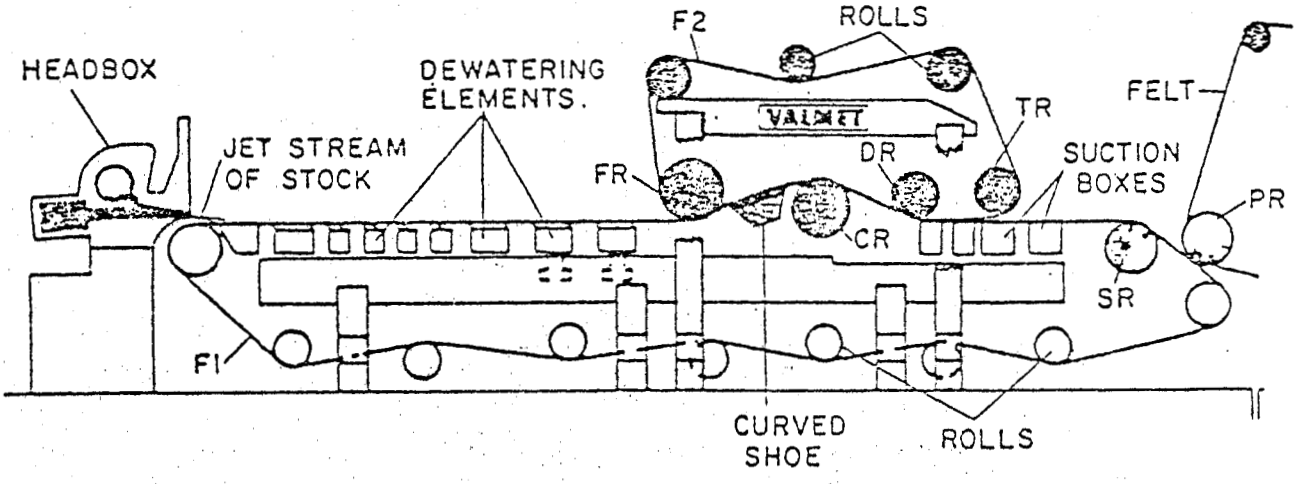


ATTACHMENT I

BEL-BAIE™ WATER REMOVAL

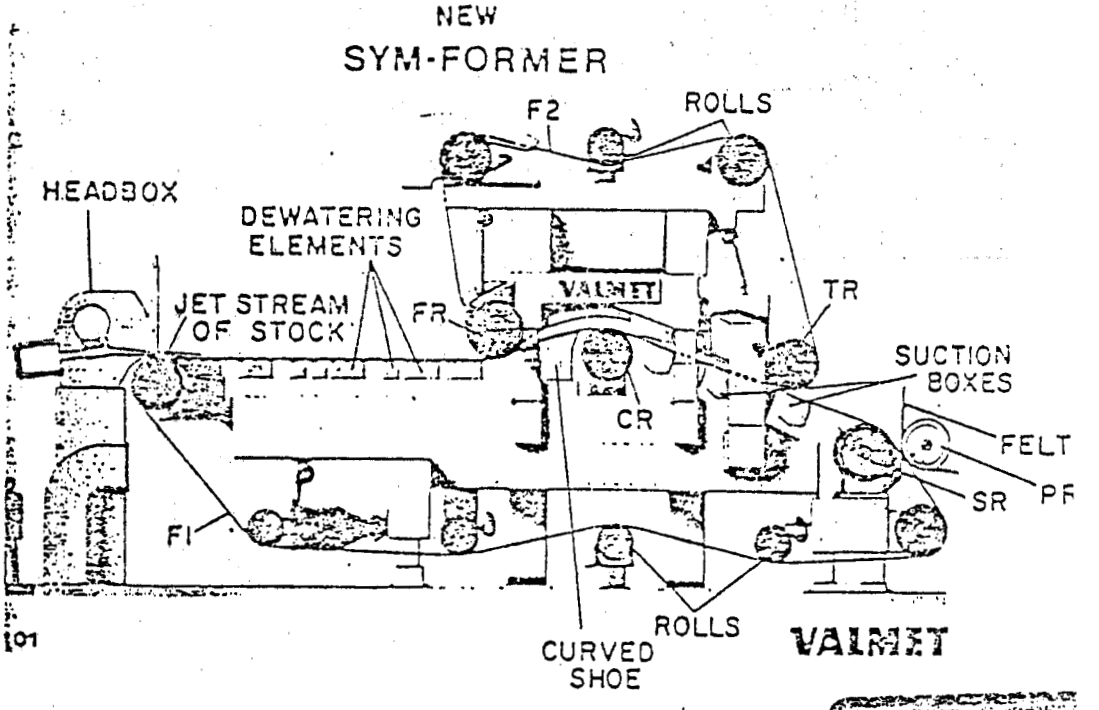


ATTACHMENT II



SYM-FORMER R

ATTACHMENT III



ATTACHMENT IV

0500L

LIST OF EXHIBITS */

Documentary Exhibits 032740

C.X.	Description
1.	USLP 3,726,758 (Certified Copy)
2.	Assignment of Subject Matter of USLP 3,726,758 to Beloit Corporation
3.	File History of United States Patent Application Serial No. 160,879 Filed July 8, 1971.
4.	File History of United States Patent Application Serial No. 127,948 Filed March 25, 1971
5.	File History of United States Patent Application Serial No. 080,297 Filed October 13, 1970
6.	Paper presented by Otto Kallmes at 1979 International Wet End Operations Training Seminar, October 22, 1979, "Monitoring the Formation of a Sheet".
7.	Letter dated November 26, 1968 from A.T. Ranson (W.P. Thompson and Co.) to D. Veneman (Gustafson C.X. Exhibit O)
8.	Paper authored by Saastomoinen and Hujala presented at TAPPI 1983 Wet End Seminar, pp. 305-310, "Valmet Sym-Former R -- Excellent Tool for Optimizing Machine Quality and Efficiency".

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* Asterisk designates a confidential document produced by respondents under protective order.

APPENDIX I

9. Paper authored by Maurenen and Hujala presented at 69th Annual Meeting of CPPA in Montreal, February 1983, B195-B200, "Valmet Former For Papermachine Rebuild and New Papermachine".

10. Beloit Calculation of Drainage Forces in Forming Section at St. Francisville.

11. Paper authored by Roger Kanitz presented at Annual Meeting of A.T.C.P., Mexico City, May 23, 1983 "Top Wire Formers by Beloit".

12. Article "Commercial Twin Wire Forming Options", Pulp & Paper, September 1982, page 135.

13. Beloit Research Report on Bel Roll, production nos. 137064-137073.

14. Beloit Research Report on Bel Roll, production nos. 137074-137080.

15. "Bel-Baie Former Design Characteristics and Performance," Justus & Gustafson, production nos. 130662-130681.

16. "Water Removal from the Bel-Baie Former," Gustafson, production nos. 134981-134996.

• 17. TVW, summary of sales call report with customer, FSC

• 18. Letter from Alan T. Marana of FSC to Matti Parviainen of TVW dated March 21, 1983.

• 19. Telex dated March 28, 1983 from Bill Hohns to Markku Saastomoinen concerning FSC.

*	20.	Call report dated April 6, 1983 from Rauno Kaartinen of TVW concerning FSC.
*	21.	Telex dated April 8, 1983 from Bill Hohns to Marrku Saastamoinen concerning FSC.
*	22.	Letter from Riston Turunen of Valmet to FSC dated April 13, 1983 with a quotation for rebuilding P.M. 4.
*	23.	Letter from Valmet to FSC dated April 13, 1983 with quotation 42/83
*	24.	Telex dated April 29, 1983 from Bill Hohns to Markku Saastamoinen concerning Velmet quote 42/83
*	25.	Letter dated May 3, 1983 from Teemu Kuokkanen of Valmet to Alan T. Marena of FSC concerning revised quotation 42A/83
*	26.	Telex dated May 5, 1983 to M. Saastamoinen and T. Kuokkanen from Risto Turunen con- cerning FSC.
*	27.	Telex dated May 5, 1983 to M. Saastamoinen from Bill Hohns concerning FSC.
*	28.	Telex dated May 16, 1983 to Teemu Kuokkanen from M. Saastamoinen concerning FSC paper machine.
*	29.	Telex dated June 2, 1983 to M. Saastamoinen from Bill Hohns concerning FSC machine.
*	30.	Telex dated June 8, 1983 to T. Kuokkanen from Bill Hohns concerning FSC machine.

*	31.	Telex dated June 10, 1983 to Bill Hohns from T. Kuokkanen concerning FSC machine.
*	32.	Letter dated June 11, 1983 to FSC from T. Kuokkanen concerning revised quotation 42B/83 for P.M. 4
*	33.	Letter dated June 11, 1983 from Valmet to FSC with quotation 42B/83.
*	34.	Telex dated June 22, 1983 to M. Saastamoinen from TVW concerning FSC engineering schedule.
*	35.	Letter dated June 24, 1983 to Bill Hohns from FSC concerning FSC's acceptance of Valmets revised quotation 42B/83.
*	36.	Purchase order letter dated August 16, 1983 from FSC to TVW concerning purchase of Sym-Former R.
	37.	Letter of inquiry from Abitibi dated January 20, 1983 to TVW regarding PM 1.
*	38.	Letter dated December 31, 1982 to Abitibi from Valmet with quotation 220/82 for PM 1.
*	39.	Letter dated February 17, 1983 to Abitibi from Valmet with quotation 220A/82.
*	40.	Telex dated April 22, 1983 to M. Saastamoinen from V. Kainu concerning Abitibi Augusta PM 1.
*	41.	Letter dated April 26, 1983 to Bill Hohns from Simeco concerning PM 1 rebuild in Augusta.

