In the Matter of

CERTAIN AMORPHOUS METAL ALLOYS AND AMORPHOUS METAL ARTICLES

Investigation No. 337-TA-143

USITC PUBLICATION 1664

NOVEMBER 1984

UNITED STATES INTERNATIONAL TRADE COMMISSION

COMMISSIONERS

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Susan W. Liebeler, Vice Chairman.
Alfred E. Eckes
Seeley G. Lodwick
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Address all communications to
Kenneth R. Mason, Secretary to the Commission
United States International Trade Commission
Washington, DC 20436

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

In the Matter of

CERTAIN AMORPHOUS METAL ALLOYS AND AMORPHOUS METAL ARTICLES

Investigation No. 337-TA-143

NOTICE OF ISSUANCE OF GENERAL EXCLUSION ORDER

AGENCY: U.S. International Trade Commission.

ACTION: Notice is hereby given that the Commission has issued'a general exclusion order in the above-captioned investigation.

AUTHORITY: 19 U.S.C. 9 1337.

SUPPLEMENTARY INFORMATION: By virtue of the Commission's decision not to review the presiding officer's May 14, 1984, initial determination, the subject investigation resulted in a Commission determination that there is a violation of section 337 of the Tariff Act of 1930 (19 U.S.C. S 1337 and 19 U.S.C. 9 1337a) in the importation of certain amorphous metal articles. The Commission found that all respondents except for Hitachi Ltd. had engaged in unfair acts in connection with the importation of amorphous metal articles mane by a process that would infringe claims 1, 2, 3, 5, 8, or 12 of U.S. Letters Patent 4,221,257 if the process were practiced in the United States. Such unfair acts were found to have a tendency to substantially injure an inaustry, efficiently and economically cperated, in the United States.

A notice soliciting written comments on the issues of remedy, the public interest, and bonding was published in the Federal Register of July 13, 1984, (49 F.R. 29519). In addition to submissions filed by the parties, the Commission received letters or statements filed on behalf of interested members of the public and a national laboratory operated by the U.S. Department of Energy.

On October 15, 1984, the Commission determined that a general exclusion order pursuant to section 337(d) is the appropriate remedy, that the public interest considerations enumerated in section 337(d) do not preclude such relief, and that the amount of the bond during the Presidential review period under section 337(g) shall be 100 percent of the entered value of the imported articles. The order does not apply to articles imported by and for the use of the United States, or imported for, and to be used for, the United States with the authorization or consent of the Government.

Copies of the Commission's Action And Order, its Opinion in support tnereot, 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, Docket Section, U.S. International Trade Commission, 701 E Street NW., Washington, DC 20436, telephone 2U2-523-0471.

FOR FURTHER INFORMATION CONTACT: P.N. Smithey, Esq., Office of the General Counsel, U.S. International Trade Commission, telephone 202-523-0350.

By oraer of the Commission.

Kenneth R. Mason
Secretary

Issued: October 15, 1984

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

In the Matter of CERTAIN AMORPHOUS METAL ALLOYS AND AMORPHOUS METAL ARTICLES	Investigation No. 337—TA-143

COMMISSION ACTION AND ORDER

Background

A complaint was filed with the Commission on March 11, 1983, by Allied Corp., alleging unfair acts and methods of competition in the importation and sale of certain amorphous metal alloys and amorphous metal articles. The Commission on April 13, 1983, instituted the above—captioned investigation to determine whether there is a violation of section 337 of the Tariff Act of 1930 (19 U.S.C. 9 1337 and'19 U.S.C. 9 1337a) in the importation of certain amorphous metal alloys and amorphous metal articles into the United States, or in their sale, by reason of alleged infringement of U.S. Letters Patents 3,856,513, 4,331,739, and 4,221,257, the effect or tendency of which is to aestroy or substantially injure an industry, efficiently and economically operated, in the United States. 48 F.R. 15963.

On May 14, 1984, the presiding officer issued an initial determination that there is a violation of section 337 in the importation of certain amorphous metal articles. The presiding officer determined that all respondents except Hitachi Ltd. had engaged in unfair acts in the importation of amorphous metal articles made by a process that would infringe claims 1-3, 5, 8, or 12 of U.S. Letters Patent 4,221,257 if the process were practiced in the United States. The presiding officer also found that the respondents' unfair acts had the tendency to substantially injure an industry, efficiently and economically operated, in the United States.

On July 6, 1984, *the* Commission determined not to review the initial determination, thereby adopting the initial determination as the Commission's determination on violation of section 337. 1/

A notice soliciting written comments on the *issues* of remedy, public interest, and bonding was published in the Federal Register on July 13, 1984 (49 F.R. 29159). In addition to submissions from the parties, the Commission received submissions from interested members of the public and a national labororatory operated by the Department of Energy.

Action

Having determined that the issues of remedy, public interest, and bonding are properly before the Commission, and having reviewed the aforesaid written *submissions* and the information relating to those issues on the record, the Commission has determined to issue a general exclusion order prohibiting entry of amorphous metal articles made by a process that would infringe claims 1, 2, 3, 5, 8, or 12 of U.S. Letters Patent 4,221,257, if practiced in the *United* States, except under license of the patent owner and as provided by law. The Commission also has determined that the public-interest factors enumerated in section 337(d) (19 U.S.C. 4 1337(d)) do not preclude issuance of such an

1/ The Commission notes that its determination is based in part on the sanctions imposed in Order No. 32 against the Japanese-based respondent listed in the notice of investigation as TDK Electronics, Co., Ltd.

exclusion order, and that the bond during the presidential review period should be in the amount of 100 percent of the entered value of the imported articles.

Order

Accordingly it is hereby ORDERED that--

1. Amorphous metal articles manufactured abroad in accordance with the process set forth in claims 1, 2, 3, 5, 8, and/or 12 of U.S. Letters Patent 4,221,257 are excluded from entry into the United States for the remaining term of said patent except (1) as provided in paragraphs 2 and 3 of this order, or (2) as licensed by the patent owner;

2. Pursuant to 19 U.S.C. § 1337(i), this Order shall not apply to articles imported by and for the use of the United States, or imported for, and to *be* used for, the United States with the authorization or consent of the Government;

3. The amorphous metal articles ordered to be excluded are entitled to entry into the United States under bond in the amount of 100 percent of the entered value of the subject articles, from the day after *this* order is received by the President pursuant to subsection (g) of section 337 of the Tariff Act of 1930, until such time as the President notifies the Commission that he approves or disapproves this action, but, in any event, no later than 60 days after the date of such receipt;

4. Notice of this Action and Order shall be published in the Federal Register;

5. A copy of this Action and Order and of the Commission Opinion in support thereof shall be served upon each party of record in this investigation and upon the Department of Health and Human Services, the Department of Justice, the Federal Trade Commission, and the Secretary of Treasury; and

6. The Commission may amend this Order in accordance with the procedure described in 19 CFR § 211.57.

By order of the Commission.

enneth R. Mason
Secretary

Issued: October 15, 1984

UNITED STATES INTERNATIONAL TRADE COMMISSION
Washington, DC 20436

In the Matter of

CERTAIN AMORPHOUS METAL ALLOYS AND AMORPHOUS METAL ARTICLES

Investigation No. 337—TA-143

COMMISSION OPINION ON REMEDY, THE PUBLIC INTEREST, AND BONDING

I. Remedy

We have determined that a general exclusion order is the appropriate remedy for the violation in this case, since the facts in the record demonstrate that the guidelines for the issuance of general exclusion orders promulgated by the Commission in investigation No. 337—TA-90, Certain Airless Paint Spray Pumps And Components Thereof have been met. 1/

In Paint Spray Pumps, we indicated that, in order for a complainant to obtain a general exclusion order, a complainant must prove (1) a widespread pattern of unauthorized use of the patented invention and (2) the existence of business conditions from which it could be inferred that foreign manufacturers

*/ All confidential business information has been replaced by asterisks.

1/ The following abbreviations will be used in this opinion: ALJ--the administrative law judge; CX—complainant's exhibit; CPX—complainant's physical exhibit; FF—finding of fact appended to the ALJ's initial determination; ID—the ALJ's initial determination; RX—respondents' exhibit; SX--Commission investigative attorne0 exhibit; Tr.--evidentiary hearing transcript. The citations to.tbe: rOCoralfaVappear in this opinion are representative of the information obtained on thka points in question but do not include such all informatip.n., other than the respondents might attempt to enter the U.S. market with infringing articles. The purpose of these requirements was "to balance the complainant's interest in obtaining complete protection from all potential foreign infringers with the inherent potential of a general exclusion order to disrupt legitimate trade." 2/

In the present investigation, there is a widespread pattern of unauthorized use of the patented invention. All of the amorphous metal articles accused in this investigation were found to be made by a process that would infringe claims 1, 2, 3, 5, 8, and/or 12 of U.S. Letters Patent 4,221,257 (the '257 patent) if the process were performed in the United States. 3/ The infringing articles were manufactured by three respondents in Japan and by one respondent in Germany. 4/ The record shows that respondents' sampling activities have been widespread. At least * * * * * potential customers in the United States were involved. 5/

Business conditions in the United States and the world with respect to amorphous metals are such that it reasonably can be inferred that foreign manufacturers other than the respondents might attempt to enter the U.S. market with articles produced according to the patented process. There is an established demand for the amorphous metal articles made by the patented process in the power electromagnetics, pulse power, electronics, security strip, and brazing markets. 6/ Some U.S. consumers of amorphous metals in

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2/ USITC Pub. 1199 (November 1981) at 18. See also Certain Self—Stripping Electrical Tap Connectors, Inv. No. 337—TA-150 (October 1984); Certain Caulking Guns, Inv. No. 337—TA-139, USITC Pub. 1507 (March 1984); Certain Heavy—Duty Staple Gun Tackers, Inv. No. 337—TA-137, USITC Pub. 1506 (March 1984).

3/ ID at 61-73; FF 446-94, 516-53.

4/ Id.; Order No. 32; FF 7, 12, 15, 17.

5/ FF 905-1093.

6/ ID at 117-24.

various markets have expressed an interest in having alternate sources of supply and have received samples from respondents. 7/ In addition, there is evidence that demand for amorphous metals will be substantial when the various markets enter the sales growth phase. 8/ There also is information on the *record* indicating that foreign firms other than the respondents already are exploring the development of amorphous metals. 9/

It is likely that marketing and distribution networks in the United States would be available to potential foreign infringers. Complainant Allied points out that it is customary for foreign metal manufacturers to have sales operations in the United States and trading companies that could be used to market amorphous alloys to U.S. customers. 10/ This practice is evidenced by the fact that 5 of the 10 respondents are U.S. marketing agents for foreign metal manufacturers. 11/ Moreover, because the various markets for amorphous metals are still in their incipiency, it appears that extensive marketing and distribution networks currently are not necessary for successful entry into the U.S. marketplace. 12/

The barriers to entry into the U.S. market by foreign manufacturers are low. The production facilities necessary for the production of amorphous metals in commercial quantities are not complex, either for high—volume applications (e.g., distribution and power transformers) or for specialty

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7/ ID at 129-30, 133, 136; FF 992-1010, 1060-64; SX 9 at 187-88; SX 25 at 23, 64.

8/ ID at 117-24, 128, 136; CX 217 at 500802; SX 17 at 142; CX 9 at 183; RX E-125 at 66.

9/ CX 217 at 500802; CX 188 at 8-10, 14-17.

10/ Tr. 3249; CPX EEE at 22.

11/ ID at 3-5; FF 8, 12, 14, 16, 18, 20.

12/ See ID at 136; Tr. 3519-20; CX FFF at 8-9, 30, 90; ID at 129-30; Tr. 46690-,74684.

products (e.g., amorphous metal tags used in the security strip market). 13/ * * * * * * * * * * . 14/ If a general exclusion order is not issued, there is nothing to prevent nonrespondent companies from acquiring the production facilities of respondents and exporting to the United States amorphous metal articles made by an infringing process.

From the foregoing facts and circumstances, it reasonably can be inferred that foreign producers other than the respondents may attempt to enter the U.S. market with infringing materials. The question then becomes whether complainant Allied's interest in obtaining complete protection from all potential foreign infringers is outweighed by the inherent potential of a general exclusion order to disrupt legitimate trade.

In assessing the potential disruption of lawful trade in Paint Spray Pumps, the Commission took into account the feasibility of administering and enforcing the proposed order, and the possibility of a chilling effect upon foreign trade in noninfringing articles, resulting from business uncertainties created by the order. 15/

The feasibility of administering and enforcing a general exclusion order is a matter of particular importance in cases where the patent in controversy is a process patent and articles produced according to an infringing process have characteristics that are not visually discernible. It does not appear that the U.S. Customs Service will have difficulty administering and enforcing a general exclusion order in this case, however. The Commission investigative attorney reports (on the basis of a meeting with Customs officials) that

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13/ ID at 130; FF 1101; CX 230; Tr. 234, 3512, 3640-43.
14/ ID at 135; CX 123 at 3; FF 1011; CX 175; SX 5 at 48.
15/ See USITC Pub. 1199 at 17-18.

Customs has the facilities and equipment to test imported metal articles. 16/ In addition, Allied indicates that it will provide samples, testing data, testing procedures, and any additional information or equipment that would facilitate the administration and enforcement of the order. 17/

Any respondent which changes its infringing production process or desires to import amorphous metal articles produced according to an allegedly noninfringing process may petition, pursuant to section 211.54(b) of the Commission's rules (19 CFR § 211.54(b)), for a Commission advisory opinion as to whether the proposed new course of action or conduct would violate the • Commission's order or section 337.

II. The Public Interest

Section 337(d) authorizes the issuance of an exclusion order, unless, after considering the effect that such exclusion would have on (1) the public health and welfare, (2) competitive conditions in the U.S. economy, (3) the production of like or directly competitive articles in the United States, and (4) U.S. consumers, the Commission determines that exclusion should not be ordered. 19 U.S.C. § 1337(d).

A. The public health and welfare

The legislative history of section 337 states that the public interest is to be paramount in the administration of section 337, and that the public health and welfare and the assurance of competitive conditions in the U.S. economy must be the overriding considerations. 18/

16/ Written comments of the Commission investigative attorney concerning remedy, bonding, and the public interest (hereinafter, Commission investigative attorney's comments) at 5-6.

17/ Complainant's submission on the issues of remedy, the public interest, and bonding (hereinafter, complainant's submission) at 9-10.

18/ S. Rep. No. 1298, 93d Cong., 2d Sess. 193, 197 (1974).

Amorphous metals are being used in (1) basic scientific research conducted by the U.S. Government in the field of particle accelerators and laser applications, as part of the national defense effort, 19/ and (2) research being jointly conducted by utilities and transformer manufacturers in an effort to develop new distribution and power transformer cores that are potentially capable of reducing the nation's energy consumption. 20/ Amorphous metals also are used in bone growth stimulators 21/ and in antishoplifting devices known as electronic article surveillance (EAS) systems. 22/

Such research and uses for amorphous metals clearly have an impact on the public health and welfare. The question is whether the impact is such that exclusion of the amorphous metals made by an infringing process should not be ordered. We find that there is no significant risk of harm to the public if the subject amorphous metal articles are excluded.