*	42.	TVW memo dated May 10, 1983, concerning Abitibi-Price PM 1.
*	43.	Call Report dated November 12, 1980 by TVW concerning Abitibi-Price Corp.
*	44.	Letter dated November 21, 1980 from Bill Hohns to Frank Morton of Abitibi concerning Augusta machine.
*	45.	Letter dated December 13, 1980 to Abitibi from Valmet concerning Augusta machine.
*	46.	Letter dated December 13, 1980 to Abitibi from Valmet with quotation 176/80.
*	47.	Letter dated June 12, 1981 to Abitibi from Valmet with quotation 176A/80.
*	48.	Letter dated June 30, 1981 to Abitibi from Valmet with delivery warranty for Augusta PM 2.
*	49.	Letter dated July 28, 1981 to Abitibi from Pekka Aalto with revised quotation 176B/80 for Augusta machine.
*	50.	Letter dated July 24, 1981 to Abitibi from Valmet with quotation 176B/80.
*	51.	Letter of August 28, 1981 from Risto Hautamaki to R. Sundberg with quotation 176C/80 for Augusta PM 2.
*	52.	Purchase order dated August 28, 1981 from Augusta Newsprint Co. to Valmet for PM 2.
*	53.	Acknowledgement letter dated December 31, 1981 from Valmet to Augusta Newsprint Co. concerning quotation 176C/80.

*	54.	Memo dated May 10, 1982 by TVW concerning Abitibi.
*	55.	Letter dated June 11, 1982 to Abitibi from R. Hautamaki concerning TVW visit to Toronto.
*	56.	Telex dated June 18, 1982 to P. Aalto from Bill Hohns concerning AN-2.
	57.	Telex dated June 28, 1982 to P. Aalto from W.F. Llewellyn of Simeco.
*	58.	Telex dated June 25, 1982 to P. Aalto from M. Parviainen concerning Augusta Newsprint.
*	59.	Letter dated June 29, 1982 to W. Llewellyn from Valmet with quotation 112/82.
*	60.	Telex dated July 6, 1982 to P. Aalto from B. Hohns concerning Augusta Newsprint.
*	61.	Telex dated July 8, 1982 to P. Aalto from B. Hohns concerning AN 2.
*	62.	Telex dated July 23, 1982 to P. Aalto from B. Hohns concerning Augusta PM 2.
*	63.	Telex dated July 26, 1982 to B. Hohns from M. Saastamoinen concerning AN 2 Sym-Former R.
*	64.	Telex dated July 26, 1982 to N. McLenaghen from Bill Hohns concerning Augusta Newsprint Co. PM 2.
*	65.	Telex dated July 30, 1982 to P. Aalto from Bill Hohns concerning Augusta Newsprint Co. PM 2 Sym-Former R.

* 66.	Telex dated July 30, 1982 to M. Saastamoinen from Bill Hohns concerning AN 2 Sym-Former R.
* 67.	Telex dated July 30, 1982 to Bill Hohns from Valmet concerning Augusta PM 2 Sym-Former R Forming Roll.
* 68.	Telex dated August 2, 1982 to M. Parviainen from Valmet concerning Augusta Sym-Former R Forming Roll Shell.
* 69.	Telex dated August 12, 1982 to P. Aalto from W.F. Llewellyn concerning performance guarantee for Sym-Former R.
* 70.	Telex dated August 16, 1982 to R. Willis from Valmet concerning AN 2 Sym-Former R.
* 71.	Telex dated August 27, 1982 to B. Hohns from P. Aalto concerning AN 2.
* 72.	Telex dated August 3, 1982 to Abitibi from M. Parviainen concerning Augusta PM 2 Sym-Former conversion to R version.
* 73.	Telex dated August 3, 1982 to P. Aalto from M. Parviainen concerning AN 2.
* 74.	Transmittal list dated August 30, 1982 to Simons Eastern from Valmet concerning AN 2 delivery schedule.
* 75.	Telex dated September 27, 1982 to P. Aalto from W.F. Llewellyn concerning Augusta Newsprint.
* 76.	Telex dated September 28, 1982 to W. Llewellyn from P. Aalto concerning AN 2 spare parts.

*	77.	Letter dated October 14, 1982 from TVW to Augusta Newsprint with quotation 1651/82.
*	78.	Letter dated October 14, 1982 to Valmet from Simons Eastern concerning Augusta Newspring purchase order 0001.
*	79.	Letter dated November 12, 1982 to W. Llewellyn from TVW concerning spare parts for quote 1651/82.
*	80.	Letter dated November 18, 1982 to B. Hohns from Simons Eastern concerning Augusta News- print P.O. No. 0001.
*	81.	Letter dated November 18, 1982 from Simons Eastern to Valmet concerning Augusta News- print P.O. No. 0242.
*	82.	Acknowledgment letter dated December 23, 1982 to Augusta Newsprint from Valmet concerning AN 2.
*	83.	Invoice dated February 15, 1983 by Valmet concerning AN2.
*	84.	Bill of lading by Sea-Land Service, Inc. concerning delivery of PM 2 to Augusta.
*	85.	Letter dated May 28, 1982 to rrom TVW concerning Valmet quotation 93/82.
*	86.	Letter dated May 28, 1982 to with quotation 93/82.
*	87.	Telephone call report dated June 11, 1982 by M. Parviainen concerning wet end rebuild.

*	88.	Letter dated June 17, 1982 to M. Saastamoinen from M. Parviainen concerning rebuild.
*	89.	Telephone cal report dated June 17, 1982 by M. Parviainen concerning rebuild.
*	90.	Request for quotation dated July 15, 1982 from to Valmet.
*	91.	Letter dated July 16, 1982 to from Valmet with quotation 110/82 for Rebuild.
*	92.	Telex dated August 26, 1982 to Bill Hohns from Valmet concerning quotation 110A/82.
*	93.	Letter dated October 4, 1982 to from M. Parviainen concerning Sym-Former R Start-up.
*	94.	Telex dated October 7, 1982 to M. Saastamoinen from V. Kainu concerning 110A/82 to
*	95.	Telex dated October 27, 1982 to M. Saastamoinen from concerning Valmet quote 85/82 to .
*	96.	Letter dated November 5, 1982 to from Valmet with quote 85A/82 for PM3 Rebuild.
*	97.	Telex dated April 14, 1982 to M. Saastamoinen from Bill Hohns concerning .
*	98.	Telex dated April 16, 1982 to M. Saastamoinen from Bill Hohns concerning .

*	99.	Telex dated April 20, 1982 to Bill Hohns from M. Saastamoinen concerning .
*	100.	Letter dated April 20, 1982 to Bill Hohns from . concerning invitation to quote No. 6 PM Rebuild.
*	101.	Telex dated April 22, 1982 to M. Saastamoinen from concerning PM 6 wood grades.
*	102.	Letter dated April 23, 1982 to TVW from concerning invitation to quote No. 6 P.M. Rebuild.
*	103.	Call report dated May 4, 1983 by M. Parviainen concerning PM 6.
*	104.	Telex dated May 11, 1982 to Bill Hohns from R. Turunen concerning preparation of quotation for PM 6.
*	105.	Telex dated May 12, 1982 to R. Turunen from J. Immonen concerning PM 6 Rebuild.
*	106.	Letter dated May 25, 1982 to from R. Turunen with quotation 78/82 for Rebuild.
*	107.	Letter dated May 24, 1982 to from Valmet with quotation 78/82.
*	108.	Telex dated June 9, 1982 to R. Hautamaki from M. Parviainen concerning
*	109.	Telex dated June 2, 1982 to M. Saastamoinen from concerning Sym-Former R trials.

*	110.	Acknowledgement letter dated June 14, 1982 to from Valmet concerning PM 6.
*	111.	Telex dated June 17, 1982 to R. Hautamaki from M. Parviainen concerning Sym-Former R trials.
*	112.	Telex dated June 22, 1982 to M. Saastamoinen from Bill Hohns concerning trials.
*	113.	Program dated June 28, 1982 prepared by Valmet concerning Trials.
*	114.	Telex dated November 9, 1982 to M. Saastamoinen from Bill Hohns concerning
*	115.	Telex dated Novembaer 12, 1982 to M. Saastamoinen from Bill Hohns concerning PM 1.
*	116.	Letter dated November 17, 1982 to from M. Parviainen concerning Valmet quota- tion 192/82 for P.M. 1 Rebuild for
*	117.	Telex dated December 10, 1982 to M. Saastamoinen from M. Parviainen concerning Sym-Former R quotation.
*	118.	Telex dated December 13, 1982 to R. Turunen from M. Parviainen concernig Sym-Former R.
*	119.	Telex dated December 21, 1982 to M. Parviainen from R. Turunen concerning requirements.

* 120.	Call report dated January 24, 1983 by M. Parviainen concerning meeting discussing project.
* 121.	Letter dated February 11, 1983 to Paper from R. Turunen concerning quotation 5/83 for rebuilding No. 3 machine.
* 122.	Letter dated February 11, 1983 to from Valmet with quotation 5/83 for No. 3 PM Rebuild.
* 123.	Telex dated March 11, 1983 to Bill Hohns from M. Saastamoinen concerning quotation 192/82.
* 124.	Letter dated December 3, 1982 to from TVW concerning PM 3 Rebuild.
* 125.	Telex dated January 4, 1982 to M. Saastamoinen from M. Parviainen concerning PM 3 Rebuild Pilot Plant Trials.
* 126.	Telex dated January 4, 1982 to M. Saastamoinen from M. Parviainen concerning PM 3 Rebuild.
* 127.	Telex dated January 5, 1983 to M. Parviainen from M. Saastamoinen concerning PM 3 159/82.
* 128.	Letter dated January 10, 1983 to from Valmet with quotation 159B/82 for PM 3 Rebuild.
* 129.	Telex without date to TVW concerning PM 3 tests.

*	130.	Telex dated January 18, 1983 to M. Saastamoinen from M. Parviainen concerning PM 3 Rebuild.
*	131.	Telex dated January 25, 1983 to M. Saastamoinen concerning PM 3 Rebuild.
*	132.	Telex dated February 10, 1983 to R. Turunen concerning PM 3 Rebuild, Valmet Quote 159B/82.
*	133.	Call report dated March 2-3, 1983 by M. Parviainen concerning PM 3 Rebuild Meeting.
*	134.	Telex dated March 9, 1983 to M. Saastamoinen from M. Parviainen concerning Valmet Pilot Plant Trials for
*	135.	Letter dated March 24, 1983 to from Valmet with quotation 159C/82 for PM 3 Rebuild.
*	136.	Telex dated March 30, 1983 to M. Saastamoinen concerning PM 3 Trials.
*	137.	Telex dated March 31, 1983 to M. Saastamoinen from V. Kainu concerning European Mill Visits.
*	138.	Telex dated April 20, 1983 to M. Parviainen from M. Saastamoinen concerning and Trials 159/82.
*	139.	Telex dated May 4, 1983 to M. Saastamoinen from Bill Hohns concerning PM 3.

* 140.	Telex dated May 5, 1983 to D. Hale from Bill Hohns concerning PM 3.
* 141.	Telex dated May 6, 1983 to Bill Hohns from M. Aalto concerning PM3 vacuum power requirements.
* 142.	Call report dated December 8, 1982 by V. Kainu concerning conversation about
* 143.	Letter dated January 18, 1983 to V. Kainu from Inc.
* 144.	Telex dated January 18, 1983 to V. Kainu from M. Saastamoinen concerning 212/82.
* 145.	Telex dated January 21, 1983 to V. Kainu from M. Saastamoinen concerning
* 146.	Letter dated February 4, 1983 to from Valmet with quotation 212/82 for PM 1 Rebuild.
* 147.	Call Report dated November 11, 1982 by P. Soikkanen concerning conversation with personnel.
* 148.	Memorandum dated December 20, 1982 by M. Saastamoinen concerning meeting about Rebuilt Targets.
* 149.	Telex dated January 13, 1983 to M. Saastamoinen from E. Lievonen concerning PM 3.
* 150.	Meeting notes dated February 21, 1983 con- cerning

* 151. List of Sym-Former R offers.

* 152. Letter dated August 17, 1983 to from Valmet with quotation 79/83 for Rebuild of PM 1 at

* 153. Letter dated June 21, 1983 to from Valmet with quotation 60/83.

* 154. Letter dated August 22, 1983 to from Valmet with quotation 76/83 for Sym-Former R Top Wire Unit for PM 3.

* 155. Letter dated November 17, 1982 to from M. Parviainen con- cerning Valmet quotation 194/82

* 156. Letter dated October 10, 1983 to from J. Immonen with quotation 120/83 for PM 4 Rebuild in

* 157. Letter dated June 8, 1983 to from Valmet with quotation 59/83.

* 158. Letter dated November 17, 1982 to from Valmet with addendum to quotation 99H/80 for Rebuild of PM 1 Wire Section.

* 159. Letter dated October 20, 1983 to from Valmet with quotation 62A/83 for Sym-Former R Top Wire Unit.

* 160. Diagram of Sym-Former R.

161. Valmet Report "New Forming Technology" by A. Lehtinen.

162. Diagram of Sym-Former R.

163. Picture of Sym-Former R with list of advantages thereof.

164. Charts and Diagram of Sym-Former R with list of advantages thereof.

165. Valmet Report "New Sym-Former Twin Wire Units" by L. Aroviita and J. Hujala.

166. Valmet Report "Improved Sheet Forming with the New Sym-Former Design" by A. Lehtinen.

167. Valmet Report "Sym-Former R, Rebuild Unit for Fourdrinier" by P. Mauranen.

168. Diagram of Cantilevering Alternatives for Valmet Sym-Former R.

* 169. TVW, Valmet Product Group Sym-Former Club, "Sym-Former R, Rebuild Unit for Fourdrinier".

* 170. Internal correspondence dated September 28, 1982 by M. Parviainen concerning start-up of Sym-Former R on Husum PM 7 in Sweden.

* 171. TVW report on Valmet Sym-Former R by O. Goos, M. Parviainen, and P. Soikkanen.

172. Valmet Report "Improved Sheet Quality through Sym-Former for Newsprint and Other Printing Grades" by A. Lehtinen.

173. Valmet Report "The Valmet Former Family" by R. Hautamaki and A. Lehtinen prepared for Madden Machine Co., Inc.

174. Diagrams on Sym-Former R Drainage on Newsprint.

175. Pulp and Paper, August 1977, "Philosophy of twin-wire forming is reflected in three former designs"; interview with Lehtinen of Valmet.

176. Valmet Report "Sym-Former R" dated May 20, 1982 by L. Aroviita.

177. Diagrams and pictures dated May 20, 1982 by L. Aroviita concerning Sym-Formers.

178. Valmet Report dated March 26, 1982 by O. Goos concerning Sym-Former R.

179. Valmet Report "Latest Developments of Valmet Low Energy Sym-Concept Paper Machines" by A. Lehtinen.

180. Valmet Sym-Former promotional material.

*	181.	Internal correspondence dated July 7, 182 to TVW-A Service Engineers from M. Parviainen concerning Valmet Sym-Former R.
*	182.	TVW Strategic Planning Meeting on North American conditions dated April 26-27, 1983.
	183.	Letter dated July 4, 1983 from Finnish Export Credit Ltd.
	184.	1981 Annual Report of Finnish Export Credit Ltd.
	185.	1982 Annual Report of Finnish Export Credit Ltd.
	186.	Publication on SITRA Technical Guarantee.
	187.	1982 Annual Report of VTL.
	188.	1978 Valmet Annual Report.
	189.	1979 Valmet Annual Report.
	190.	1980 Valmet Annual Report.
	191.	1982 Annual Report, Union Bank of Finland.
	192.	1982 Annual Report, Bank of Helsinki Ltd.
	193.	1981 Annual Report of the Supervisory Board of Postipankki.
	194.	Witness Statement of William J. Roell (including exhibits thereto).
	195.	Witness Statement of Richard J. Regnier (including exhibits thereto).
	196.	Witness Statement of L.J. Jenkins (including exhibits thereto).
	197.	Brochure entitled "The Beloit Group".
	198.	Brochure entitled "Beloit Bel Baie II Twin Wire Former".
*	199.	Exhibits to Parviainen Deposition.
	200.	International Paper Invitation to Quote, Dated November 4, 1983.

201. Not admitted.

202. Not admitted.

203. Not admitted.

204. Witness Statement of Michael Waller.

205. Witness Statement of David R. Gustafson.

* 206. Answers of Respondent Valmet to Complainant's First Set of Interrogatories.

* 207. Answers of Respondent TVW to Complainant's First Set of Interrogatories.

* 208. Answers of Respondents to Complainant's Second Set of Interrogatories.

209. Graph made by Elliot showing output PM 2 at St. Francisville after start up.

210. Article authored by Anders Nordstrand and Antti Lehtinen, Tappi Journal - June 1983. "Improved sheet forming with the new Sym-former design."

211. Not used.

212. Article authored by Otto J. Kallmes, Paper Trade Journal, February 15, 1977. "Understanding the role of turbulence should lead to improved formation."

213. Paper authored by Kallmes, 1983 Wet End Operations. "New Redispersion system improves formation of thue Fourdrinier."

214. Revised Stipulations.

215. Beloit Engineering Drawing, No. LF-132395-21-0-2.

Physical Exhibits

C.X.	Description
A.	Valmet Slide 8332B - Sym Former R.

B. Beloit Slide of Bel Roll.

C. Beloit Slide of Bel Baie II.

D. Beloit Slide of Bel Baie II.

E. Beloit Slide of Bel Baie II.

F. Deposition transcript of William Gianotti (Yet to be taken).

G. Deposition transcript of A. Terrence Ranson (Yet to be taken).

H. Stock sample prepared by Beloit Corporation having consistency of typical newsprint stock in a Sym-Former R headbox.

I. Stock sample prepared by Beloit having consistency representative of the material at the entrance nip of a typical Sym-Former R (based on C.X. H).

J. Stock sample prepared by Beloit having consistency representative of the material immediately ahead of the stationary curved surface in a typical Sym-Former R (based on C.X. H).

K. Stock sample prepared by Beloit having consistency representative of material immediately following the stationary curved surface in a typical Sym-Former R (based on C.X. H).

L. Stock sample prepared by Beloit having consistency representative of material immediately following the rotary cylinder in a typical Sym-Former R (based on C.X. H).

M. Stock sample prepared by Beloit having consistency representative of material immediately ahead of Couch Roll in a typical Sym-Former R (based on C.X. H).

N. Valmet Slide 9610 - Portion of Sym-Former R in Operation.

O. Valmet Slide 9013 - Portion of Sym-Former R in Operation.

P. Valmet Slide 9012 - Portion of Sym-Former R in Operation.

Q. Valmet Slide 9624 - Portion of Sym-Former R in Operation.

R. Valmet Slide 9623 - Portion of Sym-Former R in Operation.

S. Valmet Slide 8668B - Web Forming on the Forming Roll - Sym-Former R.

T. Valmet Slide 9507A - Sym-Former R Drainage Diagram on Newsprint.

U. Valmet Slide 8667A - Multifoil Shoe- Sym-Former R.

V. Valmet Slide 8643 - Sym-Former R Drainage Diagram.

W. Valmet Slide 8670A - Web Run on the Bottom Wire Break Back Roll - Sym-Former R.

X. Valmet Slide 9730 - Sym-Former R Development of Web Consistency.

Y. Valmet Slide 8669 - Web Forming on the Multishoe - Sym-Former R.

Z. Beloit Slide of Inverform.

AA. Beloit Slide of Twinverform.

BB. Beloit Slide of portion of St. Francisville machine.

CC. Beloit Slide of portion of St. Francisville machine.

DD. Beloit Slide of portion of St. Francisville machine.

EE. Not admitted.

* FF. Deposition of Matti Parviainen, August 19, 1983.