It does not appear that U.S. Government research will be impeded. Although Allied initially was unable to provide the amorphous metals needed for research being conducted by Lawrence Livermore National Laboratory (LLL) and was unwilling to develop the necessary product, 23/ Allied since has supplied LLL and other Government laboratories with amorphous metals and has expressed an interest in continuing to supply *the* Government's needs. 24/

19/ Public interest submission of Lawrence Livermore National Laboratory (hereinafter, LLL submission); ID at 122; FF 907-12. See also respondents' joint statement on public interest, relief, and bonding (hereinafter, respondents' joint statement) at 7-8, Appendixes A and B.

20/ ID at 117-22. See also respondents' joint statement at 9-12, 15, 17, 19.

21/ ID at 122.

22/ ID at 123.

23/ ID at 133; FF 924, 928, 955-58, 960-61.

24/ Complainant's submission at 16-18; LLL submission, letter dated July 30, 1984 at 1, Davis affidavit at 1, Birx affidavit at 1.

Although LLL's public—interest submission indicates that the imported metals possess qualities that are better for some applications with which LLL is concerned, it also notes that Allied's products are better for others. 25/ The Government would not be forced to rely on one source, because under section 337(i) of the Act, an exclusion order does not not apply to "any articles imported by and for, and to be used for, the United States with the authorization and consent of the Government." 19 U.S.C. s 1337(i). 26/

It also does not appear that the development and commercialization of core transformers that reduce energy losses and result in energy cost savings would be adversely affected by exclusion of the subject amorphous metals. Allied has the capacity to meet present and future demand for amorphous metals. 27/ The respondents introduced evidence during the investigation which indicated that * * * * * . 28/ However, the companies in question did not file public—interest submissions registering such complaints.

The respondents argue that the availability of more than one source of material and the participation of other metal producers would speed the development of solutions to existing technical problems and the development of a commercially viable product and would bring the realization of potential energy cost savings closer.

* * * * * * * * * * * . 29/ * * * * * * * * * * * . 30/

•25/ LLL submission, letter of July 30, 1984, at 1, Davis affidavit at 1, Birx affidavit at 1.

26/ Such importations could result in damages being awarded to the patent owner under 28 U.S.C. § 1498, however. 19 U.S.C. g 1337(i).

27/ ID at 126. The fact that Allied has the requisite capacity to meet domestic demand similarly alleviates the risk of injury to the public from an inadequate supply of amorphous metals for use in bone growth stimulators.

28/ See respondents' joint statement at 10-12.

29/ ID at 120; CX 599.

30/ Id

* * * * * * * * * * * . 31/ * * * * * * * * * * * . 32/

It also does not appear that the exclusion of amorphous metals would harm the public by depriving it of more effective theft detection and prevention devices, since Allied has the capacity to meet domestic demand for amorphous metals, and other materials * * * * * can be used in EAS systems in place of amorphous metals. 33/

In conclusion, we think that the present investigation is not one in which the public health and welfare would be adversely affected by a general exclusion order.

B. Competitive conditions in the U.S. economy and U.S. consumers

The legislative history of section 337 indicates that competitive conditions in the U.S. economy is one of the considerations which Congress intended to be overriding in determining whether to grant or deny relief under section 337. It further-indicates that exclusion should not be ordered in cases where there is any evidence of price gouging or monopolistic practices. 34/

During the investigation, the respondents asserted various affirmative defenses, including patent misuse and antitrust violations. Those defenses were based largely upon a * * * * * agreement entered by Allied and Minnesota Mining 6 Manufacturing Co. * * * * *. * * * * *
* * * * * . * * * * * * * * * * . 35/

31/ SX 17 at 23, 62, 110, 112-13; RX E-132 at 81; Tr. 3287; CX 248 at 1; SX 10 at 51-52, 55; SX 9 at 139-40, 142-43; RX E-225. See also Tr. 4424-25, 4463-64; ID at 118, 121, 122; CX 165, * * * * * ; Tr. 3177.

32/ Id.

33/ FF 805, 809, 853; Tr. 4591-93.

34/ S. Rep. No. 1298, 93d Cong., 2d Sess. 197 (1974).

35/ CX 57.

The agreement does not violate the antitrust laws, nor does it extend the patents in controversy, or any other Allied patent. An analysis of the * * * * * industry, the relevant product and geographic markets, the agreement and its impact on ,competition provided by the Commission's Acting Chief of the Office of Economics indicates that the agreement is a procompetitive endeavor to introduce a new product into an industry previously characterized by difficult entry and blocking patents. 36/

It does not appear that there is a dangerous probability of monopolization * * * * * . 37/ * * * * * * * * * * * . 38/ * * * * * * * * * * . 39/ * * * * * * * * * * . /

Respondents point out that * * * * * . 41/

However, the agreement * * * * * . * * * * * * * * * * * 42/

Consequently, it does not appear that * * * * * .

It also does not appear that exclusion of the amorphous metals made by an infringing process would have an adverse impact on domestic prices. There is no evidence of price gouging. The ALJ found that Allied's prices are not unreasonable, considering its costs and the necessity of recouping its investment in basic research and development. 43/ Although the ALJ noted that further price reductions would be necessary if the market for amorphous metals

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36/ See app. B to Commission investigative attorney's comments and 11-22. See also response of the Commission investigative attorney to respondents' petitions for review of the initial determination at 39-54.

37/ Id.

38/ Commission investigative attorney's comments at 14-15, app. B (Gooley affidavit) at pars. 11-12; CX 55 at 3-4.

39/ Id.

40/ See ID at 123, FF 860.

41/ ID at 107-12. * * * * * * * * * * * . ID at 109-11.

42/ See ex. G to complainant's submission and the subsequently filed amendment. See also Commission investigative attorney's comments at 22.

43/ ID at 127-28.

is to be expanded, the record shows that Allied costs and prices have been decreasing. 44/

For the sum of the foregoing reasons, it does not appear likely that exclusion of amorphous metals would have an adverse impact upon competitive conditions in the U.S. economy.

C. The production of like or directly competitive articles

There is no indication that the production of like or directly competitive articles in the United States would be adversely affected by exclusion of infringing amorphous metals.

D. U.S. consumers

It does not appear that a general exclusion order would not have an adverse effect on consumers of amorphous metals. Allied has been found to have the requisite capacity to supply domestic demand. 45/ Moreover, * * * * * . 46/ Although various consumers of amorphous metals have expressed a desire for an alternate source of supply, 47/ we find that, in this case, business expediency does not justify the importation of infringing articles in violation of section 337.

In conclusion, we determine that the impact of a general exclusion order on the aspects of the public interest enumerated in section 337(d) is not such that exclusion should not be ordered.

Bonding

In determining the amount of the bond to be imposed during the Presidential review period, pursuant to section 337(g)(3),

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44/ ID at 119, 126; see Commission investigative attorney's comments at 10; CX 258, Technical Proposal at 3-49; ID at 120.

45/ ID at 126.

46/ ID at 120.

47/ See e.g., ID at 120; FF 850-52; SX 25 at 23, 64; SX 9 at 187-88; SX 17 at 63, 130-32, 135; respondents' joint statement at 12-17.

19 U.S.C. 337(g)(3), the Commision is required to take into consideration the amount that would offset any competitive advantage resulting from unfair methods of competition and unfair acts enjoyed by parties benefitting from the importation in question. 48/ Using that standard, we determine that the amount of the bond should be 100 percent of the entered value of the imported articles.

There is no established price structure for the subject amorphous metal articles. The imported articles have been sold at various prices. 49/ The prices for Allied's products are unsettled, because the markets for amorphous metal materials are in their incipiency, and Allied is still in the process of developing amorphous metal alloys for the various markets. 50/

Furthermore, the-importation of infringing materials has consequences beyond the loss of revenues derived from the transactions in question. The ALJ determined that the importation of the respondents' amorphous metal articles in connection with sales or sampling of such products by present or potential customers has the tendency to substantially injure the domestic industry, because large markets for amorphous metals are developing, and the respondents have been able to prepare their products to meet the specifications of future purchasers by engaging in sampling procedures during the lifetime of the patents in controversy. 51/

It would have taken a considerable amount of time after the expiration of the patents before the respondents could begin competing with Allied, if sampling and evaluation had not taken place prior to the expiration of the patents.

48/ 19 CFR S 210.14(a)(3).

49/ ID at 129, 132; FF 947, 1026.

50/ Complainant's submission at 29; Commission investigative attorney's comments at 7.

51/ ID at 136.

The qualification process can take 1 to 2 years. 52/ * * * * * * * * * * . 53/ The loss of projected lead time erodes Allied's opportunity to obtain the maximum projected return on its investment. 54/

Respondents Nippon and Hitachi * * * * * . 55/ Respondent VAC * * * * * , and is seeking to increase its sales. 56/ TDK is in a similar position in the pulse power market because of its transactions with LLL. 57/ A bond of less than 100 percent would be inappropriate under the circumstances.

52/ FF 1094.

53/ Tr. at 2504-05,•2516.

54/ FF 1095, 1099. The AO found that two types of damage can result from the importation of amorphous metal articles made by an infringing process: (1) a potential buyer, seeing a potential second source of supply, may compare and evaluate the infringing products and may begin to qualify those products for purchase, instead of buying from Allied immediately; or (2) Allied may lose early sales while the buyer determines whether the amorphous metal product in question can be obtained from a second source at a lower cost—or Allied may be forced to lower its price. FF 1096, 1098.

55/ ID at 134; FF 990-1014; ID at 134-36; FF 1050-93.

56/ ID at 129-31; FF 1015-49.

57/ ID at 132-33; FF 905-89.

INITIAL DETERMINATION AND FINDINGS OF FACT

THE FOLLOWING PAGES WERE DELETED BECAUSE THE INFORMATION THEREON IS CONFIDETIAL

INITIAL DETERMINATION, PAGES: 71, 72, 73, 103-113.

FINDINGS OF FACT, PAGES: 25, 64, 67-73, 99, 129, 130, 132, 133, 140-149, 153-161, 187, 204-227, 233, 249-267, 271-279, 281.

UNITED STATES INTERNATIONAL TRADE COMMISSION
Washington, D.C.

In the Matter of

CERTAIN AMORPHOUS METAL ALLOYS
AND AMORPHOUS METAL ARTICLES

Investigation No. 337-TA-143

NOTICE TO ALL PARTIES

Attached hereto is a public version of the initial determination issued May 14, 1984. All deletions requested by the parties have been made. Due to the breadth of the deletions, any party may file a motion seeking declassification of material claimed to be confidential.

Janet D . j4xom
Janet D. Saxon
Administrative Law Judge

Issued: May 24, 1984

PUBLIC VERSION

UNITED STATES INTERNATIONAL TRADE COMMISSION
Washington, D.C.

In the Matter of CERTAIN AMORPHOUS METAL ALLOYS AND AMORPHOUS METAL ARTICLES	)	Investigation No. 337-TA-143

INITIAL DETERMINATION

APPEARANCES

For Allied Corporation:

Robert S. Swecker
Norman H. Stepno
Platon N. Mandros
E. Joseph Gess
Samuel C. Miller, III
Robert G. Mukai
Regis E. Slutter
BURNS, DOANE, SWECKER & MATHIS

For Hitachi Metals, Ltd.,
Hitachi Metals International, Ltd. and
Hitachi, Ltd.:

Thomas J. Macpeak
Waddell A. Biggart
Ronald I. Eisenstein
SUGHRUE, MION, ZINN, MACPEAK & SEAS

Alan J. Neuwirth
Richard A. Mescon
KASSEL, NEUWIRTH & GEIGER

For Siemens Capital Corporation:

Tom X. Schaumberg
Alice A. Kipel
Joel D. Kaufman
PLAZA, SCHAUMBERG & deKIEFFER

For Vacuumschmelze GmbH:

John D. Simpson
Steven R. Noll
HILL, VAN SANTEN, STEADMAN & SIMPSON

For Nippon Steel Corporation and .
Nippon Steel U.S.A. Inc.:

Daniel J. Plaine
Jane C. Luxton
Jeanne E. Davidson
Robert W. Fleishman
Bradley E. Lerman
Mark D. Whitener
John K. Kelly
STEPTOE & JOHNSON

Thomas L. Creel
Robert T. Tobin
Edward W. Greason
Philip J. McCabe
KENYON & KENYON

For TDK Corporation, TDK Electronics Corp., and
MEW International Corporation:

Martin Fleit
Allen S. Melser
Masaho Odano
FLEIT, JACOBSON, COHN & PRICE

For United States International Trade Commission:

David I. *Wilson*
Stephen L. Sulzer

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HISTORY OF THE CASE

On March 11, 1983, complainant Allied Corporation filed a complaint with the U.S. International Trade Commission alleging violations of 19 U.S.C. Section 1337 and 19 U.S.C. Section 1337a.

On April 13, 1983, the Commission published a notice of investigation initiating an investigation to determine whether there is a violation of Section 337 of the Tariff Act of 1930, as amended, in the unlawful importation of certain amorphous metal alloys and amorphous metal articles into the United States, or in their sale, by reason of alleged (a) infringement of the claims of U.S. Letters Patent No. 3,856 513; (b) infringement of the claims of U.S. Letters Patent No. 4,331,739; and (c) infringement of the claims of U.S. Letters Patent No. 4,221,257, the effect or tendency of which is to destroy or substantially injure an industry efficiently and economically operated in the United States.

The Commission named nine respondents in the original notice and amended the notice of investigation on September 14, 1983 to add two new respondents, Nippon Steel Corporation and Nippon Steel, Inc. An unopposed motion to terminate a company named by mistake (Hitachi Magnetics Corporation) was granted in Order No. 22.

The following ten companies remain as respondents in *this* case:

1. TDK Corporation
   13-1, 1 Chome
   Nichonbashi, Chuo-ku
   Tokyo 103, *Japan*

2. TDR Electronics Corporation
   12 Harbor Park Drive
   Port Washington, New York 11050

3. MH&W International Corporation
   14 Leighton Place
   Mahwah, New Jersey 07430

4. Vacuumschmelze GmbH
   Gruener Weg 37
   D-6450 Hanau 1, West Germany

5. Siemens Corporation
   186 Wood Avenue South
   Iselin, New Jersey 08830

6. Hitachi, Ltd.
   New Marunouchi Bldg.
   5-1, 1 -chome, Marunouchi
   Chiyoda-ku
   Tokyo, Japan

7. Hitachi Metals, Ltd.
   Kishinoto Bldg.
   2-1, Marunochi 2-chome
   Chiyoda-ku
   Tokyo, Japan

8. Hitachi Metals International, Ltd.
   1 Red Oak Lane
   White Plains, New York 10604

9. Nippon Steel Corporation
   6-3, Ote-Machi 2-Chome
   Chiyoda-ku
   Tokyo 100, Japan

10. Nippon Steel, Inc.
   345 Park Avenue
   New York, *New* York 10154

An initial determination amending the notice of investigation to add "prevention of establishment of an industry in the United States" to the scope of the investigation became final on January 25, 1984.

The hearing opened on January 16, 1984, and was closed on February 21, 1984. All parties have submitted post trial briefs. Findings are attached hereto.

JURISDICTION

None of the respondents contested the personal jurisdiction of the Commission, and All appeared at the hearing and litigated one or more issues.

Three respondents, TDK Corporation, TDK Electronics Corporation and MREN International Corporation, contested the Commission's subject matter jurisdiction over these respondents arguing that because the only sales made by these respondents were to the United States Government at its request, the U.S. Claims Court has exclusive jurisdiction to hear their case.