* GG. Continued Deposition of Matti Parviainen, August 20, 1983.

* HH. Continued Deposition of Matti Parviainen, November 1, 1983 (Volume II).

* II. Deposition of Risto Hautamaki, September 29, 1983 (including exhibits thereto).

* JJ. Continued Deposition of Risto Hautamaki, September 30, 1983 (including exhibits thereto).

* KK. Continued Deposition of Risto Hautamaki, October 1, 1983 (including exhibits thereto).

* LL. Deposition of Jori Pesonen, October 5, 1983 (including exhibits thereto).

MM. Sketch by Professor Waller showing stock cross section approaching shoes in Bel Baie forming section.

NN. Sketch by Gustafson - Inverform (1957-1962); Twinverform (1961-1965); St. Anne's Pre (1967); Bolton Unit (1967); Bolton (1967-Nov.).

OO. Film of St. Francisville PM #2 after February 1, 1969, start up.

LIST OF RESPONDENTS' EXHIBITS ADMITTED AT HEARING */

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
* 1				Excerpt from PM2 start-up book
2				12/6/66 letter from Time to M.L Tietz
3				1/16/67 letter from Time to M.L Tietz
4				Undated Beloit document from PM2 start-up book (included in RX-1)
5				4 page memo entitled "Fourdinier Section"
6				C-1 drawing no. 21288 of 2/13/6
7				2/6/67 Beloit Roadman Report (included in RX-1)
8				13 page Ron Sholl memo to C.E. Elliot
9				5 page Elliott memo to J.C. Delisle
10				U.S. Patent No. 3,438,854
11				C-2 PM2 production statistics (attachment to Holcomb witness statement, RX-380)
12				C-2 invoice register (attachment to Holcomb witness statement, RX-380).
13	R-3		115071-72	Letter, 6/19/81 from A.G. Olson, to Mr. Watabe,
14			115069-70	Memo 7/1/81 from T.R. Angle to T.E. Duffield and R. Aldag, Subject: Abitibi Price Inc.

RX 0

*/ Asterisk designates documents produced by respondents under protectiver order. Documents designated in their description as confidential are asterisked even if produced by Beloit.

	HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
	15			115082-86	Letter, 7/31/81 from A.G. Olson to Mr. Watabe
	16	E-6		115094	Memo, J. Whitener, Beloit Manhattan, Inc., re sales report on Augusta mill, plus handwriting
	17	E-5		115111	Beloit Corp. delivery schedule for Augusta No. 2 proposal
	18			115091	Letter 7/10/81 from A.G. Olson to Mr. T. Watabe
	19	Roell-1		115093	Memo 7/13/81 from T.G. McKie to E.S. Rothe re Abitibi
*	20	McL-1		102114-21	Augusta purchase order dated 8/28/81
*	21	McL-2		101219-20	Augusta purchase order dated 11/18/82
*	22	McL-3		103489-91	Valmet quotation to Abitibi-Price, Inc., 2/17/83
*	23	McL-4		115139-40	Abitibi-Price request for quotation, dated 10/15/80
	24	McL-5			Drawing by Newman McLenaghen
	25	Roell-2 Thompson-3		115197-216	Cover letter from T.J. Bal to FSC Paper Corp., dated 4/13/83 and attached quotation
*	26	Roell-3 Thompson-2		118342	Top wire comparison sheet

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
27	Roell-25 Thompson-4		118343-44	Quotation letter from Timothy J. Bal to Harry Thompson, 6/17/83
28			118367	Letter from A.G. Olson to Beloit Italia, 5/5/83
29			118368	Letter from A.G. Olson to Beloit Italia, 5/13/83
30	Roell-22		118366	Letter, A.G. Olson to A.R. Micheletta 5/18/83
31			118363	Letter, A.G. Olson to A.R. Micheletta 5/15/83
32	Roell-23		118365	Telex, D.D. Docker to Beloit Corp.
33			118350-51	Letter, A.G. Olson to Don Docker, 5/27/83
34			136824-25	Letter, A.G. Olson to Don Docker, 6/15/83
35			118343	Letter, A.G. Olson to Don Docker, 6/15/83
36			118345	Letter, A.G. Olson to Don Docker, 6/16/83
37	Roell-26		136792	Beloit Corp. Estimate for FSC Paper Corp., Alsip, Ill.
38	Roell-31		137064-73	R & D Report: Bel Roll Newsprint Trial with a 4-Blade Shoe
* 39	Thompson-6			Letter of intent from FSC Paper Corp., to TVW Papermachines, Inc., 6/24/83
* 40	Thompson-7		100791-94	Valmet quotation to FSC Paper Corp., 4/13/83

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
* 41	Thompson-8		100833-36	Valmet quotation to FSC Paper Corp., 5/3/83
* 42	Thompson-9		105454-57	Valmet quotation to FSC Paper Corp., 6/11/83
43	Roell-8		115316-48	Beloit Corp. proposed agreement with Southern Newsprint Enterprises, Inc.
* 44				Letter from Beloit counsel to respondents' counsel and attached list of Beloit offers and informal proposals, 11/9/83 and supplemental letter 11/15/83
45	Roell-10		113858	Memo from J.E. Macklem to R.S. Hebb, 10/26/78 re Beloit Italia manufacture of Boise Southern machine
46	Roell-11		113843	Memo from T.R. Brossard to H.S. Rothe, 1/22/79 re Boise Southern delivery schedule
47	H-10		114929-41	Letter from J.A. Hoover Jr. to C.L. Gobble re backcharges, late delivery to Bowater Southern Paper Co.
48			114426	Letter from A.J. Seaquist, to Eugene Shaw, 12/11/75
49			114427-29	Memo to T.G. McKie from K.N. Maitra re "MEI/ Taiwan Machine," 9/6/77
50			100140-57	Licensing agreement between Beloit Corp. and Mitsubishi Heavy Industries
51	Roell-7		105157-207	Reference List of Twin Wire Formers to March, 1983 prepared by Beloit Corp.

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
52	Roell-12		114709-12	Memo from A.L. Johnson to Bob Barker re Champion Courtland 30
53			unnumbered and 119027	Letter, Beloit assistant patent counsel to respondents' counsel, and attached list, 8/1/83
54			115359-411	Beloit Corp. proposal for Karioi, N.Z.
55	Roell-5		102121-83	Beloit contract agreement with Crown Zellerbach Corp., Camas, Wash., revised 9/23/81
56	Roell-6		102105-106	Beloit contract agreement with Crown Zellerback, Camas, Wash., 5/8/81
57	Roell-5/6		102121-203 102693-706 102674-92 102653-73	Complete Beloit Corp. agreement with Crown Zellerbach Corp., Camas, Wash., revised 9/23/81
58			118794-95	Memo, Bob Brauns to Karl Fries, 2/9/83, Subject: Future of Bel Bond.
59			116214-16	Memo, Bob Brauns to George Masterson, 5/9/78 Subject: Bel Bond applications on single ply grade
60			116210-13	Description of Bel Bond former by Bob Brauns
61			116207-09	Memo, from R. Brauns re Bel Bond additions for upward dewatering purposes 3/6/78

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
62	Roell-4		115699-719	Agreement between Beloit Corp. and Garden State Paper Co., 2/18/80
63	Roell-18		118775-82	Memo from J.E. Macklem and R.A. Brauns re Bel Bond Coat Study, 6/1/83
64			137942-138119	Cover letter from R.C. Pearson, Beloit sales engineer, to Pat Maley, Midtec Paper Corp., 8/20/82, and attached quote for a papermachine to be built in Brazil for delivery in Wisconsin
65			138137	Letter, R.C. Pearson to Pat Maley 1/19/83
66			138212 138214	Memo, A.G. Olson to H.S. Pothe re visit to Midtec, 8/2/82 (Middle page, 138213 not produced but has been requested from Beloit
67			138372-74	Memo from A.G. Olson to H.S. Rothe, 7/23/82 re Midtec No. 7 Machine
68			138721	Letter from A.G. Olson to Wolf Diggle, Beloit-Rauma, Campinas, Brazil 6/9/82
69			138746-49	Memo from A.A. Neese Jr. to Marty Saltorelli re Midtec Paper Corp., 5/17/82
70			138750-51	Letter, A.G. Olson to Martin O. Saltarelli, Beloit-Rauma, Brazil, 5/18/82
71			137083-86	Memo, H.S. Rothe re Midtec Paper Co., 7/15/83

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
72			137087	Memo, A.A. Neese Jr. to Tom McKie, 7/26/83 (attachment not produced with cover memo by Beloit)
73			137088-89	Memo from Don Wolf to K. Pearson, 8/3/83 re Midtec Paper Co.
74			137767-68	Memo from G.M. Rossa to A.A. Neese Jr., 8/31/83 re Midtec Paper Co.
75	Roell-28		137013-027	Agreement between Beloit and Publisher Paper Co., Oregon City, Ore., 7/21/83, revised 8/9/83
* 76				Complete transcript of deposition of T. Newman McLenaghen, senior vice president, Abitibi-Price Corp., Toronto, Canada
78				Deposition of David L. Hale engineering manager, Wilamette Industries
79				Complainant's Responses to Respondents' Requests for Production of Documents and Interrogatories 1 through 140 and Supplemental Responses
80	Roell-9		114469-71	Memo, 10/25/78, from P.S. Hebb to J.E. Macklem Subject: Boise Deridder No. 3
81	Roell-13		118142-197	Sales prospects, May 1983