This question *was* briefed before trial, and Order No. 27 granted an application for interlocutory review of Orders 14, 19 and 24. These orders found that the issues of patent validity and infringement should be heard under Section 337, even though *sales* to the U.S. Government are involved. The question of damages incurred by Allied from any patent infringement would be heard subsequently by the U.S. Claims Court.

The TDK respondents submitted evidence at the hearing relating to this *issue,* as well as to certain other issues in this case, and they will brief the jurisdictional question again to the Commission. All orders issued in this proceeding are subject to review if exceptions are filed after the initial determination *is* issued.

The Commission has subject matter jurisdiction over alleged unfair acts in connection with the importation of products alleged to infringe U.S. patents (the '513 and '739 patents) under Section 337 of the Tariff Act of 1930 (19 USCA S1337). Alleged unfair acts in connection with the importation of products produced under a process covered by claims of an unexpired U.S. patent (in *this* case the '257 patent) are brought under the Commission's Section 337 jurisdiction by Section 1337a of the Tariff Act of 1930 (19 USCA 51337a).

A. Validity of the '513 Patent

1. Background of the '513 Patent

The application for the '513 patent was filed on December 26, 1972, the patent was issued on December 24, 1974, and it was assigned to Allied Corporation. The named inventors are Warren Ho—Sou Chen and Donald E. Polk. Both were employed by Allied.

The '513 patent relates to certain amorphous metal alloys and to partly amorphous, partly crystalline metal alloys. A completely amorphous metal alloy *is* one with no crystalline structure. Completely amorphous metal alloys have a random atomic structure and exhibit no long range order in atomic arrangement. The atoms in amorphous metal alloys lack the orderly, crystalline lattice structure ordinarily found in metals. (Allied Ex. 656, TR 1857).

All metals start out with a crystalline structure. An amorphous (or glassy) state sometimes can be obtained by heating suitable metal alloy to a high heat, and cooling it very *fast* before crystals can form in the metal. To obtain an amorphous state, a molten alloy of a suitable composition must be quenched rapidly, or a deposition technique must be used. (Allied Ex. 18, col. 1). Depending on the composition of the alloy, rapid quenching may produce generally amorphous metal, or partly amorphous and partly crystalline metal. Various deposition techniques include vapor deposition, sputtering, electrodeposition, and chemical (electro—less) deposition.

The claims of the '513 patent are set forth in Appendix A. Claim 1, from which claims 2, 3 and 4 depend, claims a metal alloy having the formula "M_aYbZ_c" wherein "M" is iron, nickel, chromium, cobalt or vanadium or mixtures thereof is amounts between 60 and 90 atomic percent, "Y" *is* phosphorous, carbon or boron or mixtures thereof in amounts between 10 and 30 atomic percent, and *is* aluminum, silicon, tin, antimony, germanium, indium or beryllium, or mixtures thereof in amounts between 0.1 and 15 atomic percent. (Ex. P-444; Ex. P-443, col. 10, lines 14-26).

The '513 patent *is* an extremely broad patent covering literally thousands of possible alloy combinations falling within the "MYZ formula." The "MYZ formula" covers any alloy consisting of one or more metals or metalloids from each group in a certain relationship to one another. (Metalloids are semi-metals.)

The '513 Patent Invention

A' reading of the '513 patent file history and the patent gives a sense of what the applicants or the attorney prosecuting the application thought that the invention was at the time of patent prosecution.

In the specification, the applicants state that the first object of the invention was to provide "novel amorphous metal compositions which are readily quenched to the amorphous state, have increased stability and *possess* desirable physical properties." (Ex. P-444; Allied Ex. 18, col. 2, lines 58-61). The "desirable physical properties," listed *in* columns 2, 5 and 6, are the qualities found in amorphous metals or in metals that are partially crystalline but at least 50 percent amorphout.

Other objects of the invention were to provide articles of manufacture of these novel amorphous metals in a variety of forms (ribbons, sheets, wire, powder, etc.). (Allied Ex. 18, col. 2, 3 and 6). The specification states that additional objects and advantages of the invention would become apparent from the description and examples provided. (Allied Ex. 18, col. 3).

The patent specification includes a number of examples. All are described in the past tense, as if the work described had been done. In fact, there is no documentary evidence that the applicants had carried out any of the examplei described. The record shows that the applicants could not have done much of the work described in the examples. Some of the examples relate to quenching from the melt, but others relate to deposition techniques. The applicants did not have the equipment to use deposition techniques. Dr. Chen and Dr. Polk worked only on alloys liquid quenched from the melt. (Ex. P-1210, TR 139-140; Ex. P-1224, TR 129-136; Ex. P-1224A, TR 29-30).

Examples using deposition techniques are not made by quenching from the melt. These examples have nothing to do with providing novel amorphous metal compositions that are readily quenched to the amorphous state or to the formation of wire, but they could illustrate some other object of the invention.

Regardless of the description of the invention in the patent, both the scope of the invention and the scope of the claims are limited by the doctrine of file wrapper estoppel because of the representations made by the applicants to the Patent Office to overcome rejection of the claims.

At column 2 of the patent, the applicants pointed out that at that time no practical guideline was known for predicting with certainty "which of the multitude of different alloys will yield an amorphous metal with given processing conditions and hence which of the alloys are 'better' glass formers." The applicants offered the formula of the '513 patent as this guideline.

The Examiner initially rejected a number of the claims under Section 112 as "non—enabling to support claims of the present scope which read on a plethora of alloys alleged to be 'amorphous' but not disclosed, contemplated or discovered without undue, rigorous experimentation." (Ex. P-444, at 21).

To overcome this rejection, applicants responded that the "alloy combinations and propositions have been carefully selected after much experimental effort..." (Ex. P-444, at.27). Again, at p. 29, applicants stated that "rigorous experimentation has actually been conducted by applicants."

Applicants revised their claims to "at least 50% amorphous" composition "to obviate the basis of confusion as to whether the alloys claimed are indeed amorphous." (Ex. P-444 at 29).

Finally, to overcome the Examiner's rejection of applicants' claims over the-Mader '154 patent, applicants represented that "the essence of applicants' teaching is to disclose and teach compositions which are unique in that they be easily obtained in the amorphous state. The alloys designated by applicants may be obtained by lower quench rates and thus enabling them to be produced with greater (more useful) thicknesses than other alloy processes." *(Ex.* P-444 at 30).

Applicants distinguished Mader as teaching "quenching of alloys by vapor deposition, a process which provides a quench rate which is unusable in cooling a liquid. The compositions listed by Mader are not glass forming when quenched from a melt. Vapor deposition, and melt quenching are differences in kind...." (Ex. P-444 at 31).

Applicants criticized Mader's vapor quenching technique at p. 31. of the file history:

> While vapor quenching as taught by Mader involves a means for production of amorphous compositions, it is apparent to one skilled in the art that it is entirely impractical and reasonably unrelated to the teaching provided by applicants of specific metal alloy amorphous compositions, compositions which can be made available in practical quanti.ies from a melt of the desired compositions. •

A reading of the *file* history demonstrates that Allied is now estopped from arguing that the '513 patent formula works with respect to all compositions falling within the formula even if some compositions cannot easily be quenched from the melt into an amorphous state, as long as they can be made amorphous after exhaustive effort by a deposition technique.

In overcoming the Examiner's rejection of claims, Allied represented that the essence of the invention was a formula to show one how to make alloy compositions easily quenchable from the melt to an amorphous state, without undue experimentation, so that practical quantities of amorphous metals can be obtained. Allied is estopped from asserting that the invention of the '513 patent is any broader than this.

2. Section 103

A patent claim will be found invalid if the differences between the prior art and subject matter of the claims in *issue 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. 35 U.S.C. 5103; Graham v. John Deere Co., 383 U.S. 1, 148 U.S.P.Q. 459 (1966). Graham v. Deere requires a determination of the scope and content of the prior art, the differences between the prior art and the claims at issue, and the level *of* ordinary skill in the pertinent art. The obviousness or nonobviousness of the subject matter may then be determined. 148 U.S.P.Q. at 467.

Scope and content of the prior art

The scope of the prior art in connection with the '513 patent includes metallurgy in general, and amorphous metal alloy technology in particular.

The prior art includes the Fizika article of Professor Duwez published in about 1970 (Ex. P-249), the article of Yamauchi and Nakagawa, published in 1971 (Ex. P-394) and the Felsch articles published in 1966 and 1970. (Exs. P-1013, P-388).

At the time of filing of the application resulting in the '513 patent (December 26, 1972), amorphous metals were relatively new.

In the 1960's it was a matter of experimentation to determine what alloy compositions could be made amorphous by rapid quenching from the melt. Some alloys simply could not be made amorphous by any means at that time. Some of the alloys that were found to be easily made amorphous included precious metals and were expensive to make. The experimentation required to find other alloys that could be made amorphous easily was time consuming.

In about 1960, Professor Poi Duwez at California Institute of Technology showed that an alloy of 75% gold and 25% silicon could be made amorphous by rapid quenching from the melt. From 1960 to 1970, Professor Duwez identified a number of other alloy compositions that could be made amorphous.

The first important conference in the field of rapid quenching of amorphous metals was held at the University of Zagreb in Yugoslavia in 1970. The proceedings of this conference were published in Fizika and included an article by Professor Duwez summarizing the development of liquid quenching of amorphous metals and his observations regarding factors influencing the formation of amorphous metal alloys.

One of the alloy systems referred to in the Fizika article by Professor Duwez *was* the iron-phosphorous-carbon amorphous alloy Fe75P 15C10 prepared by liquid quenching from the melt. Other ternary alloys of transition metals and metalloids also had been formed, including iron-palladium-silicon (Fe-Pd-Si), cobalt-palladium-silicon (Co-Pd-Si), nickel, palladium-silicon (Ni-Pd-Si),-and gold-silicon-germanium (Au-Si-Ge).

The Fizika article contained the following information (at 1.2-1.3):

(1) An amorphous phase *is* likely to be found near a eutectic composition providing the eutectic is of the "deep" type.

(Z) Ternary or quaternary alloys are generally easier to quench into an amorphous state than binary alloys (the "confusion principle").

(3) Amorphous alloys containing from 70 to 80 percent transition metal with the remainder non-metals such as boron (B), carbon (C), silicon (Si), germanium (Ge), arsenic (As) or

phosphorous (P) had been formed by liquid quenching. (Transition metal *is* a generic term covering elements in all of the first, second and third transition series.)

The Fizika article was available to anyone working on the formation of amorphous metal alloys in 1970, over a year before Dr. Chen and Dr. Polk began their project which resulted in the '513 patent.

Another prior art reference was the article of Yamauchi and Nakagawa in Japanese Journal of Applied Physics, published in 1971. This taught that iron—phosphorous—boron (Fezt0P13B7), cobalt—phosphorous—boron (Co73P151112), iron—boron—carbon (Fe76B17C7) and nickel—phosphorous—boron (Ni75P15B10) alloys could be formed in the amorphous state by splat cooling, a melt quenching process.

The Felsch articles published in 1966 and. 1970 taught that the addition of silicon to iron and to cobalt, in amounts far below the eutectic percentages, increased the crystallization temperature, making it easier to produce amorphous metals from the iron—silicon and cobalt—silicon binary alloys. This *also* increased the thermal stability of the amorphous alloy systems.

The above information *was available* to Dr. Chen and Dr. Polk when they began their study. On October 6, 1971, Dr. Polk wrote on the first page of his notebook (Ex. P-216):

> An investigation will be made having as its primary object the formation of metallic glass wire directly from the melt. Various metallic alloys which have in common a composition which is about 80 atomic % transition or noble metal and 20 atomic % metalloid have been shown to exist as metastable glasses. These alloys are generally in the vicinity of eutectics and hence have the advantage that spinning can proceed at lower temperatures ... Iron-phosphorous-carbon alloys have previously been shown to form 'glasses directly from the melt. This study will concentrate primarily on iron based alloys containing other metals and metalloids and will seek to determine which alloys are most suitable for spinning into a glass. Alloying elements to be considered include Mn, Co, Ni, Cu, and Al and metalloids such as B, C, Si, P, & S. ...

Dr. Polk recognized a relationship between eutectics and amorphous metal formation, and he mentioned the known metalloids to be added to the Fe-P-C alloy system at around the 80-20 atomic % level, as pointed out in the Duwez Fizika article.

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Professor Duwez had taught that a compositional range around 80% metal and 20% non-metal or metalloid is favored for glass formation and that examination of the phase diagram 6f the binary system for the eutectic points is useful for predicting ease of glass formation. (TR 2880-2882, Ex. P-1015).

Dr. Polk then stated (Ex. P-222 at 4):

> The metalloids which are of interest include B, C, Si, P, S, Ge, As, and Sb. For Fe and Ni, the P eutectics are the deepest while Si shows appreciable solubility in both Fe and Ni. Neither Fe-P nor Ni-P can be quenched to a glass from the melt, though Fe-P-C had been thus obtained while amorphous Ni-P had been obtained with deposition techniques.

The metalloids mentioned by Dr. Polk are those set forth in Fizika or already known in the art.

Finally, Dr. Polk stated (Ex. P-222 at 4):

> Generally, suitable ternaries are better glass formers than the related binaries, etc. The primary reason for this is presumably the destabilization of crystalline phases when additional elements. are added while entropic effects can stabilize the amorphous phase. Thus, alloys based on Fe-P containing C, B, Si, S, Al, Co, Mn, Ni, Cu, and Cr were produced.

Dr. Polk was aware of the "confusion principle" set forth by Duwez in Fizika. This principle states that ternary and quaternary alloys are generally easier to quench into the amorphous state than binary alloys. Ac that time Polk apparently accepted the three guidelines of Fizika including the deep eutectic, the "confusion principle," and the use of the known glass formers C, B, Si, and S, added to Fe-P containing alloy systems.

(Ex. P-222 at 6). Allied's expert, Dr. Turnbull, testified that stabilization by inclusion of oxygen with silicon was the teaching of Felsch. (TR 5590, Ex. 2-1013).

Differences between the prior art and the claimed invention

The principal distinction between the subject matter of the '513 patent and the prior art is that Chen and Polk offered a formula for combining a number of the glass—forming elements known to the prior art into the "Y" and "Z" groups in combination with one or more elements from the "M" group. The record contains no evidence of an amorphous "MYZ" alloy having been melt—quenched prior to the work of Chen and Polk, but the prior art did include various binary and ternary amorphous alloys including MY, HZ and MYY alloys.

Level of skill in the art

The level of ordinary skill in the art was high at the time of filing of the '513 patent application. Most of the early research in the field of amorphous metal alloys was done by persons with Ph.D. degrees.

The subject matter of the '513 patent was not obvious

The subject matter of the '513 patent would not have been obvious to one of ordinary skill in the art in 1972. It may have been "obvious to try" alloys with compositions of_the type claimed, but obvious to try is not obviousness which invalidates an invention. At the early stages of making amorphous metals, it would have been obvious to try virtually any alloy combining metals, or combining metals and metalloids, that had not been tried before. Adding certain ingredients known to have made other alloys more easily quenched to an amorphous state would have been especially obvious to try.