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
82	Roell-15		114806-26	Memo, 9/4/83 from Don Knezel to Howard Pothe re Champion Courtland Auditor's review
83	Roell-16		114897-903	Estimate sheet, Champion International, Courtland
84	Roell-17		114915	Profit Realization study as of 10/22/78
85	Roell-19		104948-62	Management Report for Month Ending June, 1980 and Nine Months Ending June, 1980
86	Roell-20		134115-20	Memo, A.G. Olston to A.J. Schmitt, 8/23/79 re Jasper Mardon Consulting Visit
87	Roell-21		135763-65	Memo, from R.C. Vondereau to circulation list re Southeast Paper Co. Program to Improve Rentention
88	Roell-24			Bel Bond advertisment
89	Roell-27		137010-11	Memo, Ken Hunter to engineering/production re Publishers, Oregon City No. 3
90	Roell-29		136814	Letter from T.J. Bal to Harry Thompson, June 28, 1983
91	Roell-30		136816	Memo, T.J. Bal to record re FSC Paper Corp., 6/27/83
92	Roell-32		136895-06	Beloit Corp. Estimate Summary for Bowater Southern
93	Roell-33		137006-09	Cover letter and attached drawings to Mr. Royce Adair, Garden State Paper Co. from T.J. Bal, 9/29/83

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
94	Roell-34		137030-32	Cover letter and attached drawings to Mr. Forest Louie, Boise Cascase, from Kenneth Hunter, 10/4/83
95	Roell-36		137030-32	USA Patent No. 3,856,618
96	Roell-37			Drawing LF-130236-21-1-0
97	Roell-38		118552-54	Memo from Bill Roell to Tom McKie and Joe Schmitt, 2/14/79
98	Roell-39			Article from Papermaking
99				Witness statement of P. Thoma
100				Certified translation of French Patent No. 1,473,988 (RX 147)
101				U.S. Patent 3,150,037 (Lee)
102		Hujala		article 9/24/73 paper trade journal
103			103709	Sym-Former F
104			103709	Sym-Former N
105			103963	Sym-Former R
106	P-2	Hujala		New Sym-Former
107			105270	enlargement of forming roll
108			105268	enlargement of shoe
109		Hujala		pressure profile of Sym-Former
110			105268	drainage diagram of Sym-Former R

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
111				Drawing of Fourdrinier
112			114957	Bel Baie II retention data
113			105274	distribution of fillers and fines, gap-former, Sym-Former, fourdrinier
114	DRG-1			sketch of Inverform
115	DRG-2			sketch of Twinerform
116	DRG-4			sketch of converging wedge former
117	DRG-3			sketch of Vertiforma
118	DRG-5			sketch of roll former
119	DRG-6			sketch of open roll
120	DRG-7			sketch of open roll dipped into the bottom wire
121	DRG-8			Gustafson sketch of Bel Baie I
122	DRG-9		133178-182	12/8/67 J. Chapman memo
123	DPG-10		130924-932	6/22/68 memo from J.D. Parker to R.A. Daane
124	DRG-11		117943-963	The Walmsley Group Ltd. Review of Inverform R&D to December 31 1967
125	DRG-12		131661-664	7/29/66 memo from D. Gustafson D. Veneman
126	DRG-13			U.S. Patent No. 3,726,758
127	DRG-14			sketch of nip

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
128	DRG-15		132348-361	12/3/63 memo Re: Meeting at Springdale Labs.
129	DRG-16			drawing re convergence
130	DRG-17			sketch of Bel Baie I
131	DRG-18			sketch of nip and shoe of Bel Baie I
132	DRG-19			sketch showing "top" and "botto wires and "slice"
133	DRG-20			U.S. Pat. No. 3,726,758 (FIGS. 1-8)
134	DRG-21			sketch re: fig. 8 of U.S. Patent No. 3,726,758
135	DRG-22			British Patent application filed 1/24/68
136	DRG-23			sketch re: "adjacency:
137	DRG-24			Drawing: Sym-Former R
138	DRG-25			Sym-Former Drain-age Diagram on Newsprint
139	DRG-26		132560-561	5/21/70 handwritten notes re: Machine Arrangements
140	DRG-27		132784	page 74 of TAPPI Seminar Notes of 1982 illustrating a Bel Bond (Figs. 17-20)
141	DRG-28			Beloit Bel Bond advertisement
142	DRG-29		132376-385	1/29/64 memo from W.A. Strickle Re: St. Francisville No. 2 PM
143	DRG-30		132386-389	2/18/66 memo from Dr. Gustafson to Denis Goddard Re: Time Experimental Two Wire Former Samples

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
144	DRG-31		132365-367	5/6/65 "Time Life Samples For Tom Morgan"
145	DRG-32			U.S. Patent No. 3,438,854 (Means)
146	DRG-33			U.S. Patent No. 3,232,825 (Robinson)
147	DRG-34			British Pat. No. 1,129,893 and French Patent No. 1,473,988 (Justus)
148	DRG-35			Canadian Pat. No. 869,266 (Gustafson)
149	DRG-36		132953-960	3/21/67 memo from D.R. Gustafso to E.J. Justus re: Two Wire Former/Roll Former
150	DRG-37			sketch of fines distribution
151	DRG-38			Bel Baie II advertisement
152	DRG-39			Article: "Recent Developments I: Multi-Ply Sheet Forming", by B.W. Attwood (from Indian Pulp and Paper, July, 1967)
153	DRG-40		116488-544	1/30/73 paper entitled: "Twin Wire Product Information" by L.E. Dennis
154	DRG-41		117013-047	Paper/manuscript entitled: "Development of the Bel Baie Former"
155	DRG-42		135644-653	8/10/82 memo from Kumar N. Maitra Re: Bel-Roll Former
156	DRG-43		116254-267	10/26/76 "Comparison of Twin Wire Formers on Newsprint Grades
157	DRG-44		116214-216	5/9/78 memo from Bob Brauns Re: Bel Bond Applications on Single Ply Grades

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
158	MEW-1			Appendix 1 to the Complaint
159	MEW-3			Michael Waller Affidavit
160	MEW-2A			U.S. Patent No. 3,726,758 (FIGS. 1-8)
161	LED-2			U.S. Patent No. 3,726,758 (FIGS. 1-8)
162	LED-3			Schematic of Beloit Bel Baie I Former
163	LED-4			Schematic of Beloit Bel Baie II Former
164	MEW-2			Michael Waller Affidavit
* 176	LED-17		133256-265	Nov. 3, 1968 re: Simplification and development of the Inverform machine; CONFIDENTIAL
177	MEW-4			Drawing of forming roll and shoe (marked by McKie)
* 178	LED-19		132371	11/20/63 memo from J.E. Goodwill to E.D. Beachler re: Crown-Time Program; CONFIDENTIAL
* 179	LED-20		132348-361	Notes on meeting in Springdale Labs.; CONFIDENTIAL
180	LED-21		105100-110	U.S. Patent No. 3,438,854
181	LED-22			6/18/64 letter to Mr. Cawley Hoffman with attached memo dated 6/15/64 from P.J. Thoma
182	LED-23		132362	Drawing of St. Francisville machine

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
183	LED-24		132363	Drawing of St Francisville production run
184	LED-25			Canadian Patent No. 886,863 "Forming Arrangement", by E.J. Justus and Louis E. Dennis
185	LED-26		105217-221	"Beloit Bel Baie II Twin Wire Former"
* 186	LED-27		117691-710	Manuscript: "Bel-Baie Former" by D. Gustafson and Louis Denni CONFIDENTIAL
187	LED-28		117672-675	D. Gustafson paper appearing in TAPPI, March 1970
188	DAG-30			9/82 article, Pulp & Paper "Twi Wire Formers, Special Survey Details The Technology Now In Use", pp. 130-134
189	DAG-31			Memo from J.A. Means: Beloit visit to Springdale of 11/26-26/63 dated 12/2/63
190	DAG-32			Photo
191	DAG-33			Photo
192	DAG-34			Photo
193	DAG-35			Photo
194	DAG-36			Photo
197	DAG-39			4/12/66 letter from Kenneth B. Latimer to Dr. Ray D. Montigny with attached paper
198	DAG-40		132369	1/21/64 memo from J.A. Means re: January Forming Trials cone at Springdale
199	DAG-41		132386-389	2/18/66 memo Gustafson to Goddard re: Time Experimental Two Wire Former Samples, with attached drafts

	HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
*	200				Deposition transcript of McKie
*	201				Deposition transcript of Roell
*	202				Deposition transcript of Roell (2nd day)
	204	JLH-14		115184-194	Paper entitled: "Top Wire Forme: By Beloit" presented at Annual Meeting ATCP, May 13-27, 1983, Mexico City, Mexico by Roger Kanitz
	205	JLH-15		116078-083	Article entitled "Duoformer H - A New Development for Converting Fourdriniers to Twin Wires", by Albrecht
*	206	JLH-16		134492-A-507	12/8/82 Beloit Report No. P82-0: entitled: Bowater-Calhoun Trial, Nov. 23, 1982, with tables and figures; CONFIDENTIAL
*	207	JLH-17		134874	Fines distribution diagram dated 10/5/82; CONFIDENTIAL
	208	JLH-18		130682-85	Article entitled "Bel-Baie Forme Design Characteristics and Performance", by E.J. Justus and D.R. Gustafson reprinted from TAPPI, Vol. 54, No. 9, September 1971
	209			136521-522	1/21/66 memo from J.E. Goodwillie to H.C. Moore
*	210			131684-685	1/30/69 memo from E.J. Justus to D. Veneman; CONFIDENTIAL
	211			136402	4/28/66 memo from J.E. Goodwillie to H.C. Moore

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
212			136430-454	2/4/66 memo from E.J. Justus to H.C. Moore (with attachment)
213			136524-533	1/22/66 memo from D.H. Taylor to J.E. Goodwillie
214			136541-542	4/15/66 letter from J.E. Goodwillie to D.H. Taylor
215			137056-057	6/27/67 memo from Loren Waller - Roadman Report
216			137641-642	2/6/67 Roadman Report
217			137432-437	1/23/64 Supplement #2 to Contract Specifications for one (1) 264" Twin Wire Former Paper Machine For St. Francisville Paper Machine
218			137405-426	11/21/63 Proposal specifications by MGL
219			136764-765	10/29/63 memo from L.M. Stuebe to R. Blair
220			136705	3/24/64 memo from D.A. Goddard to D. Wolf
221			137373	6/1/64 memo from A.J. to B. Boyce
222			137374	6/2/64 memo from A.J. to T. Morgan
223			137089-098	Proposal specification (illegible date) - job no. 59669