The amorphous metal field was almost entirely experimental when Chen and Polk were doing the work leading to the '513 patent. Very few theories had been tested and proven. No universally accepted theory existed to explain why some alloys could be made amorphous easily and others could not. There was no reason to assign a high degree of predictability to the results of adding silicon, aluminum or other Z elements to binary or ternary MY compositions. The '513 patent claimed a functional difference between the Y and Z elements alone and these elements combined with M elements, in a certain proportion. (EX. P-222 at p.

The prior art use of Y and Z elements as glass formers in transition metal and noble metal-based alloys did not lead to a logical conclusion that Y and Z elements, when combined and added to a transition metal alloy, would result in an increased likelihood of easier amorphous metal formation. The prior art combination of the elements silicon and germanium with metals such as iron or cobalt resulted in amorphous alloys which could be formed only with difficulty and which were stable only at a low temperature. (Ex. P-388, P-1013)..

The '513 patent formula was surprising rather than obvious, if it resulted in the ready quenching of amorphous alloys from the melt.

The formula is novel, but the difficulty *is* that it does not always work. Some products under the formula are not readily made amorphous by any means. It would be immaterial whether the formula worked because of one theory or another, as long as the formula worked. But it does not.

The formuli of the '513 patent covers so many possible alloy combinations that even if the formula were useless as a teaching, it might include many alloys that could be readily quenched from the melt to a glassy state.

If the formula worked, it would be expected to work on all products within the formula. If it does not work, either the alloys that are readily quenched to the amorphous state must have this characteristic for some other reason, or the applicants were not aware of some factor or factors that would prevent the formula from working under certain conditions. Such an invention *is* not useful if the conditions are unknown.

3. <u>Section 112 and Section 101</u>

Under Section 101 of the Patent Act (35 USC 101) an invention must be "useful" to be patentable. Under Section 112 (35 USC 112), the specification must describe the invention in such a way as to enable any person skilled in the art "to make and use" the invention.

The '513 patent is invalid under Sections 112 and 101 because the invention, as limited by file wrapper estoppel, does not always work.

The patent satisfies the "best mode" requirement *of* Section 112. It satisfies the requirement that one or more *claims* particularly point out and distinctly claim the subject matter of the invention. There is no requirement that the applicants test all possible alloy combinations under the '513 formula, or that the claims be limited to examples in the specification. <u>Smith .v. Snow,</u> 294 U.S. 1, 24 USPQ, 26 (1935), and <u>Stevenson v. USITC,</u> 612 F.2d 546, 204 USPQ 276 (CCPA 1979).

The '513 patent is not invalid because of Allied's positions taken in later patent applications. Positions taken by Allied in patent applications filed after issuance of the '513 patent are not inconsistent with a finding that the '513 patent *is* useful, although the positions taken by Allied here and in those patent applications are sometimes inconsistent (for example, with respect to boron as the sole Y element). Later patents such as the '262 patent (Ex. P-38) and the '201 patent (Ex. P-12), are directed to alloy compositions of a much narrower range than those claimed in the '513 patent. They represent specific improvements in the broad generic compositions of the '513 patent.

There is no requirement that all examples of a patent be equally useful. A patent's failure to achieve all of its stated objectives does not defeat patentability if some of its objectives are accomplished by its teachings. E.I. du Pont de Nemours & Co. v. Berkley Et Co., Inc., 205 USPQ 1, 10 (8th Cir., 1980).

In the '513 patent, however, the essence of the invention as stated in the file wrapper (at 30-31) is to provide alloy combinations that readily can be made ,amorphous by quenching from the melt so that practical plant/ties can be made. If the formula does not work, the patent *is* not useful. Even though many alloys under the formula may be readily made amorphous, the patent will be invalid unless all products using the formula are readily made amorphous by quenching from the melt.

File wrapper estoppel limits the claimed invention to the claim that MYZ alloys are easily quenched from the melt. It has not been shown that any claimed alloy combinations cannot be made amorphous by some means, including vapor deposition, sputtering, or other techniques. Vapor deposition was mentioned in the specification and *was* known to those skilled skilled in the art. If the alloys under the formula cannot be readily quenched from the melt, however, the invention lacks utility, because the applicants overcame the Examiner's rejection of the claims *based* on Mader by arguing that the compositions of Mader were made by vapor deposition rather than quenching from the melt, whereas applicants' product was unique in being glass forming when quenched from a melt. Mader's vapor quenching *was* described as "entirely impractical," whereas applicants' product could be made in practical quantities from a melt. (Ex. P-444, at 31). The record shows that certain alloys under the formula could not be made amorphous by Dr. Chen and Dr. Polk by quenching from the melt. (Exs. P-253, P-222). Other alloys under the formula cannot be readily quenched from the melt to an amorphous state. (P-205 through P-213, P-1172). Other techniques had to be used to make these alloys amorphous. It is for this reason that the patent is found to• be invalid under Section 101.

Some alloys made according to the claimed formula *also* fail to satisfy another of the objectives of the patent, that of providing amorphous metal alloys which are more thermally stable. For example, alloys falling within the claimed range and containing greater than 6 atomic percent beryllium demonstrate decreased thermal stability. (TR 2965-2969, Ex. P-173).

It *was* surprising that so many alloys in the formula could be- readily melt-quenched to an amorphous state, but the patent claimed that all alloys under the formula readily could be quenched from the melt to an amorphous state, and such was not the fact.

An applicant ordinarily is not entitled to a claim foe a large group of compounds merely by showing that a selected few are useful. The exception to this rule is when a group of compounds share a key structural feature from which a common utility is derived. In that case, a formula can be the *basis* for the patent even though very few compounds are discussed. In re Cavallito, 282 F.2d 357, 127 USPQ 202 (CCPA 1960), Hercules Inc. v. Exxon Corp., 207 USPQ 1088, 1106 (D. Del. 1980).

Here, the '513 formula covers some compositions that are not readily quenched from the melt to an amorphous state. Either the characteristic *of* being easily quenched from the melt to an amorphous state *is* not the result of the formula, or something not disclosed in the patent keeps the formula from working for some compositions. In either case, since the formula does not work for some compositions, and experimentation is required to determine when a composition covered by the formula can be made amorphous by quenching from the melt, the '513 patent is not "useful."

Infringement of the '513 Patent

1. **Nippon Steel Corporation**

2. **Vacuumschmelze**

Vacuumschmelze (VAC) has imported into the United States amorphous metal alloy ribbon or strip having the following compositions (Allied E 515; Allied Phys. Ex. GC(13)—(17)):

(6025, 6025F, 6025X, 6025Z)

(6030, 6030Z)

(4040, 4040F, 4040Z)

(0080)

(6010)

The last two compositions fall within the language of claims 1, 3 and 4 of the '513 patent. (Tr 2254-2258). The first three can be found to infringe the patent claims only if the term "about" in the claimed compositional ranges is read expansively, or if the doctrine of equivalents is applied broadly.

The term "about" will not be read to allow Allied to broaden the reach of its claimed compositions beyond some tenths of a percent, i.e., less than one percent at the upper or lower range limit of any specific range claimed. A variance of "some tenths of a percent" of one element in proportion to the others may be the result of inability to control the precise amounts in the manufacture of the product. (TR 3564).

The ranges claimed are already so broad as to include thousands of alloys that have not been tested by Allied, and some that cannot easily be made amorphous. Allied placed considerable importance on the restricted range of elements in each formula to obtain allowance of the claims.

In an Amendment dated May 10, 1974, during the course of prosecution of the application resulting in the '513 patent, Allied stated at page 4 in -eply to a previous rejection under Section 112:

> The Examiner further notes that the claims are incomplete in omitting the particular ranges in which :the desired amorphous state is retained. In light of applicants' teachings and in light of knowledge available to those skilled in the art, the reasonableness of this position is respectfully traversed. Subscripts in each of the formula indicates the composition. range of glass formation; indeed, as noted above, a rather restricted range of *less* than 1 percent of the possible range of proportions.... As a matter of actual fact, the specific alloy combination claimed by applicants obviate any undue or rigorous experimentatiod because in naming the metals of the formula 14, Y and Z and the proportions recited, the rigorous experimentation has actually been conducted by applicants. (Emphasis added).

As a result of these representations to the Patent Office, Allied is now estopped from seeking even broader ranges. The rejection under Section 112 was removed after Allied made these representations. Although Allied did not have to amend the '513 claims since the subscripts appeared in the originally—filed claim language, it is not necessary for an applicant to. amend a patent claim in order to give rise to estoppel in subsequent interpretation of that claim. As stated by the Federal Circuit in Hughes Aircraft Co. v. United States, 717 F.2d 1351, 219 U.S.P.Q. 473, 481 (Fed. Cir. 1983):

> The doctrine of prosecution history estoppel precludes a patent owner from obtaining a claim construction that would resurrect subject matter surrendered during prosecution of his patent application. The estoppel applies to claim amendments to overcome rejections based on prior art, Dwyer v. United States, 357 F2d 978, 984, 149 U.S.P.Q. 133, 138 (Ct. Cl. 1966), and to arguments submitted to obtain the patent, Coleco Industries, Inc. v. ITC, 573, F2d 1247, 1257, 197 U.S.P.Q. 472, 480 7775.A. 1978). (Emphasis added).

Allied chose the range limitations and asserted their importance, and Allied is bound by its own arguments. See Aluminum Company of America v. Thompson Products, Inc., 51 U.S.P.Q. 237 (6th Cir. 1941), a case which involved claims to alloys containing "about" certain percentages of elements, and Nationwide Chemical Corp., v. Wright, 584 F.2d 714, 200 U.S.P.Q. 257 (5th Cir. 1978).

In VAC's 6025 series alloys, the Z element (silicon) exceeds the claimed maximum percentage, compared to 15%. In the 6030 series, the Y element (boron) is less than the claimed minimum percentage, compared to 10%. In the 4040 series the Y element (boron) *is* less than the claimed minimum, compared to 10%. In each of these instances, it is found that the actual VAC percentage is not "about" the claimed percentage. It is found that the 6025, 6030, and 4040 series alloys do not literally infringe claims 1, 3 or 4 of the'513 patent.

For the same reasons, Allied *is* estopped from claiming that alloys having compositions outside the claimed ranges infringe under a broad construction of the doctrine of equivalents.

It is found that claims 1, 3 and 4 of the '513 patent, if valid, have been infringed by the importation into the U.S. of ribbons or strips made from the VAC VITROVAC 0080 and 6010 series alloys.

. Any improved magnetic qualities of the VAC alloys are found not to be a defense to a charge of infringement of the '513 patent, for the reasons discussed above with respect to Nippon Steel. Nor can a defense to a finding of infringement be grounded on a promise to import only non—infringing alloys in the future.

3. Hitachi Metals Limited and Hitachi Metals International

There is a judicially—created "experimental use" exception to the pro scrip tion against making, using or selling a patented invention. The history of this exception is set out in Pfizer, Inc. v. International Rectifier Corp., 217 USPQ 157, 160-61 (C.D. Cal. 1982). The exception is inapplicable here because the underlying purpose of the *use* was commercial in nature. 217 USPQ at 161.

TDK

Sanctions have been imposed on respondent TDK Electronics which include a finding that TDK Electronics has imported amorphous metal alloys which infringe claims of the '513 patent. See Order No. 32.

No such sanction was sought against TDK Corporation, and none was imposed.

TDK Corporation has imported into the United States an amorphous metal alloy having the following composition: Fe76.7B7.67Si15.6. (Allied *Ex.* 518). This composition *is* outside the ranges of claim 1 of the '513 patent. The Y element, boron, is below the minimum amount claimed (7.67% compared to 10% in the claim), and the Z element, silicon, *is* above the ma:timum amount claimed. The claimed ranges will not be expanded that much to cover compositions not actually claimed. The TDK Corporation alloy actually imported into the U.S. *is* found not to infringe the '513 patent claims.

The '257 Method Patent

A. Validity

1. Background of the '257, '571 and '739 Patents

On October 22, 1967, Allied filed a patent application *based* on the invention of Dr. Mandayam C. Narasimhan. (Ex. P-294). The application included apparatus claims, method or process claims, and product claims. Eventually, three separate patents issued. Allied alleges that *two* patents growing out of the Narasimhan invention have been infringed. These are the '257 process patent and the '739 strip patent. (Allied Exs. 19 and 20). The '571 apparatus patent *is* not alleged to be infringed in this case, but the file history of that patent is important to the construction of claims in the '257 patent.

Dr. Narasimhan's invention, which *was* reduced to practice in December, 1975, was a process for making continuous amorphous metal strip with a relatively uniform width at least 7 mm *wide.*

When Dr. Narasimhan first came to Allied in the summer of 1975, a number of methods of casting amorphous metal strip were known, and all of these methods had problems. At Allied, jet casting, double roll casting, and jet casting in a vacuum had been tried.

In jet casting, *a* crucible of molten metal with a nozzle at the bottom is positioned over a rotating wheel that *is* cooled. The molten metal falls in a "free jet" between the nozzle and the wheel surface. The chilled surface cools the metal quickly, and an amorphous metal strip or ribbon *is* formed. This worked for narrow ribbon but did not work well for wide strip (over 7 mm wide). Rectangular nozzle openings were tried. A row of nozzle openings was tried. It was still difficult to obtain wide strip because the "free jet" between the nozzle and the wheel surface was unstable, and there was a molten pool at the wheel surface that kept breaking up because of the air carried around by the wheel rotating at high speed. (TR 542). When jet casting was done in a vacuum, the strip rapidly became welded to the surface of the wheel. (TR 592-593).

Double roll casting, in which the molten metal was solidified into a ribbon and pressed between two rolls, produced wide strip, but the strip was of poor quality and the width of the strip was irregular because of the rolling.

Dr. Harasimhan saw the problems that others were having at Allied in casting amorphoui strip. (TR 742-746).

After trying double rolling without success (TR 762-764), he built himself a movable crucible. At the bottom of the crucible he had a rectangular nozzle opening surrounded by flat lips. He positioned the nozzle over a rotating chill wheel moving at a fast speed. He had a means to heat metal alloys in the crucible and a means to inject gas pressure into the crucible over the melt. In December, 1975, he succeeded in making a wide amorphous ribbon by his new process. (TR 766-780).

Dr. Narasimhan's invention was a result of trial and error experiments in which he tried to hold the nozzle in his hand at various distances from the chill wheel. He found that he could make wide ribbon when the gap between the nozzle opening and the chill wheel was extremely small, but the nozzle did not touch the surface of the wheel. (TR 777, 790, 800).

—1. Section'T1T

Section 112 of the Patent Act (35 U.S.C. 112) in part requires that the claims particularly point out and distinctly claim the. subject matter which the applicant regards as his invention. The specification shall contain a written description of the invention and of the manner and process of making and using it, in such full, clear, concise and exact terms as to enable any person skilled in the art to which it pertains, or with which it *is* mostly clearly connected, to *make* and use the same. The specification *also* shall set forth the best mode contemplated by the inventor of carrying out his invention.

Section 112 encourages the inventor to set forth the scope of the invention in the claims rather than the specification, so that others reading the claims can avoid infringement. In re Hammack, 427 F.2d 1378, 1382 (CCPA 1970). Many courts have held, however, that it is not *fatal to* an ambiguous claim if certain aspects of the invention are described only in the patent specification.

The following questions about the '257 patent are raised under Section 112:

(a) What subject matter did the applicant regard as his invention?

(b) Do the claims of the '257 patent include this subject matter?

(c) Are the features of the invention that are not included in the claims critical to the invention?