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
224			137165	8/4/65 letter from John A. Means to W.A. Strickler
225			137172	7/23/65 memo from G.O. Siekkinen to Engineering Department
226			137177	7/16/65 memo from T.G. Chekouras to Engineering Department
227			137289	10/16/64 letter from R.K. Sutter to Mr. William Strickler
228			137292	10/12/64 letter from R.K. Sutter to Mr. William Strickler
229			137299-300	9/25/64 memo from D.J. Wolf to Ray Betley
230	JC-1		117943-963	Figure 8 (Prod. No. 117958) from Walmsley R&D Report dated 12/31/
231	JC-2			10/68 Pulp & Paper International article entitled "Experimental machine used for Inverform Development" by J. Chapman and M. McCormick
232	JC-3			Columns 9 and 10 of the '758 patent
233	JC-4			FIGS. 3 and 4 of the '758 patent
234	JC-5			FIGS. 5-8 of the '758 patent
235	JC-6			Exhibit E2 to the Complaint
236	JC-7			Sym-Former and Sym-Former P configurations (FIGS. 4-7) from TAI Proceedings

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
237	JC-8			Columns 7 and 8 of the '758 pate
238	JC-9			Exhibit O to the Complaint
239	JC-10			Page from an advertisement for the Bel Bond Former entitled "B Bond Formers minimize two-sidedness"
240	JC-11			4/2/76 memo from J. Chapman to Richard Lynn Re: Inverform II Trials
241	JC-12			3/2/76 memo from J. Chapman to Richard Lynn Re: Beloit-Walmsley Answer to Sym-Former Challenge
242	JC-13			4/6/76 meo from J. Chapman to Ja Wardle, et al Re: Inverform II Trials with attachments
243	JC-14			4/30/76 memo from J. Chapman to J.W. et al Re: Status of the Inverform II Programme with attachment
244	JC-15			Blueprint Prop. High Speed Forme Job. No. 610089, drawn by Hess stamped 11/6/68 Walmsleys (Bury) Ltd.
245	DRG-C		133819	4/16/68 memo from D.J. Veneman t T.E. McKearn Re: J.D. Parker Application "Multi-Ply Web Formation"
246	DRG-D		130906-909	2/27/69 memo from D.R. Gustafson to C.B. Dahl Re: Propored Two-Wire Former
247	DRG-E		130924-932	6/22/68 memo from J.D. Parker to R.A. Daane Re: A Suggested Design for a Twin Wire Former
248	DRG-K		133003-010	2/16/67 memo from J.D. Parker to Justus Re: Proposed Inverform Design

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
249	TGM-1		137136-137	Flow chart entitled "Committee Formed & Briefed"
250				Witness statement of Jorma Hujala
251	TGM-3		137146	4/25/63 memo from C.R. Hoffman to T.G. McKie Re: Time Labs, Springdale, Conn.
252	TGM-4			12/6/66 letter to M.L. Tietz from unknown (no signature page (see RX-2)
253	TGM-5		137085-087	10/23/63 handwritten notes entitled "Time Property"
254	TGM-6		136519-520	1/17/66 memo from J.E. Goodwill to E.C. Lever Re: Twinverform Royalties to Time, Inc.
255	TGM-7			Blueprint: Elevation Twin Wire Fourdrinier and Press Section for St. Francisville Paper Co.
256				Outstanding performance rating.
258				MPEP §707.05(b), July, 1969
265				Deposition transcript of Dennis Goddard (Aug. 17, 1982)
266	OR-1			PCT application entitled "Web-Forming Section of a Paper Machine" filed 2/28/83
267	OR-9			U.S. Patent No. 3,311,533 (DeMontigny)
268	OR-10			U.S. Patent No. 3,326,745 (Graham)
269	OR-11			Kallmes sketch of forming sectic

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
270	OK-12			U.S. Patent No. 3,262,841 (Embry)
271	OK-13			consistency graph
272	OK-14			Sheet fines distribution illustration
273	OK-15			Article entitled "High-Speed Filtration of Compressible Fibrous Media", by C.R. Headley (from "Consolidation of the Pap Web: Transactions of the Symposium Held at Cambridge, September, 1965)
274			136760-1	2 page memo 10/30/63 from Goddard to Maitra, Betley and Szaszynski
275				3 page letter 12/6/66 from Time, Inc. to Mel Tietz
276				Drawing 2/15/80 entitled Elevation Twin Wire Fourdrinier and Press Section
277				Excerpt Abandoned Reissue Application Serial No. 043,105, filed 5/29/79
278				Supplemental Amendment "B" Serial No. 043,105 dated 3/6/81 including Exhibits A, B and C.
279			136759	Memo dated 10/30/63 subject: Review of Planning objectives and delegation of work from D.A. Goddard.

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
280			136415	Memo dated 7/29/65 subject: Time-Life Beloit negotiations from Justus
281			137099	Memo dated 1/21/64 subject: January Forming Trials from J.A. Means
282			137568-9	2 Page Memo dated 12/6/68 from McKie subject: Phone call from Jack Means
283			105643-4	2 page letter 4/12/68 to Dr. Ray de Montigny from Kenneth B. Latimer re information on Twin Wire Former.
284			137149-61	Report dated 11/26/63 re experimental machine improvement.
285			137088	Handwritten memo from M.L.P. dated 11/8/63 re call from Jack Means
286			137329-39	Memo dated 7/6/64 from Merle Linkletter subject: St. Francisville #2 machine, Step VI customer meeting
287			137314-17	Memo dated 9/14/64 from Merle Linkletter subject St. Francisville #2 machine
288			137122	Drawing dated 6/22/64 of breast roll, jet & grating location
289			137644	Drawing of Arr. 1 Twin Wire Former Fourdriner

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
290				Drawing 672" Twin Wire Fourdrinier
291				Drawing Top Wire Unit (Innerform) Elev.
292			119028	Drawing of Top Unit of Crown Zellerbach PM2 drawing No. 6-A505-20
293			137044-7	Report from Ken Barnett dated 5/19/67 re Installation and Instrumentation of Paper Machine
294			131686-8	Memo dated 1/21/65 from Joe Parker to E.J. Justus re: Forming Arrangement Patent Application
295			130937-8	2 page letter 2/7/61 to Dr. Clark from J.P. Brezinski
296			132775	Letter dated 11/9/82 to Ben Thorpe from E.J. Justus
297			137326	Letter dated 7/14/64 to W. Strickler from John A. Means
298			137291	Letter dated 10/15/64 to W. Strickler from John A. Means
299			137284-87	Letter dated 11/4/64 to J.H. Solbakken from John A. Means, drawing of Headbox Controls and memo to file re Driving Rawstock from J. Means

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
300			137255	Letter dated 1/20/65 to W. Strickler from John A. Means
301			137225-5	Memo dated 1/25/65 from R.K. Sutter re Flexible Hose for Flow System
302			137243	Letter dated 2/15/65 to W. Strickler from John A. Means
303			137238	Letter dated 2/26/65 to W. Strickler from John A. Means
304			137239	Letter dated 2/16/65 to W. Strickler from John A. Means
305			137219-20	Letter dated 3/19/65 to W. Strickler from John A. Means
306			137203	Letter dated 4/14/65 to W. Strickler from John A. Means
307			137214	Letter dated 3/25/65 to M. Papesh from John A. Means
308			137201	Letter dated 4/21/65 to W. Strickler from John A. Means re No. 2 Paper Machine
309			137188-91	Letter dated 5/6/65 to W. Strickler from John A. Means re No. 2 Paper Machine Flow System; plus attachments

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
310			137340-2	Handwritten memo subject Headbox
311			137181	Handwritten memo to Geo Siekkinen dated 6/29/83 from Strickler
312			137185-87	Memo dated 5/17/83 subject #2 Machine from Siekkinen
313			137197	Memo to Strickler dated 5/5/83 re Jet Inlet (2nd Primary box) from Goddard
314			137231-32	Memo dated 3/10/65 re: #2 Paper Machine from Siekkinen
315			105633-40	Letter dated 6/18/64 to Carl Hoffman from Paul J. Thoma plus attachments
316			137121	Drawing of Top Wire Unit -Crown Zellerbach Drawing No. 6-A505-20
317			136666-70	Beloit Corporation Calculation Sheet
318			137021-22	2 page memo dated 3/30/65 from Goddard to Strickler
319			137101-4	Memo dated 5/6/64 from Morgan to McKie
320			137105-6	Memo dated 5/18/64 to record from Means
321			137276	Memo dated 11/24/64 to record from Means re #2 Flow System Meeting

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
322			137260-1	2 page letter dated 12/21/64 to Strickler from Means
323			131831-2	Letter dated 3/3/67 from Goodwillie to Wilson and attachment
324				Memo dated 11/1/65 from Means to record re Springdale Pilot Plant Program
325				Memo dated 11/30/65 from Means to record
326				Memo dated 12/30/65 from Means to record
327				2 page letter dated 3/4/66 from Brewer to Sutter re Scraper Bar Relief
328				Memo dated 3/21/66 from Miller to Taylor re Proposed Release
329				Letter dated 2/28/67 from Thoma to Solbakken and attachments
330				U.S. Pat. No. 3,149,028 dated 9/15/64, Robinson
331				British Pat. No. 1,078,010 dated 9/14/64, Robinson and Moran
332				British Pat. No. 1,078,009 dated 9/14/64, Time,Inc.
333			136790	Drawing
334			136748-49	Memo dated 11/27/83 to Beachler from Hoffman and attachments