(d) If so, can these features be read into the claims from the patent specification or *from* what someone with ordinary skill in the art would have known?

(a) What subject matter did Narasimhan regard as his invention?

Dr. Narasimhan believed that he was successful only when the nozzle was a short distance from the surface of the moving chill wheel because the molten metal was supported in part by the flat lips of the nozzle. The ribbon began to solidify when it touched the surface of the chill wheel. Because the melt was supported between the flat lips and the wheel surface, the force of the air moving around the swiftly moving wheel did not break up the molten metal before it solidified. The metal solidified after it moved away from the front lip of the nozzle and touched the chill wheel. As Dr. Narasimhan described his invention, the way in which he solved the problem of unsupported molten metal coming out of the crucible at uncontrolled speed was to use adjustable pressure on the molten metal in the crucible and a narrow slotted nozzle as an outlet for the molten metal,. and to force the metal out of the nozzle at a controlled rate, while the molten metal was supported partially by the width of the lips of the nozzle. While the molten metal was held under the front and back lips of the nozzle, it was still molten. The molten metal solidified and formed a ribbon when it touched the chilled wheel surface and was pulled away. When the nozzle was too far from the wheel, the molten metal would break up and spatter. When the nozzle was too close to the wheel, the molten metal touched the wheel surface too soon, the metal would solidify too soon, the wheel would stick on the crucible nozzle, and no ribbon would be formed. (TR 794-800, 812, 905, 910, 917).

(Allied Ex. 329) Dr. Narasimhan also testified at his deposition that the lips, the dimensions, and the way the nozzle was structured provided the support for the melt pool in his process.

Dr. Narasimhan first named his process the "Supported Melt Drag Process." (TR 838-839, 908, 595). He testified that the melt is supported between the front lip and the "solidification" front, and between the back lip and the beginning of the ribbon before it had solidified.

Dr. Narasimhan considered that the critical aspects of his invention included the wide back lip of the nozzle that held the melt as it came out of the slot and the wide front lip that provided support for the melt on the front side before it touched the wheel surface, solidified into ribbon, and was carried away by the movement of the wheel. In the Narasimhan process the melt pool is supported between the rapidly moving "solidification front" and the stationary front lip of the nozzle opening. The melt must be supported by both the front and back lips.

Allied's Patent Department agreed that this support was critical to the Narasimhan invention.

Mr. Wellslager had worked with Mr. Bedell on casting of amorphous metal strips and had recognized that problems such as turbulence, heat loss and oxidation could be eliminated by moving the crucible up to the wheel as close as possible. (Ex. P-434, at 45). Before Dr. Narasimhan came to Allied, Mr. Wellslager had tested this idea in a device using solder as the melt. (TR 685. Solder was commonly used at Allied to test ways for casting amorphous metal.)

Several years later, Mr. Wellslager was told by Allied patent attorney 'Gerhard Fuchs that he could not be considered a co-inventor of the Narasimhan process because Wellslager had not disclosed the specific configuration of the lips discovered by Narasimhan. (Ex. P-708, TR 4324-4333).

Allied recognized in this proceeding that this feature is critical to the Narasimhan invention. On pages 93 and 94 of the Allied brief complainant points out that Dr. Narasimhan discovered that if the molten metal alloy could be constrained or supported, to keep it from breaking apart before it solidified, this would allow the production of continuous wide amorphous metal strip. Allied's brief points out that Dr. Narasimhan discovered that by forcing the molten metal under pressure through a slotted nozzle less than

1 mm from a chilled surface, the melt became constrained or supported between the front and back lips of the slotted nozzle and the ribbon as it began to solidify on the chilled surface.

The width of the lips of the nozzle, and the use of these lips to support or constrain the molten metal was and still is considered by the inventor and by Allied to be critical to the invention. This is part of the "subject matter" that the applicant regarded as his invention.

(b) <u>Do The claims in the '257 patent include this subject matter?</u>

Claims 1-5, 8 and 12 of the '257 method patent are in issue in *this* case. These claims read as follows:

> 1. A methOd *of* forming continuous strip of amorphous metal from a molten alloy capable of forming an amorphous structure comprising:
>
> a. forcing the molten alloy under pressure.through a slotted nozzle positioned generally perpendicular to the direction of movement of a chill surface and located in close proximity to the chill surface to provide a gap of from about 0.03 to about 1 millimeter between said nozzle and the chill surface;
>
> b. advancing the chill surface, at a predetermined speed; and
>
> c. quenching the molten metal in contact with the chill surface at a rapid rate to effect solidification into a continuous amorphous metal strip.

2. The method of claim I wherein the chill surface *is* advanced relative to said nozzle at a velocity of from about 200 to about 2000 meters per minute.

3. The method of claim 1 wherein the molten alloy *is* quenched at a rate of at least 10^{4}° C. per second.

4. The method of claim I wherein the slotted nozzle is located in close proximity to the chill surface to provide a gap of from about 0.03 to about 0.25 millimeter between said nozzle and the chill surface.

5. The method of claim 1 wherein the slotted nozzle has a width of from about 0.03 to about 1 millimeter, measured in direction of movement of the chill surface.

...

8. The method (sic) claim I wherein the chill surface is provided by a rotating chill roll, and the molten alloy is deposited onto its peripheral surface.

...

12. The method of forming continuous strip of amorphous metal from a molten alloy capable of forming an amorphous structure, comprising:

(a) forcing the molten metal under•pressure through a slotted nozzle onto the peripheral surface of a chill roll, wherein *said* nozzle is located in close proximity to *said* peripheral surface such that the gap between the nozzle and *said* peripheral surface *is* from about 0.03 to about 1 millimeter, wherein the nozzle has a width of from about 0.3 to about 1 millimeter, measured in the direction of rotation of the chill roll, and wherein the nozzle is positioned generally perpendicular to the direction *of* the chill roll;

(b) rotating the chill roll at a predetermined speed to provide a peripheral velocity of from about 200 to about 2000 meters per minute; and

(c) quenching the molten metal in contact with the peripheral chill roll surface at a rate of at least about 10^{4} °C per second to effect liquidification into a continuous amorphous strip.

The claims of the '257 patent do not mention anywhere the width of the lips of the nozzle, or the dimensions of these lips, or their supporting or constraining function.

(c) Are the features of the invention that are not <u>included in the claims critical to the invention?</u>

The file history of the '571 apparatus patent shows that to overcome the objections of the Examiner, Allied argued that the dimensions of the slotted nozzle were critical. In connection with that patent application, the width *of the* slot and of the lips and the gap between the lips and the chill surface were described as critical and critically interrelated. Each of the claims of the '571 apparatus patent included dimensions for the width of the lips, but no mention *is* made in the claims of the other two patents of dimensions for the width of the lips.

On August 17, 1979, Allied amended its application for the method or process claims (resulting in the '257 patent), and argued that the new claims were patentable over the prior art because prior art did not teach the use of a slotted nozzle or the close spacing between a nozzle and a chill surface, or how to cast amorphous metal. (Ex. P-450). During the prosecution of this patent application Allied did not argue that the width of the lips was critical to the Narasimhan process, as it had argued in connection with the Narasimhan apparatus, but the '257 patent specification still states that the width of the lips is critical.

The specification for all three patents is about the same. It refers to mechanically supporting the molten metal on a chill surface. It states that the width of the lips is a "critical parameter," and that the first lip has a lip at least equal to the width of the slot, and the second lip has a width from about 1.5 to about 3 times the width of the slot. The slot must have a width of from about 0.3 to about 1 millimeter. (Allied Ex. 19, col. 3, 6, 7).

At the time of prosecuting the application for the '257 process patent Allied must have considered the width of the lips of the nozzle to be critical to the Narasimhan process because the specification describes it as critical, and Allied's Patent Department had taken the position that it was critical

(d) Can the critical features of the invention be read into the claims?

Ambiguous claims can be clarified by a reading of the specification but the failure of unambiguous claims to include a critical aspect of the invention may be fatal to the patent under Sections 103 and 112.

The '257 patent specification indicates that the lips must have a certain width relative to the width of the slot of the nozzle, and the figures in the patent show examples of the width of the lips relative to the size of the slot. (Figures 1, 4, 6 and 7).

The claims of the '257 patent do not mention the width of the lips of the nozzle at all. (Claim 12 defines "the width of the nozzle," between about 0.3 to about 1 millimeter, measured in the direction of rotation of the chill wheel. This refers to the opening or slot of the nozzle, rather than the width of the lips on both sides of the opening or slot.)

Allied repreatedly argued in this case that the step of "supporting the melt puddle" is critical to the invention, but this step is not mentioned in the '257 claims, and this step was not pointed out as critical to the Examiner in the file history. The specification can be used to clarify an ambiguity in the claim, but it cannot be used to add an additional critical element or step into an unambiguous claim.

One with ordinary skill in the art, however, would have known from reading the '257 patent specification file history that a nozzle with wide lips was critical to the invention.

A critical limitation cannot be "read into" unamibiguous claims even though the features are described as critical in the specification. The specification may be utilized to interpret ambiguous words or phrases in the claims, but the specification cannot be used to supply a missing element or step. An unambiguous claim which is silent as to a limitation necessary not only to practice an invention but to distinguish the claim over the prior art may be invalid under•Section 103 if other documents cannot be used to read the limitation into the claim.

In SSIH Equipment v. U.S. I.T.C., 218 U.S.P.Q. 678, 689, 718 F.2d 365, 378 (Fed. Cir. 1983), the complainant asked the court to "resort to the specification" to add a limitation to a claim. The court refused, because the specification disclosed the limitation in one embodiment but disclosed another embodiment without the limitation. (Footnote 20, at 378). The present case can be distinguished from the facts in SSIH Equipment because no embodiment without the lips supporting the melt is disclosed in the specification.

The court in SSIH Equipment stated: we. cannot alter what the patentee has chosen to claim as his invention," citing Autogiro Co. of America v. U.S., 155 USPQ at 701 (Ct. Cl. 1967), and the cases cited therein.

In Autogiro, the Court of Claims stated that the claims of the patent provide the concise formal definition of the invention. "Courts can neither broaden nor narrow the claims to give the patentee something different than what he has set forth." (155 USPQ at 701). The court stated:

> Although courts are confined by the language of the claims, they are not, however, confined to the language of the claims in interpreting their meaning. Courts occasionally have confined themselves to the language of the claims. When claims have been found clear and unambiguous, courts have not gone beyond them to determine their content. ... Courts have also held that the fact that claims are free from ambiguity is no reason for limiting the material which may be inspected for the purpose of better understanding the meaning of claims. 155 USPQ 701.

Although the language used by the court in Autogiro supports a literal reading of unambiguous claims, the court concluded that claims, cannot be clear and unambiguous on their face. (at 702). It found that a claim cannot be interpreted without going beyond the claim itself, and that claims are best construed in connection with other parts of the patent. The court then inspected "all useful documents" to reach what Justice Holmes called the "felt meaning" of the claim. These documents included the specification, the drawings and the file wrapper. (at 702). In the present case, the specification and drawings suggest that the width of the lips is critical to the invention as set forth in the patent claims. Only the file wrapper suggests that it is not critical to this patent. To practice the invention, one would be likely to read the patent claims and specification, but one would not be likely to read the file wrapper. One with ordinary skill in the art would be told by the patent specification that the structure of the lips of the nozzle was critical to the invention.

After the court in Autogiro construed the claims in the light of the specification, it indicated that literal infringement of the claim language would not be enough to prove infringement. The infringing structure must do the same work, in substantially the same way, and accomplish substantially the same result, as described in the specification before infringement will be found.

It is found that the word "nozzle" as used in the '257 patent claims is ambiguous as to the structure of the nozzle, and that the *specification-can* be used to construe this word. The '257 claims are construed as including the critical feature of the wide lips on the nozzle. Allied, however, must prove that each respondent has used this feature before infringement can be found.

The '257 patent is not invalid under Section ILZ. The claims read in the light of the specification particularly *point* out and distinctly claim the subject matter which the applicant regards as his invention.

Other ambiguous wording of the claims

Respondents also contend that the '257 claims are "fatally indefinite and ambiguous" under Section 112. Some *of* the claims are ambiguous, but a reading of the specification gives a general understanding of the Narasimhan invention, and how to-practice it.

Claim I refers to a "slotted nozzle positioned generally perpendicular to the direction of movement *of* the chill surface." This phrase is ambiguous, but the specification can be used to clarify the ambiguity. The references to "perpendicular" in the specification are inconsistent, but the meaning of perpendicular in any particular context is usually clear. The one exception to this *is* Figure 5.

The specification states that

> there *is* no limitation on the length of the slot (measured perpendicular to the direction of movement of the chill surface) other than the practical consideration that the slot should not be longer than the width of the chill surface.

(Allied Ex. 20, col. 3). In other words, the length of the slot is measured across the width of the surface of the wheel, and that Length is generally perpendicular to the direction of movement of the wheel. am 1008-1012).

The written description -of Figure 5 of the patent describes a "cross—sectional view taken at a plane perpendicular to direction of movement of the chill surface illustrating a preferred embodiment of a nozzle employed in the practice of the present invention providing concave—shaped internal sidewalls." (Allied Ex. 20, col. 4). Figure 5 shows the concave *walls* of the nozzle structure *above the slot,* and although it shows the width of the lips of the slot, it does not show the Length of the slot. Respondents take the position that the description of Figure 5 teaches that a "slotted nozzle" referred to in claim 1 is the structure above the slot as well as the lips forming the slot, and that this structure is "generally perpendicular to the direction of movement of the chill surface." In other words, respondents argue that claim 1 refers to the perpendicularity of the whole structure above the nozzle slot to the direction of movement of the chili surface. The axis of this structure can be perpendicular to the movement of the chill surface even if the nozzle is rotated in a circle around its *axis.* If respondents were correct, the nozzle could be perpendicular to the direction, of movement of the wheel, even if length *of* the slot were not centered in the direction of movement of the wheel. If this occurred, the ribbon being. cast would run off the side of the wheel.

Figure 5 must be a draftsman's error, because the Narasimhan invention, *as* clearly described elsewhere in the specification, would not work if claim 1 were construed to reflect the meaning of "perpendicularity" as shown in Figure 5.

The patent specification sometimes uses the phrase "slotted nozzle" to refer only to the two lips and the slot between them. In other places, this phrase means the structure over the slot. The patent utes the words ."perpendicular," "nozzle," and "slotted nozzle" in different contexts with different meanings. After reading the entire specification, it would be clear to one with ordinary skill in the art how to practice the Narasimhan invention. .

It would be clear to such a person that giving certain words the wrong meaning in a particular context would make the process unworkable.

Respondents also argue that the claims do not tell the reader where the gap between the nozzle and the wheel surface should be measured. Dr. Narasimhan testified that the gap should be measured between the front lip and the chill surface. Dr. Mehrabian, reading the same claim, was not sure where he would measure the gap. In most circumstances, however, it would not matter very much where *this* measurement was made. The gap can be between 0.03 to about 1 millimeter. The specification makes it clear that the gaps between the lips and the chill surface sometimes may be equal and sometimes unequal. The reader *is* told that the gap can be larger on one side than the other so that strip of varying thickness can be made. (Col. 6). If a measurement is made from any part of the bottom-surface of the nozzle and *it* falls within this range, it would come within claim 1.

The *claims* of the '257 patent are not invalid because they are ambig-

. <u>Section 103</u>

Under Section 103 a patent may not be obtained if the differences between <u>the subject matter sought to be patented</u> 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.

To determine whether an invention is invalid under Section 103, it is necessary to determine the scope and content of the prior art, the differences between the prior art and the claims at issue, and the level of ordinary skill in the pertinent art. <u>Graham v. John Deere Co., supra,</u> at 17.

It *is* important at the outset to distinguish between a comparison of Narasimhan's invention as he saw it (including the width of the lips of the nozzle supporting the molten metal) with the prior art, and a comparison of the claims of the '257 patent with the prior art. If. the Narasimhan invention is compared with the prior art, the subject matter of the invention *as a* whole would not have been obvious to one with ordinary skill in .the art at the time of the invention. :f the '257 claims (read literally) are compared with the prior art, however, 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 *of* casting amorphous metal. The critical features of the Narasimhan invention relating to supporting the melt on the width of the lips of the nozzle can be read into the claims from the specification because the references to "nozzle" in the claims are ambiguous. The decisive comparison therefore is between the invention *as* set forth in the specification and the prior art.

The Narasimhan invention (as described by Dr. Narasimhan and as set forth in the patent specification) will be compared with the prior art, and a second comparison will be made between the claims and the prior art.

(a) The level of Ordinary Skillin the Art

At the time of.the Narasimhan invention (December, 1975), the level of ordinary skill in the pertinent art (casting amorphous metals) was high. Host researchers in the field had a Ph.D., or were working for a Ph.D., or had extensive practical experience with amorphous metals LT a research laboratory.

(b) The Prior Art •

Those skilled in the art would have been aware that certain methods for casting crystalline metals could be adapted to casting amor— . phous metals. (TR 4757-4759). The specification in the '257 patent indicates that the Narasimhan process could be used to cast crystalline or amorphous metals, and the '257 patent specification refers to prior art relating to casting crystalline *metals.* (Allied Ex. 20, cola. 1 and 12). Although the claims *of* the '257 patent are limited to amorphous metals, Dr. Narasimhan was aware that crystalline casting methods' could be adapted to casting amorphous metal. The '513 patent also discloses that amorphous metal alloys and crystalline metal alloys could be made from the same process. (Allied Ex. 18).

While it would have been clear to one with ordinary skill in the are in 1975 that the prior art included methods of casting crystalline metals, such a person also would have been aware that certain modifications had to be made in the casting methods fat—crystalline metals to cast amorphous metals successful•y. (TR 4757-4759). The principal• difference, understood by anyone skilled in the art, is that the melt must be cooled extremely quickly if amorphous rather than crystalline metal is to be made. Even with fast cooling techniques, certain alloys *still* could not be made amorphous by casting; molten metal on a quenching wheel.

One with ordinary skill in the art wishing to experiment with the casting of amorphous metals naturally would look at the prior art relating to casting crystalline metal because very little had been done with casting amorphous metals. The process was still in an experimental stage. Re would realize that certain modifications would have to be made in methods for casting crystalline metals, and he would also consider the limited prior art relating to experimental casting of amorphous metals.

Respondents rely upon the Hazelett patent (United States Letters Patent No. 1,600,688), the Strange and Pim patent (United States Letters Patent No. 905,758), the Masumoto—Maddin apparatus, and the King patents (United States Letters Patent No. 3,605,863 and 3,522,836) to show that the claims of the '257 patent would have been obvious to one with ordinary skill in the art.

The Hazelett Patent

The Hazelett patent (Ex. P-1000) was not considered by the Patent Office during the prosecution of the '257 patent application. Although a patent is presumed to be valid under Section 282 of the Patent Act, if prior art more relevant than that considered by the Patent Office *is* raised in litigation of patent validity, it is easier to overcome the presumption of validity. SSIH Equipment S.A. v. USITC, 718 F.2d 365 (Fed. Cir. 1983).

The Hazelett patent was issued in 1926. It discloses a heated crucible holding molten metal positioned over a moving casting wheel so that the bottom of the crucible touches the upper surface of the cast metal causing the cast Metal to cool slowly. (Ex. P-I000 at 2).

Hazelett does not teach fast quenching of the melt so that amorphous metal can be cast. Hazelett does not disclose the rate of speed of rotation of the wheel necessary to obtain amorphous metal. It discloses a gasket between the bottom of the crucible and the wheel. This gasket might reduce the speed of the wheel, or if the wheel goes too fast, the gasket might destroy the surface of the wheel by friction. Although Hazelett does not disclose a gap between the nozzle opening at the bottom of the crucible and the wheel. surface from about 0.03 to about 1 mm as required by the '257 patent claims, it does disclose a gap of about the thickness of the cast metal. This thickness of the metal sometimes would be within the 0.03 to 1 mm gap size specified by the '257 patent claims.

Allied distinguishes Hazelett from the '257 patent principally by noting that, contrary to the Hazelett teaching, the '257 patent specifica tion discloses that the *solidification* front misses the front lip, and that Narasimhan required the melt to be supported on the wide lips of the nozzle.

The Hazelett patent does not disclose the precise range of the measurements of the gap between the nozzle opening and the wheel surface, although it teaches that the crucible should be close to the wheel. Hazelett teaches cooling the melt slowly, and this *is* impossible in casting amorphous metal. It teaches away from *fast* cooling because the wheel must move slowly due to the gasket between the bottom *of* the crucible and the wheel.

'If the claims of the '257 patent are compared with Hazelett, Hazelett discloses the general idea of holding the nozzle close to the wheel, but it does not disclose the specific measurements or speeds required to cast amorphous metal. If the Narasimhan invention is compared with Hazelett, Hazelett does not mention the critical feature of the melt supported on the lips of the nozzle opening. Hazelett *is* not more relevant than the prior art considered by the Examiner.

The Strange and Pim Patent

The Strange and Pim patent *(Ex.* P-317) was described in the specification of the '257 patent and was considered by the Patent Office during the prosecution of the '257 patent application.

This patent discloses molten metal contained in a receptacle with an outlet that may be "slitted." To solidify the molten metal coming out of the outlet, the patent discloses a cool and traveling surface *in* close proximity to, but not in contact with, the outlet. This surface *is* 'preferably a disk, wheel or roller." A very thin sheet, foil, strip or ribbon results when the metal or alloy "sets" by contact with the cooled surface of the wheel. (Ex. P-3I7, at 1).

The Strange and Pim patent discloses a receptacle with a slotted nozzle close to the chill surface, but it does not disclose the precise measurement of the gap between the slotted nozzle and the surface of the wheel, as set forth in the '257 claims. Dr. Narasimhan originally had described his invention as requiring the nozzle to be "close" to the surface of the wheel, but the Patent Office required specific dimensions for the gap before the '257 claims would be allowed over the prior art.

In the Strange and Pim patent the speed of the, chill surface *is* not defined. The relationship of the speed of the chill roll and the size of the gap, the need for controlled pressure on the melt and a certain rate of cooling to obtain a continuous strip of wide amorphous metal was not disclosed. One with ordinary skill in the art would have known. that to make amorphous metal, an appropriate alloy must be used and that the melt would have to be cooled quickly, but he would not have known from the Strange and Pim patent that wide strip amorphous metal could be made by a precise relationship of a certain speed of the wheel, a certain size gap, and a certain rate of cooling, and the *use* of controlled pressure pushing the melt through the slot in the nozzle.

The Strange and Pim patent does not disclose all the required features of the '257 claims, nor does it mention the critical feature of the Nara-*simhan* invention, the metal supported on the lips of the nozzle.

<u>The Masumoto-Maddin Apparatus</u>

Dr. Masumoto developed a process using the Masumoto-Maddin apparatus (a modification *of* the Pond-Maddin apparatus for *casting* crystalline *strip).* This process was not considered by the Patent Office in connection with the application for the '257 patent. Dr. Masumoto used a rapidly rotating cylinder and he cast amorphous metal strip on the inside of the cylinder using a nozzle. Dr. Masumoto testified at the hearing that the nozzle outlet was between .5 and 1 mm from the chill surface, and the rotation speed was about 1500 samin. These measurements were not supported by contemporaneous records, and Dr. Hasumoto was unable to prove that he had *lade* wide strip amorphous metal with uniform dimensional width by his process before *Dr.* Narasimhan's invention, or even shortly after Dr. Narasimhan's invention. (TR 1921-1928).

Dr. Masumoto's work did not *disclose* the relationship *of* a particular speed of the wheel, a specific size of the gap, the specific temperature of the chill wheel, and the *use* of pressure on the melt in casting amorphous metal strip. It also did not disclose the importance to the Narasimhan invention of supporting the melt on the lips of the nozzle.

The King Patents and the Melt Drag Process

The King patents, U.S. Letters Patent 3,605,863 (Ex. P-62) and 3,522,836 (Ex. P-61), were considered by the Patent Office in connection with the application for the '257 patent. The Ring patents *used* one embodiment of the melt drag proCess." (TR 3394-3397).

In the melt drag process the melt is deposited from a reservoir onto a rotating cooling wheel through a spout close to the surface of the wheel. External pressure *is* supplied to the reservoir to control the amount .of melt falling onto the wheel. The external pressure comes from the weight of the metal above the spout as well as from externally supplied gas. Sufficient pressure is applied to the melt in the reservoir to permit the miniscus of the melt to touch the surface of the wheel. The miniscus then is drawn out of the spout as the wheel turns. When the melt drag process *is* used to cast ribbon, a slotted orifice *is* used between the reservoir and the wheel. (TR 3385-3390).

The Xing patents disclose that by regulating the speed of the wheel and the temperature of the wheel surface, the crystalline structure of the product and the desired mechanical properties can be controlled. (Ex. P-62, col. 6). The ring patents teach the principles of the elements claimed in the '257 patent and the relationship of these elements to the properties of the metal cast, but they do not disclose what Narasimhan described as his invention, the lips supporting the melt. The ring patents also do not disclose the precise range of=measurements and speeds set forth-in the '257 patent claims.

In the prosecution of the '257 patent, Allied distinguished the King melt drag process from the Narasimhan process by contending that•the melt drag process did not force molten metal under pressure through a nozzle, but that instead the molten metal is dragged from the meniscus. Allied relied upon an amendment during the prosecution of the '836 King patent to support *this* position. Although the owner of the '836 King patent could not enforce the claims of that patent beyond the scope of the amendment the applicant made in order to get the King '836 patent claims allowed, the <u>teaching</u> of the King patent as issued includes references to the use of external gas pressure.

Nevertheless, there are still significant differences between the melt drag process *as* described in the King patents and as known in the prior art and the invention of Narasimhan. In the Narasimhan process, the wide lips of•the slotted nozzle are critical to the process. This *is* not mentioned in the King patents or in the '257 patent claims. In the Narasimhan process, the wheel must rotate at high speed, in order to quench the melt fast enough by the relatively slow moving wheel. If the wheel moves too fast, the meniscus will be dragged away completely and the ribbon would break unless additional controlled pressure is applied to keep enough melt in the meniscus so that the ribbon will not break when the meniscus is. exhausted. The need for the wheel to move *fast to* make amorphous metal would have been obvious to one with ordinary skill in the art in 1975, but the need to have the wide lips of the nozzle would not have been obvious to one who was familiar with the prior art.

The King patents disclose that the slotted nozzle must be close enough to the wheel for the meniscus of the melt to touch the wheel. For this to occur it would probably have to be within the gap size specified in the '257 patent claims. As in the Narasimhan process, the melt has not yet solidified when it *is* touching the lip& of the nozzle opening.

Although the King patents teach the relationship of various factors such as the speed of the wheel, the temperature of the wheel, the size of the gap (between the nozzle opening and the wheel surface), and the use of external pressure of the melt, they do not disclose the precise gap measurements, wheel speeds, and wheel temperatures set forth in the '257 patent claims.

Although the precise measurements of the gap and temperature of the wheel and the use of external gas pressure are not spelled,out in the King patents, the relationship of these factors to the characteristics of the cast metal was understood.

The subject matter of the '257 patent claims would have been obvious in 1975 to one with ordinary skill in the art who would have been aware of the melt drag process and would have known that the wheel would have to move faster to make amorphous metal. This was known to Bedell and Masumoto before the Narasimhan invention.

Dr. Narasimhan first deicribed his new process as the "supported melt drag process." The Narasimhan invention as described in his fikst title for his process, included the concept of supporting the melt on the lips of the nozzle. This subject matter would not have been obvious in 1975 to one with ordinary skill in the art.

Only the precise measurements set forth in the '257 patent claims are not found in the prioi art. If one measured the size of the gap between the nozzle and the chill wheel surface in the melt drag process, it would fall within the range of the '257 patent claims. The prior art includes a wheel moving at the rate of speed specified in the '257 patent claims. This rate of speed was used, for example, by Bedell in his jet process, as was the chilling of-the wheel to specific low temperatures. Pressurizing the melt was known in the melt drag process, the Belden jet process, and the melt spin process. (See specification, '257 patent, column 1). The relationship among these features and their effect on the characteristics of the cast metal was understood. (See King patents).

If all that Dr. Narasimhan did was to measure the gaps, the temperatures, and the speeds used by others in the prior art, this would not have been inventive. The essence of the Narasimhan invention was that by using all these features together, and using a nozzle having wide front and back lips, he was able to support the melt on the lips of the nozzle, so that would not be broken up by the air carried around the moving wheel. The pressure of the air breaking up the melt puddle had been recognized as a problem by others trying to cast continuous amorphous metal strip by fast quenching on a rotating wheel. This problem had not existed in the slower casting methods used to cast crystalline metal strip, and *was* unique to casting amorphous metal strip. Dr. Narasimhan was the first to use this solution to the problem, and his solution is set forth in .the '257 patent specification.

(c) <u>Objective evidence of nonobviousness</u>

There *is* other evidence in the record supporting the finding that the subject matter of the Narasimhan invention (including the idea of supporting the melt on the lips of the nozzle) would not have been obvious to one with ordinary skill in the art in 1975.

' A long felt need was shown for a process to make continuous wide amorphous metal strip. Although the quality of strip made•by Allied using the Narasimhan process was frequently poor, and the width varied somewhat, Allied was able to make continuous amorphous strip more than 7 mm wide using the Narasimhan process, when continuous *amorphous* strip of this width could not be made before. There was a substantial demand for amorphous strip that *is* consistently more than 7 mm wide, even though its quality sometimes might be poor and the width might not be completely uniform.

Dr. Narasimhan's process (the idea of supporting the melt on the lips of the nozzle) *was* credited as a significant improvement by many experts in this field, including Dr.Inzinger at VAC. (Allied Ex. 341) . Mr. Belden at Allied had been using a larger gap than Narasimhan between the nozzle and the wheel. He was surprised at Dr. Narasimhan's solution because Mr. Bedell had encountered spattering problems when bringing the nozzle as close as 3 to 4 mm from the surface of the wheel. (TR 571-573).

Although Mr. Wellslager had the same idea as Dr. Narasimhan of moving the nozzle close to the wheel, his idea was not followed up by Allied.

Dr. Narasimhan was given the material and time to build his own equipment so that he was in a posi tion to try moving the nozzle close to the wheel to make amorphous metal strip. When this worked, and he was able to make continuous wide amorphous strip, he surmised that it worked because the melt was supported by the lips of the nozzle when there was a small gap between the nozzle and the wheel surface. Dr. Narasimhan was not the first to think of moving the nozzle close to the wheel, but his explanation of why it worked in terms of supporting the melt on the nozzle lips before it solidified into ribbon and was pulled away by the wheel was novel.