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
335			13675-58	Memo dated 10/30/63 to McKie from Hoffman
336			137244	Letter 2/15/65 to Strickler from Means
337			137245	Letter 2/8/65 to Strickler from Means
338			137199-200	Letter 4/29/65 to Strickler from Means and attachment
339			137246-51	Letter dated 1/28/65 to McKie from Means
340			137311-13	Memo dated 9/14/64 from Wolf to record.
341			137301-7	Memo dated 9/25/64 from Linkletter to Engineering/Sales Dept.
342			137167-9	Memo dated 7/29/65 from Strickler and Siekkinen to Engineering Department
343			136695-6	Memo dated 3/12/64 from Hoffman to Vickerman
344			137318-20	Memo to record from D.J. Wolf
345			137368-70	Memo dated 6/15/64 from McKie to Goddard
346			137257	Memo dated 12/29/64 from Strickler to Siekkkinen
347			137211	Memo dated 3/12/64 to Hoffman from Papesh
348				Memo dated 12/2/63 to record from Means

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
349			137371-372	6/2/64 letter from C.R. Hoffman to Mr. F.O. Boylon
350			136500-504	9/24/65 Agreement between Time, Inc. and Beloit Corporation
351			136390-391	8/30/65 Agreement between Time, Inc. and Beloit Corporation
352			no prod. #	Blueprint copy
353			137632	7/12/67 memo from Denis A. Goddard to Bill Strickler
* 354			132371	11/20/63 memo from J.E. Goodwillie to E.D. Beachler CONFIDENTIAL
* 355			136744	12/11/63 memo from D.A. Goddard to T.G. McKie CONFIDENTIAL
356				2/2/64 clipping from Chicago Tribune "Zellerbach and Time to Expand Paper Mill"
* 357			132376-384	1/29/64 memo from W.A. Strickler et al to Engineering/Sales Depts.; CONFIDENTIAL
358			132368-370	2/7/64 memo from M.L. Papesh to W. Turner (with attachments)
* 359			132372	3/27/64 memo to C.R. Hoffman; CONFIDENTIAL
360			132364-367	Time Life samples for Tom Morgan from George Davidson

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
361			132386-389	2/18/66 memo from D. Gustafson to D.Goddard
362				U.S. Patent No. 3,403,073 (J. Moran)
363			no prod. #	7/27/72 memo from E. J. Justus re technical review board
364			137019-020	495 letter from J. A. Means to W. A. Strickler
365			137610	4/3/69 memo from D. Goddard to R. G. Pillbach
366				U.S. Patent No. 2,881,672 (Thomas)
367				U.S. Patent No. 3,400,045 (Graham)
368				U.S. Patent No. 2,881,678 (Thomas)
369				U.S. Patent No. 3,215,593 (Green)
370				U.S. Patent No. 3,382,143 (Justus)
371				U.S. Patent No. 2,688,276 (Showers)
372				U.S. Patent No. 3,150,037 (Lee)
373				U.S. Patent No. 2,977,277 (Kelly)
374				U.S. Patent No. 3,582,467 (Gustafson)
* 375			132826	Gustafson sketch of Bel Bond, Bel Roll down, Bel Rollup, CONFIDENTIAL

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
376				File wrapper of U.S. Patent No. 3,726,758
377				File wrapper of U.S. Serial No. 795,954
378				File wrapper of U.S. Serial No. 792,713
379				File wrapper of U.S. Serial No. 1,824
380				WS of Richard G. Holcomb with exhibits
381				Dep. transcript of Josiah Chapman
382				U.S. Serial No. 730,444 (Gustafson)
383				License Agreement between Valmet and Time, Inc.
384				Article from Pulp & Paper International 10/68 entitled "Experimental Machine Used for Inverform Development"
385				Bel Bond Advertisement by Beloit Canada LTEE/LTD
386				Bel Bond and Bel Roll advertisement 6/83
387				Article from Paper Trade Journal 1/30/67 entitled "Papermaking: New Formers Lead the Way to Higher Speeds", pp. 84-87
388				Preprint "The Bel Bond Former - Concept and Experience" from TAPPI

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
* 389				Excerpts from deposition transcript of John L. Hoover
* 390				Deposition transcript of David R. Gustafson
391			116270	Drawing of forming zone, North Pacific PA. Corp.;
* 392				Deposition transcript of Michael E. Waller
393				Handwritten memo to Tim Bal, 3/28/83, typewritten attachment and newspaper articl (139499-139502).
394				Telex 11/19/82 to Robert Byrd r Rust Specification No. 1031/82
395				Cover letter dated 10/9/83 and to Boise Cascade Paper Group (1 139152)
396				Flow chart entitled "Committee Formed & Briefed" Prod. Nos. 137136-137.
397				Proposal specification for St. Francisville #2 Job. No. 59669 dated 11/11/63; Prod. Nos. 136795-803.
398				4/25/63 and 5/3/63 memos from C.R. Hoffman to T.G. McGie Re: Time Labs, Springdale, Conn. Prod. Nos. 137145-147.
399				12/6/66 letter to M.L. Tietz from unknown (no signature page)
400				10/23/63 handwritten notes entitled "Time Property"; Prod. Nos. 137085-087.
401				1/17/66 memo from J.E. Goodwill to E.C. Lever Re: Twinverform Royalties to Time, Inc.; Prod. Nos. 136519-520

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
402				Blueprint: Elevation Twin Wire Fourdrinier and Press Sect for St. Francisville Paper Co.
403				Blueprint: Prop. Bel Roll Former Addition for Garden State Paper Co. Prod. No. 137008
404				Beloit Corp. PMD: Strategic Business Plan 1983-1987, Prepared March, 1983; Prod. Nos. 136561-612
405				Beloit Corp. PMD: Phase II Plan -- Fiscal 1983 dated Sept., 1982 with attachments Prod. Nos. 136052-079, 136094-095, 136109-111.
406				Week of 5/31/83 Employment Report for Paper Machinery Division and Castings Division
407				3/83 Beloit Corp. Employment Report; Prod. Nos. 105103-110.
408				Witness statement of Charles E. Elliott (Exhs. RX 1-10)
409				Witness statement of Dr. Otto J. Kallmes
410				Letter, July 7, 1983, from C.R. Hoffman to Boise Cascade Paper Group. (139116-18)
411				Handwritten memo 5/23 from Tim to Ron. (139497)
412				April 19, 1983, memo to W.S. Lucey from T.R. Angle re Arizor Newsprint Project. (139494)
413				Affidavit of Kaija Annikki Wilson and resume and English and Finnish versions of Pesone: Dep. Ex. 4.

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
* RX-414			104191-493	"Bel Baie II Former"; CONFIDENTIAL.
* RX-415				"Bel Baie II Former"; illegible CONFIDENTIAL.
* RX-416			102468	"Bel Baie Former"; CONFIDENTIAL.
* RX-417			104547	"Bel Baie Former"; CONFIDENTIAL.
RX-418			100052-067	"Bel Baie Former", by D. Gustafson and L. Dennis.
RX-419			100038-047	"Water Removal from the Bel Bai Former", by D.R. Gustafson.
RX-420			114670-698	"Champion Presentation".
RX-421			113821-823	9/5/80 letter from Hubert D. Batson to Jim Rischar.
RX 422			106278-388	"New Forming Methods", by Matti Kankaapaa and Pertti Aaltonen.
* RX-423			116707-713	"Review"; CONFIDENTIAL.
RX-424			130682-685	"Bel Baie Former Design Characteristics and Performance", by E.J. Justus an D.R. Gustafson
* RX-425			130668-669	2 pages re: Bel Baie former; CONFIDENTIAL.
* RX-426			116973-980	Bel Baie II Twin Wire Tissue 1981; CONFIDENTIAL.
RX-427			116451-461	Duoformer H paper.
* RX-428			114966-976	5/19/77 letter from J. E. Richardson to Jack Reynolds; CONFIDENTIAL.

	HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
*	RX-429			132738-744	8/5/76 memo to Patent Filing Committee - Papermaking; CONFIDENTIAL.
*	RX-430			131686-688	1/21/65 memo from J. Parker to E. J. Justus; CONFIDENTIAL.
*	RX-431			118446	KMW Papriformer configuration; CONFIDENTIAL.
*	RX-432			117676-677	Advertisement: Beloit Bel Baie Former; CONFIDENTIAL.
*	RX-433			133401-407	3/29/73 memo from D. R. Gustafson to E. J. Justus; CONFIDENTIAL.
*	RX-434			130910-923	"The Rationale for Beloit's New Twin Wire Design", by J. Parker - 2/18/69; CONFIDENTIAL.
	RX-435				7/27/72 memo from E. J. Justus.
*	RX-436			133839-840	6/18/81 memo from C. L. Sanford to D. J. Veneman; CONFIDENTIAL.
	RX-437			107700-704	11/8/67 letter from D. J. Veneman to R,M,S, Manahan (with attachments).
	RX-438				"Symmetrical dewatering in Webster-type formers", by D. Wahren et al., Pulp & Paper Canada, Vol. 79, No. 9/Septembe 1978.
	RX-439				U.S. Patent No. 3,272,692 (Haye and Hayes).
	RX-440			107696	11/25/69 letter from Hill, Sherman to John Mundy.
	RX-441			107411-413	Serial No. 792,713 filed January 21, 1967 (Parker).
	RX-442			107686-697	11/26/68 letter from A. T. Ranson to Veneman.

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
RX-443				U.S. Patent No. 3,326,745 (Graham).
RX-444				U.S. Patent No. 3,236,724 (Wahlstrom).
RX-445			107698-699	4/2/68 letter from Hill, Sherma to D. Veneman.
* RX-446			illegible	4/16/68 memo from T. E. McKearn to D. J. Veneman; CONFIDENTIAL.
RX-447				"Hydromechanische Analyse von Blattbildungsvorgangen be: Doppelsiebmaschinen", by D. Wahren and C. Lovstad.
RX-448			136430-54	Cover memorandum from E. J. Justus, February 4, 1966 and attachments.
RX-449			133198-200	Parker December 14, 1967 memo t J. E. Goodwillie.
RX-450				CX 8 as marked by Waller.
RX-451				CX 1 with markings of Waller on Figs. 3-8.
RX-452			137034-62	September 9, 1983 quotation to Boise Cascade.
RX-453			139591-604	Memo from Guetschow to Hunter, October 7, 1983 and attachments.
RX-454			139107-115	August 15, 1983 quotation to International Paper Co.
RX-455			139095-100	October 21, 1983 quotation to International Paper Co.
RX-456			138966-052	Proposed agreement with Willamette Industries, October 26, 1983.