It is found that the '257 patent claims are valid because the differences between the subject matter sought to be patented and the prior art would not have been obvious in 1975 to one with ordinary skill in the art.

B. • <u>Infringement of the '257 Patent</u>

1. TDK Corporation, TDK Electronics Co., Ltd., and MEW International Corp.

The following sanction (among others) *was* issued in Order No. 32 against TDK Electronics because of the company's failure to comply with an order compelling discovery:

> It is found that TDK has facilities in Japan for making amorphous metal alloy by the process defined by the claims of the '257 patent and that TDK has imported amorphous metal alloy into the United States that was not within the license granted by Allied Corporation to TDK and was made by the process of the claims of the '257 patent.

Sanctions were issued only against TDK Electronics, not against TDK Corporation or MEW International Corp. Since no sanctions were issued against TDK Corp. or MEW, TDK's request in its brief, that the sanctions be withdrawn as unnecessary in view of Allied's reliance on some discovery responses of TAR Electronics, is denied.

It *is also* found, based on responses to Allied Interrogatory Nos. 47, 72 and 83, that TDK Corp. exported to MEW in the United States amorphous ribbon made in accordance with the method set forth in claim 1 of the '257 patent. (Allied Ex. 518).

2. <u>Vacuumschmelze and Siemens</u>

Vacuumschmelze (VAC) has used its Casting Machines C and E to cast amorphous metal strips identified by the .trademark Vitrovac. Machine F is still under construction. Amorphous metal alloy strips produced by VAC on Casting Machines C and E •have been exported to Siemens in the United States.

Allied and VAC disagree as to whether the melt is supported on the wide lips of the nozzle of the crucible. VAC relies on Dr. Kilzinger's testimony at the hearing. Allied relies upon several documents describing VAC's process to rebut Dr. Hilzinger's testimony. Allied did not examine the

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flat lips of the nozzle. VAC concedes that the documents relied upon by Allied may accurately reflect processes VAC has used in the past, or modifications thereof. VAC argues that Dr. Hilzinger's *testimony* accurately describes the process currently used by VAC.

If VAC now uses or recently used a process that infringed the '257 patent, and the product made by *this* process was exported to the United States, discontinuance of the practice would not be an adequate defense in this investigation.

Allied argues that the "patent claims are the measure of the patent grant," citing Coleco Industries v. *U.S.* International Trade *Commission,* 197 USPQ 472 (CCPA 1978), and Graham v. Deere Co., 383 U.S. 1, 148 USPQ 459 (1966). If *this* theory were accepted for the purpose of determining infringement, it would be equally applicable to finding validity and the '257 patent would be invalid under Sections 103 and 112.

If the claims of the '257 patent are valid, it *is* only because the critical limitation relating to the width of the *lips* was read into the claims. If a respondent used a nozzle without wide lips, infringement could not be found.

Allied failed to prove that in the VAC process or in the Allied process the melt is in fact supported by the wide *lips* of the nozzle. The only direct testimony on this point is Dr. Hilzinger's, and he testified that there was, no such melt support. His testimony was not supported or contradicted *in* the record by documentary evidence or photographs. The other testimony on this point was based on Dr. Narasimhan's theory about why his process worked.

In attempting to prove that the '257 patent was invalid, VAC was unable to overcome the presumption of validity. Respondents failed to meet their burden of proof that the Narasimhan process, including a nozzle with wide lips described as "critical" in the specification, did not constitute a novel advance over the prior art. The improvement in wide amorphous strip made by the Narasimhan process was recognized by Dr. Rilzinger.

Allied has the burden of proving infringement. One using the '257 patent process was told in the specification that it was critical to use *wide* lips on the nozzle.[1] The '257 patent specification does not advise the reader that in order for the process to work he must make sure that the melt *is* always held on the flat lips of the nozzle. It *is* not a defense to a charge of infringement to show *that* Dr. Narasimhan's process works, but that it does not work tor the reasons stated by Dr. Narasunhan. Dr. Narasmnan s theory *was* not described as "critical" in the *specification.*

VAC argues that if the '257 patent is found to be valid and VAC's process is found to•fall within any of the claims, the doctrine of equivalents would require a finding of non—infringement, citing Mead Digital Systems, Inc., v. A.B. Dick Co., 723 F.2d 455 (6th Cir. 1983). Under *this* doctrine, where a device performs the same or a similar function in a substantially different way, the doctrine of equivalents may be used to defeat an action for infringement, even if a finding of literal infringement is made.

VAC has not proved that its casting machine performs the same function as the '257 process in a substantially different way. This record does not show that the '257 patent process works because of Dr. Narasimhan's theory of supporting the melt on the nozzle lips or that the flat lips perform some other necessary function.

At a minimum, the record will support a finding that until recently VAC *used* a process infringing claims 1, 2, 3 and 8 of the '257 patent.

VAC makes a second argument to show that it is not infringing the '257 patent. A claim must be .construed narrowly if the applicant obtained allowance of a broad claim based on a position taken with the Patent Office that limited that claim. Allied, in prosecuting the application resulting in the '257 patent, attempted to distinguish one of the patents to King (the '836 patent) on the grounds that the King patent did not force the molten metal under pressure through a nozzle. The '836 patent to King used the melt drag process, and Allied argued that the melt was not "forced" in the melt drag process as described in the King patent. After this representation was made, claim 1 was allowed: Claim 1 of the '257 patent requires such "forcing."

VAC contends that *it also uses the* melt drag process. It takes the position that those practicing the melt drag process do use pressure to control the *flow* of the melt and that *this* was taught by the King patent.

Allied argued co cne examiner, in order to get a claim _in the '257 patent allowed, that the Narasimhan process could be distinguished from the melt drag process because the melt drag process did not force the melt through the nozzle. Allied now takes the opposite position here, when Allied is trying to prove infringement of the '257 patent, arguing that the VAC process does use pressure to force the melt through the nozzle at a controlled rate.

Both parties agree that VAC does use pressure to control or force the flow of the melt through the nozzle. The Narasimhan process and the melt drag process *also* used some type of pressure to control the flow of melt throisgh the nozzle.

Allied would be estopped from taking the position that the melt drag process involves forcing the melt through the nozzle. The VAC process, however, appears to be distinguishable from the melt drag process described in the King patent, in that considerably more pressure is required in the VAC process than in the King '836 process, principally because the wheel must move much faster in the VAC process to make amorphous metal. In the melt drag process, the wheel could move more slowly, and drag the ribbon from the meniscus without much pressure on the melt.

(TR 3674-3675). This was not required in the King process. Therefore, Allied is not estopped by the position it took in connection with the King melt drag process from asserting that VAC uses pressure to force the melt through the nozzle slot.

3. Hitachi

Hitachi has exported amorphous metal strip to the United States. (Dep. TR 19, Allied Phys. Ex. PP(1), Allied Ex. 38, TR 2748-2752).

Hitachi has used to manufacture amorphous metal strip exported to the United States.

The specification of the '257 patent provides for tilting the whole nozzle . structure under certain conditions, and this is consistent with the construction given to the phrase "generally perpendicular" here.

It *is* found that the Hitachi process would infringe claims 1, 2, 3, 5, 8 and 12 of the '257 patent if the process took place in the United States.

4. <u>Nippon Steel</u>

A. Validity of the '739 Patent

(1) Anticipation (Section 102) and Non-obvious Subject Matter (Section 103)

Claim 1 of the '739 patent claims a strip of amorphous metal having a width of at least 7 millimeters, and having isotropic tensile properties. Claim 2 claims a strip according to claim 1 having thickness of at least about 0.02 millimeters. Claim 3 claims a strip according to claim 2 having width of at least about 1 centimeter. Allied contends that respondents have infringed "at least" claim 1 of the '739 patent. Only claim 1 will be discussed. (Allied *Ex.* 19).

Respondents contend that claim 1 of the '739 strip patent is invalid as anticipated under Section 102 or obvious under Section 103 because prior patents, publications and uses disclosed amorphous metal strip more than 7 mm wide. This prior art contains all the elements of claim 1 of the '739 patent, unless the term "isotropic tensile properties" found in claim 1 *is* a sound basis for distinguishing the product made under the '739 patent over the amorphous metal strip found in the prior art. "Isotropic" means equal physical properties along all axes.

A wide amorphous strip that posssessed "isotropic tensile properties" would not have been anticipated or obvious in light of the prior art. The difficulty with the '739 patent *is* that no one is able to prove whether a wide strip of amorphous metal has "isotropic tensile properties," or as this phrase *is* construed is the '739 patent, "isotropic tensile strength." In other words, the patent describes a strip with certain properties, and using the tests available at the present time, it *is* not possible to prove whether a strip has these properties. The '739 patent is invalid under Sections 102 and 103 of the Patent Act because wide amorphous strip that may or may not have had isotropic tensile strength was found in the prior art. The strip covered by the '739 patent *also* is not a "new and useful" composition of matter or a new and useful improvement thereof, and is therefore not patentable under Section 101 of the Patent Act.

(a) The Prior Art

Allied admits that amorphous metal strip less than 7 millimeters wide was known prior to the Narasimhan invention in December, 1975. (See columns 1 and 2, '739 patent, Allied Ex. 19).

The record also contains evidence that prior to the reduction to practice of the Narasimhan process, amorphous strip more than 7 millimeters vide had been *made.* The '739 patent claims do not require that the strip be of any particular length or be "continuous," although the specification refers to continuous strip. The same specification supported two other patent applications. The Narasimhan process was unique in producing continuous amorphous strip of a relatively consistent width, but this is not an element of the''739 strip patent claims.

The existence of wide amorphous metal strip-made by the double—roll method *is* disclosed in the Bedell patent (U.S. Patent No. 3,862,658). An article in 1973 in Chemical and Engineering News, reporting on work at Allied, referred to the production of smooth amorphous *strip* as wide as 12 millimeters. By June, 1974, Allied had produced "smooth 3/8 wide ribbons" (9.5 mm wide) of amorphous metal alloy (Ex. P-744, P-427), and in 1974 Allied supplied samples of amorphous strip wider than 7 millimeters to Schick for testing in a project to *make* razor blades. (TR 700-723). The Allied strip prior to the Narasimhan process was not necessarily continuous or consistently wider than 7 millimeters, but these limitations do not appear in the '739 patent claims.

Allied itself had used both the double—roll method and the jet casting method to produce wide amorphous metal strip. In column 2 of the '739 patent, the strip made by jet casting is distinguished from the '739 strip made by the Narasimhan process on the grounds that the jet casting method produced significant variation in width along the length of the strip, and the strip lacked uniformity of thickness. The '739 claims do not require uniform width, and only claim 2 requires a minimum thickness.

Columns 2 and 3 of the '739 patent describe the strip made under the Bedell '658 patent as having "anisotropic tensile properties," with a thickness of only 0.012 centimeters and a width of 1.27 centimeters, but Allied was unable to prove at-the hearing that anyone had tested the strip made under the '658 patent for tensile strength. Columns 2 and 3 simply represent that the Bedell patent strip had anisotropic tensile properties because the strip was rolled between two steel rolls after it had solidified.

Since the prior art disclosed amorphous strip or partially amorphous strip wider than 7 millimeters, the prior art contains all of the elements of claim 1 of the '739 patent unless the amorphous metal strip in the prior art did not have isotropic tensile properties and the '739 patent strip has these properties. Allied was unable to prove that the '739 patent amorphous metal strip had isotropic tensile strength or that the prior art amorphous metal strip did not have isotropic tensile strength.

(b) Distinction between Prior Art and the Product of the '739 Patent

The term "isotropic tensile properties" as used in the '739 patent claims is ambiguous and can be construed by reference to the specification. (TR 3407). The specification makes it clear that this term refers only to equal tensile strength in the longitudinal and transverse directions. (Allied Ex. 19, col. 2).

The '739 patent specification states:

> In any event, it has not been possible to obtain *wide* metal strips, say *wider* than about 6 millimeters, by single or multiple jet casting procedures having isotropic strengths, that *is* to say having identical tensile strengths and elongation measured in the transverseas well as in the

> longitudinal direction, or in any direction there— between, even though metal strips with amorphous structures should be isotropic at least with respect to their tensile properties, and those with cast polycrystalline structures should be approximately isotropic." (emphasis added)

This definition refers only to tensile strength, it refers to "identical" tensile strength in two directions, and it specifically ex cludes material which *is* "approximately isotropic" from the definition of "isotropic."

The specification points out that metal strips with amorphous structures should be isotropic at least with respect to their tensile proper7 ties, and that cast polycrystalline structures should be approximately iso- tropic. The specification thus distinguishes between the prior art amorphous metal strips which should have identical isotropic tensile strength because they are amorphous but do not, and the '739 *strip* which in fact has identical isotropic strength in two directions. It also recognizes that partly amorphous and partly crystalline structures should have approximately the same tensile strength in each direction.

The '739 patent specification suggests that tests actually had been made on strip made by the Narasimhan process, and that the tests demonstrated that the '739 patent strip has isotropic tensile properties:

> Tensile specimens cut from the strip in longitu- dinal and transverse direction exhibit equal tensile strength and elongation. The strip *has* isotropic tensile properties. (Col. 12, lines 3-8).

This was in contrast to the prior art amorphous metal strip made by jet casting, discussed in column 2, where the specification states that it had not been possible to obtain wide amorphous strip by jet *casting* procedures having identical tensile strength "even though metal strips with amorphous structures should be isotropic at least with respect to their tensile properties." (Emphasis added, col. 2, lines 36-63).

Allied not only represented that actual *tests* had been *made,* but it emphasized the definition of "isotropic tensile properties" as meaning "identical tensile strength." Allied took the same position in an amendment filed on August 17, 1979, which *is* contained is the file history of the parent application for the application which issued as the '739 patent. (Ex. P-450). In response to a prior art rejection of the claims directed to amorphous metal strip, counsel for the applicant stated:

> [The amorphous metal article.of] *claim* 22 *is* directed to melt-spun amorphous metal strip having a width of at least about 7 millimeters and having isotropic tensile properties, that *is* to say, having identical tensile strength and elongation measured in the transverse, *as* well as the longitudinal direction or in any direction therebetween.

The statements in the '739 specification as well *as* the arguments *made* during the prosecution of the application resulting in the '739 patent show that Allied consistently emphasized the definition of *"isotropic" as* meaning "identical in all directions."

Although this problem was not brought to the attention *of* the Examiner during the prosecution of the application for this patent, Allied pointed out at the hearing that standard testing to determine the existence *of* isotropic tensile properties *is* destructive testing. If one sample is tested for strength in one direction, that sample is destroyed by the test, and a different sample must be tested for strength in another direction.

There *is* no convincing evidence in this record that Allied or Dr. Narasimhan performed any tensile strength tests on strip made by the Narasimhan process at the time of the prosecution of the application resulting in the '739 patent, or at any time prior to the commencement of this hearing. Allied did not have any test results showing that the Narasimhan strip had equal tensile strength in the longitudinal and transverse directions. Allied did not have any test results showing that the tensile properties of Narasimhan's wide amorphous metal strips were different from the tensile properties of wide amorphous metal strips made by the methods of the prior art. Although Dr. Narasimhan testified that he had tensile tests made by other people at Allied (TR 856-876), the people at Allied who ordinarily would have done such testing stated that they could not recall doing it. Moreover, Allied *is* not able to reproduce the tests it told the Examiner that it had made.