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
RX-457				Invoice register and sales analysis, St. Francisville Pape Co. (also attached to RX-380, attached to Mr. Holcomb's witness statement).
RX-458				Munday memo, January 20, 1971.
RX-459				December 28, 1966 letter from Brunbaugh to Veneman.
RX-460				Omitted.
RX-461				March 26, 1965 letter from Veneman to Kenneth Mustard.
RX-462				March 2, 1966 memo from Justus to John Franz and attachment.
RX-463				Management Report, Beloit Corp. 12 months ending September 26, 1982.
RX-464				Omitted.
RX-465				Tracing of droplets seen in CPX-00.
RX-466				Exhibit H to the Complaint.
RX-467				Stipulations.
RPX-A		Hujala		Wire sample.
RPX-D		Hujala		arrangement of fibers along Sym-Former R.
RPX-E				arrangement of fibers along machine shown in FIG. 8 of patent in suit.

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
RPX-F				photograph of Sym-Former shoe
RPX-G			116271	Bel Baie II Nip
RPX-H				FIGS. 1 and 6 of Means U.S. Patent No. 3,438,854
RPX-I				FIG. 2 of French Pat. No. 1,473,988
RPX-J				Beloit advertisement
RPX-K				FIG. 6 of Robinson U.S. Pat. No. 3,232,825
RPX-L				Model of Sym-Former R nip
RPX-M				Model of Bel Baie II nip
RPX-N				Drawing of Sym-Former forming roll
RPX-O	LED-6			Slide of Bel Baie Former
RPX-P	LED-7			Slide of Forming Zone
RPX-Q	LED-8			Slide of Bel Baie II
RPX-R	LED-9			Slide of Bel Baie Forming Zone
RPX-S	LED-10			Slide of Forming Pressure (forming shoe)
RPX-T	LED-11			Slide of Bel Baie water remov
RPX-U	LED-12			Slide of Bel Baie II drainage
RPX-V	LED-13			Slide of Bel Baie Top Former
RPX-W	LED-18			Slide Slotted forming box
RPX-X	LED-15			Slide Twinverform
RPX-Y	LED-16			Slide of Slotted Forming Box
RPX-Z	DAG-37			VHS tape entitled "Twin Wire Paper Former"

HEARING EXH. NO.	DEPOSITION EXH. NO.	HEARING WITNESS	PRODUCTION NOS.	DESCRIPTION
RPX-AA				VHS tape of Sym-Former-R, New Sym-Former and fourdrinier. (Remainder of tape showing Bel Baie II not in evidence).
RPX-BB				Waller drawing.
RPX-CC				Waller drawing.
RPX-DD				Waller calculation.
RPX-EE				Waller calculation.
RPX-FF				Hujala drawing.
RPX-GG				Kallmes drawing.
RPX-HH				Omitted.
RPX-II				Fig. 7 of suit patent, modified by additional shoe.
RPX-JJ				Tietz tracing of droplets seen in CPX-OO.
			WITHDRAWN	
* 77				Portions of the deposition transcript of Harry L. Thompson vice president and general manager, FSC Corporation.
259				Witness statement of Rubin Friedman
			REJECTED	
None				

UNITED STATES INTERNATIONAL TRADE COMMISSION
Washington, D.C. 20436
Before John J. Mathias
Administrative Law Judge

In the Matter of CERTAIN PAPERMAKING MACHINE FORMING SECTIONS FOR THE CONTINUOUS PRODUCTION OF PAPER AND COMPONENTS THEREOF	Investigation No. 337-TA-147

COMMISSION INVESTIGATIVE ATTORNEY'S EXHIBIT LIST (REVISED)

SX 1	Commission Investigative Attorney's Exhibit List
SX 2(c)*	Excerpted deposition of William J. Roell
SX 3(c)	Excerpted deposition of Thomas G. McKie
SX 4(c)	Deposition of John L. Hoover
* SX 5(c)	Deposition of T. Newman McLenaghan
* SX 5A(c)	Augusta Newsprint Co. Purchase Order No. AN-0001 (McLenaghan Exhibit 1)
* SX 5B(C)	Augusta Newsprint Co. Purchase Order No. 0242 (McLenaghan Exhibit 2)
* SX 5C(c)	Valmet Quotation No. 220A/82 (McLenaghan Exhibit 3)
SX 5D(c)	Abitibi-Price, Inc. Request for Quotation (McLenaghan Ex. 4)
SC 5E(c)	Sketch (McLenaghan Exhibit 5)
SX 6(c)	Beloit Memorandum, July 26, 1983, re Publishers Paper, Oregon City No. 3 with attachments (18 pages)
SX 7(c)	Beloit correspondence re Boise Cascade Steilacoom No. 2 with attachments (32 pages)
SX 8(c)	Withdrawn

*/ (c) denotes business confidential information

	SX 9(c)	Beloit Corp. Rockton Research Center Report No. P83-021
	SX 10(c)	Beloit Corp. Rockton Research Center Report No. P83-034
	SX 11	First Set of Interrogatories of the Commission Investigative Attorney to Complainant Beloit Corporation
	SX 12	Answers of Complainant Beloit Corporation to First Set of Interrogatories 1-3 of the Commission Investigative Attorney
	SX 13(c)	Beloit Bel Baie Sales 1976-1983
	SX 14(c)	Deposition of Richard J. Regnier
	SX 14A(c)	Beloit's Strategic Business Plan 1983-1987 (Regnier Exhibit 1)
	SX 14B(c)	Beloit PMD Advertising Expenses (Regnier Exhibit 2)
	SX 14C(c)	Beloit Phase II Plan 1983 (Regnier Exhibit 3)
	SX 14D(c)	PMD Statement of Income, August 1983 (Regnier Exhibit 4)
	SX 14E	Beloit's Answer to Staff Interrogatory No. 3 (Regnier Exhibit 5)
	SX 14F(c)	Cost breakdown for Order No. 721 (Regnier Exhibit 6)
	SX 14G(c)	Computer Printout Costs for Order No. 721 (Regnier Exhibit 7)
	SX 14H(c)	Beloit ledger sheet showing various job costs (Regnier Exhibit 8)
	SX 14I(c)	PRS Lookup Order No. 721 (Regnier Exhibit 9)
	SX 14J(c)	Beloit Internal Order (Order No. 721) (Regnier Exhibit 10)
	SX 14K(c)	Letter of August 13, 1982, from Crown Zellerbach to Beloit (Regnier Exhibit 11)
*	SX 15(c)	Top Wire Comparision Sheet
	SX 16(c)	Letter of April 18, 1983 from T.J. Bal to H. Thompson
	SX 17(c)	Letter of June 17, 1983 from T.J. Bal to H. Thompson

*	SX 18(c)	Letter of June 24, 1983 from H. Thompson to W. Hohns
	SX 19(c)	Letter of June 28, 1983 from T.J. Bal to H. Thompson
	SX 20(c)	Beloit offers and informal proposals for certain paper mill projects
*	SX 21(c)	List of Sym-Former R Offers
	SX 22(c)	List of Twin Wire Formers in United States Not Built by Beloit
	SX 23(c)	Beloit correspondence re Great Lakes Forest Products Limited with attachments (39 pages)
	SX 24	Sym-Former R Advertisements
*	SX 25(c)	TVW Outlook for the Paper Machinery Market in the 1980's
	SX 26(c)	Licensing Agreement between Beloit Corp. and Mitsubishi Heavy Industries, Ltd.
	SX 27(c)	Letter of May 11, 1981 from Forsberg to Berkyto
	SX 28(c)	Contract of July 8, 1981 between Beloit PMD and Mitsubishi Heavy Industries, Ltd.
	SX 29(c)	Specification of Subcontracting Work for Beloit Order No. 721
	SX 30(c)	Variation II of Contract Between Beloit Corporation and Mitsubishi Heavy Industries, Ltd.
	SX 31(c)	Letter of November 10, 1981 from Ludtke to Lowe
	SX 32(c)	Letter of November 8, 1982 from Olson to Watabe with attachments (3 pages)
	SX 33(c)	Memorandum of November 12, 1981 from Olson to Salzberg with attachments (12 pages)
	SX 34(c)	Beloit Corporation Specification No. 133199
	SX 35(c)	Variation III of Contract Between Beloit Corporation and Mitsubishi Heavy Industries, Ltd.
	SX 36(c)	Memorandum of August 6, 1982 from Olson to Regnier with attachments (4 pages)

	SX 37(c)	Memorandum of August 5, 1982 from Regnier to Olson and Rossa with attachment (2 pages)
	SX 38(c)	Beloit Corporation Agreement with Crown Zellerbach Corporation
	SX 39(c)	Letter of January 27, 1983 from Olson to Watabe with attachments (19 pages)
	SX 40(c)	Summary Section Schedule, Order No. 721
	SX 41(c)	Memorandum of November 24, 1982 from Fillbach to Beck
	SX 42(c)	Inspection Result of Subcontracting Works for Beloit Order No. 721
	SX 43(c)	Letter of April 8, 1982 from Parker to Ohira with attachments (5 pages)
	SX 44(c)	Shipping Schedule of 310" Bond Paper Machine for Crown Zellerbach, Camas #20
	SX 45(c)	Order Sheet, Order No. 721
	SX 46(c)	Outstanding Items of Purchased Parts Not Yet Arrived MHI
*	SX 47(c)	Deposition of Harry L. Thompson