The term "isotropic tensile properties" as used in the '739 patent *means* equal or identical tensile strengths in the transverse direction and the longitudinal direction. The specification indicates that isotropic tensile properties may be determined by standard tensile testing methods. The standard tensile testing method, however, requires a test section of over two inches. (The ASTH test). This test could not be used on strips only 25 cam wide. The '739 patent did not disclose jum procedure for testing the isotropic tensile strength of a narrow amorphous metal strip covered by any claim of the '739 patent.

Although Allied had not mentioned the possibility of determining isotropic tensile strength based on statistical analysis in the patent or in the file wrapper, at the hearing Allied argued that statistical conclusions were necessary because standard testing destroyed each piece of strip that was tested in any direction, so that it could not be tested in another direction. Allied• found no way to prove that a single piece had <u>identical</u> strength in the longitudinal and transverse directions, although Allied had represented that such tests could be made and had been made.

In preparing for *this* hearing, Allied selected samples of Allied strip, took two pieces from each sample, and.tested one piece of strip in one direction and tested another piece of strip in another direction, until each broke. After a number of these tests had been made on strip made by the Narasimhan process, Allied asked a statistician to make a statistical analysis of the results. Dr. Laska, Allied's statistical expert, testified that the tensile strength values in the longitudinal and transverse directions for some samples were "statistically" equal.

Allied selected samples for testing which had fewer defects in them than other strips. Dr. Laska concluded that based on his statistical analysis, four of the Allied samples that were tested had statiscally equal tensile strength. Dr. Laska concluded that two of the six Allied samples tested did not have statistically equal tensile strengths in the transverse and longitudinal direction.

Dr. Laska's testimony does not provide an adequate *basis* for distinguishing the '257 patent strip from wide amorphous strip in the prior art. There *is* nothing in the record to show that selected pieces of wide strip in the prior art would not have tested as well as the '257 patent strip, if the best pieces were selected for testing.

Dr. Maddin, respondents' expert, pointed out that it is almost impossible to determine by testing whether a material is fully .amorphous. Allied's tests fell far short of proving that the strip made by the *Narasimhan* process or the strip made by respondents *was* fully amorphous. There *is* even some question as to whether a truly amorphous state ever can be realized in practice. (TR 3459-3461).

Any truly amorphous metal strip would have isotropic tensile strength in all directions by definition. (TR 4839, 4840). "Truly amorphous metal strip" would have no crystalline structure, and would not have "clusters." Clusters are small aggregates of atoms that have short range order. If the material contains clusters, it may not have isotropic tensile strength. (TR 4839).

The only way preiently known to get some idea as to whether an entire strip *is* "truly amorphous" is to use transmission electron microscopy (TEM), but this is not a satisfactory method. This shows one only a small part of the material at a time. Extensive sampling would have to be done, and even so, clusters might be missed. (TR 4839).

Allied contended that isotropic tensile properties depend on the existence of a uniform cross section and smooth surfaces, and that amorphous metal strip with a uniform cross section and smooth surfaces must have isotropic tensile properties. The '739 patent itself, however, defines a "strip" as having "regular or irregular cross section." (Allied Ex. 19, col. 1, line 23).

The term "isotropic tensile properties" therefore cannot be used to distinguish the Harasimhan strip from *wide* amorphous strip in the prior art. The claims of the '739 strip patent are therefore invalid under Sections 102 and 103.

(2) <u>Section 112</u>

Respondents also contend that the '739 patent is invalid because it is indefinite. Section 112 of the Patent Act requires that the '739 patent establish a standard that can be used by one of ordinary skill in the art to determine when a claim *is* infringed. <u>Deep Welding, Inc. v. Sciaky</u>

Bros., Inc., 417 F.2d 1227, 1241 (7th Cir. 1969), cert. denied, 397 U.S. 1037 (1970); *Kaiser* Industries Corp. v. McLouth Steel Corp., 400 F.2d 36, 50-51 (6th Cir. 1968), cert. denied, 393 U.S. 1119 (1969); Norton Co. v. Bendix Corp. 449 F.2d 553, 555 (2d Cir. I971). In re Hammack, 427 F.2d 1378, 1382 (CCPA 1970).

The '739 patent is invalid under Section 112 of the Patent Act because one with ordinary *skill in* the art is given no practical way to determine whether he is infringing the '739 patent if he makes wide amorphous metal strip.

B. <u>Infringement of the '739 Patent</u>

Allied contends that all the respondents have infringed "at least" claim 1 of the '739 patent, which reads as follows:

> 1. A strip of amorphous metal having a width of at least 7 millimeters, and having isotropic tensile properties.

All the products *in* issue made by respondents are represented by respondents to be amorphous. This includes amorphous strips that may be partly crystalline.

Whether a product is 100% amorphous does not depend on whether the quality of the strip is poor, or has ragged edges, or has holes. Transmission electron microscopy (TEM) testing can be done to show that minute sections of the strip are amorphous. (TR 4840). If parts *of* the strip are purely amorphous, those parts must by definition have isotropic tensile strength.

The '739 patent specification, however, makes it clear that it *is* referring to the tensile strength of a piece cut from the strip. The tensile strength of this piece must be equal in any direction. The specification *is* not referring to some theoretical pinpoint in the strip that might be fully amorphous. Allied failed to prove that entire pieces cut from respondents' strip infringed the '739 patent.

Dr. Laska testified that some samples selected from respondents' wide amorphous strip showed that the samples had "statistically equal" tensile strength in two directions. The tests were made in the same manner as the tests on Allied's samples. Pieces were cut from samples selected because they were not flawed. The samples selected were not representative of respondents' wide amorphous strip.

Dr. Laska used one-sided" T-test to make the statistical comparison, because Allied told him that he could assume that the strength of amorphous metal tested in the transverse direction could not be greater than the strength in the longitudinal direction because of the manner in which Allied cast the amorphous metal ribbon. This assumption was challenged by respondents, and Allied was unable to show *that this* assumption was necessarily true based on respondents' casting methods.

In testing respondents' strip, Allied did not test wide amorphous strip actually imported by respondents for sampling or sale. It tested samples furnished voluntarily by respondents in this proceeding. Allied then selected better quality pieces of the samples of respondents' strip to be tested. Even so, no test could be found to prove that these selected pieces had identical tensile strength in more than one direction. Although only the selected pieces were tested, and a statistical conclusion was *made that* some of *the* samples tested had equal tensile strength based on statistical probabilities, Allied was unable to prove that the strip had isotropic tensile properties as that term was construed by Allied in the patent specification and file history.

In the '739 patent specification Allied tried to distinguish the prior art amorphous strip. The specification points out that the strip made by the prior art jet process was amorphous, and should have isotropic tensile strength, but that it was impossible to make strip by that process that could be proved to have identical tensile strength in more than one direction. (Allied Ei. 19, col. 2). These prior art strips had "inherent imperfections" when made by jet casting. They lacked uniformity of thickness and showed "significant variations in width along their length." 'The specification represents that the strip did not have equal tensile strength because of these imperfections. Since the prior art was distinguished from the '739 patent product on the *basis* that only the '739 product could be proved by standard tests to have identical tensile strength in more than one direction, then respondents cannot be infringing the '739 patent when standard tests cannot be used to prove that their amorphous metal strip has identical tensile strength in more than one direction. Moreover, since Allied's strip cannot be proved to have isotropic tensile strength in more than one direction, Allied cannot prove that it *is* practicing this patent itself.

If it had been possible to find infringement of the '739 patent on the theory that any truly amorphous minute section of respondents' strip would have to have isotropic tensile properties by definition, such a construction of the phrase "isotropic tensile properties" in the claims of the patent would have prevented Allied from distinguishing its product over the prior art.

It is found that some of the respondents have exported to or imported into the United States amorphous strip or partially amorphous strip at least 7 millimeters wide. Allied, however, has failed to prove that the imported strip had isotropic tensile strength in more than one direction.

If the '739 patent were valid, claim 1 would be found to have been infringed only by TDK Electronics, Ltd. This respondent was subject to sanctions.

EQUITABLE DEFENSES

Equitable defenses are permitted in Section 337 cases under 19 U.S.C. 1337(c). The defense of unenforceability in a patent case *is* an equitable defense because of the public interest in permitting full and free competition in the use of ideas which are a part of the public domain. See Lear, Inc. v. Adkins, 395 U.S. 653, 670 (1969)'.

Respondents have raised equitable defenses alleging that the three patents in issue are unenforceable because of:

(A) inequitable conduct at the Patent Office in connection with the '513 patent application,

(B) inequitable conduct at the Patent Office in connection with the '257 patent application,

(C) inequitable conduct at the Patent Office in connection with the '739 patent application,

(D) patent misuse, and

(E) Nippon Steel's argument that it *was* denied due process.

All inequitable or unlawful conduct of a patentee relating to the patents *in* suit may be aggregated in order to determine whether there has been patent misuse or anticompetitive conduct. See Duplan Corp. v. Deering Milliken, Inc., 444 F. Supp. 648, 695 (D.S.C. 1977), modified, 594 F.2d 979 (4th Cir. 1979), cert. denied, 444 U.S. 1015 (1980); Kobe, Inc. v. Dempsey Pump Company, 198 F.2d 416, 425 (10th Cir.), cert. denied, 344 U.S. 837 (1952). Inequitable conduct by a patentee will bar the enforcement of all patents that are sufficiently related to that conduct to bring them within the "unclean hands" doctrine. Keystone Driller Co. v. General Excavator Co., 290 U.S. 240, 246-247 (1933).

A. Inequitable Conduct at the Patent Office in connection with the '513 Patent Application

If it is found that the '513 patent is valid and infringed, respondents contend that this patent is unenforceable due to inequitable conduct of the patentee before the Patent and Trademark Office (Patent Office). Inequitable conduct falling short of fraud still can be a defense to a charge of patent infringement. See E.I. du Pont de Nemours & Co. v. Berkley & Co., 620 F.2d 1247, 1256, 205 USPQ 1 (8th Cir. 1980).

The Patent Office requires a high standard of .honesty, good faith amd candor by a patent applicant because of the ex parte nature of the proceedings. A breach of this duty may constitute inequitable conduct. The duty of candor is met, however, if the patent applicant acts in good faith. A mistake made in good faith does not constitute inequitable conduct unless gross negligence can be shown. The person charging inequitable conduct must offer clear, convincing and substantial evidence of an intentional misrepresentation or withholding of a material fact from the Patent Office. Orthopedic Equipment Co. v. All Orthopedic Appliances, Inc., 707 F.2d 1376, 1383, 217 USPQ 1281, 1286 (Fed. Cir. 1983). See also Driscoll v. Cebalo, et al., April 6, 1984 (Fed. Cir. 1984) slip op. at 15.

Finally, a charge of inequitable conduct based on lack of candor or outright misrepresentation to the Patent Office by a patent applicant will not succeed unless the patent applicant has made a material misrepresentation or a material omission of information to the Patent Office. See Norton v. Curtiss, 433 F.Zd 779, 167 USPQ 532 (CCPA 1970), U.S. Industries, Inc. v. Norton Co., 210 USPQ 94, 107 (N.D.N.Y. 1980), Corona Cord Tire Co. v. Dovan Chemical Corp., 276 U.S. 358 (1928). Materiality *is* defined in the Patent Office Rules: "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. 11.56.

To prove inequitable conduct by a patent applicant before the Patent Office adequate to support a charge that the patent is unenforceable, the following standards must be met:

1. there must be clear and convincing evidence that there was inequitable conduct,

2. the patent applicant must have made a material misrepresentation or a material omission of information to the Patent Office, and

3. the patent applicant must have acted in bad faith. Either an intent to deceive the Patent Office, or gross negligence representing such reckless disregard for the truth as to be tantamount to bad faith must be shown.

Allied made a number of misrepresentations and *omissions* to the Patent Office in connection *with* the prosecution of the application resulting in the '513 patent.

Allied's claims initially were rejected by the Examiner because the specification did not support the broad claims which read on a "plethora of alloys alleged to be amorphous, but not disclosed, contemplated or discovered without undue, rigorous experimentation." (Ex. P-444)'. Allied overcame this rejection by representing to the Patent *Office that* the "rigorous experimentation" actually had been conducted by applicants. The Examiner then withdrew his rejection and the patent issued.

The record shows that Allied had not carried out rigorous experimentation to prove that #11 the MYZ compositions worked or that the percentages set out in the claims were within the compositional range for forming amorphous metal. More than 27,000 alloy systems are covered by Claim 1. The inventors had tried out a limited number of *alloys* all containing phosphorous, and all within a relatively narrow range of constituents. Later experiments after the patent issued disclosed that many alloys within the formula were not readily made amorphous. For example, five out of six iron-carbon-silicon alloys could not be made amorphous in 1981 using jet casting techniques known in 1972. (Ex. P-174, P-729, P-730). Although all could be made amorphous by other methods, some were not <u>easily</u> made amorphous, even with techniques known in 1981. Iron-carbon-aluminum alloys also could not be made amorphous by melt quenching. (Ex. P-323, P-324, P-733, P-734). Other alloys were made amorphous with great difficulty, and could not be made amorphous by melt quenching. (Ex. P-207 through P-213).

Allied should have been aware that its representation that it had done rigorous experimentation, implying that it had proved that all alloy systems under the formula would work, was false.

At the time of the patent application, Allied had in its files information that two alloy systems under the formula could not be made amorphous. Dr. Polk could not make iron-phosphorous-aluminum and nickel-phosphorous-aluminum systems amorphous. He described the product as having "well defined crystallinity," and testified that *this* meant completely crystalline. (Ex. P-222, Dep. TR II 88-89). In a published article he described the iron- and nickel-phosphorous-aluminum systems as "fully crystalline." (Ex. P-253 *at* 172). Allied's Patent Department cleared Polk's article for publication in 1974, before the '513 patent *issued.*

The patent specification must enable someone to practice the invention at the time the application was filed, and cannot rely on subsequently developed technology. In re Glass, 492 F.2d 1228, 1232 (CCPA 1974). Although Allied subsequently was able to make these alloy systems amorphous, this is not relevant to the inequitable conduct alleged.

Finally, Allied included 28 examples of alloys in the patent application, 26 of which were directed to alloys under claim 1. The application suggests that these examples were carried out, but the record shows that Allied did not have the equipment necessary to carry out some of the examples. (Ex. P-1210 at 139-140, Ex. P-1224 at 134).

The '513 patent has been found to be invalid. If it were valid, there would be clear and convincing evidence that there *was* inequitable conduct in that the applicant made a material misrepresentation to the Patent Office to overcome rejection of a claim. No intent to deceire the Patent Office was proved, but there was evidence of gross negligence. The Allied Patent Department approved an article for publication which stated that two alloys falling within the '513 formula could not be made amorphous, while the '513 patent application was still pending. It *is* assumed that the article was read because it was approved. The failure to report to the Patent Office the facts stated in the article can be described as gross negligence because no explanation of the failure to report these facts was offered by Allied. The facts withheld from the Examiner were material because there *is* a substan tial likelihood that a reasonable examiner would have considered it important in deciding whether to allow the application to *issue as a* patent. The Examiner had rejected the claims on these very grounds before *the* representations about rigorous experimentation were made. Had the facts been known to the Examiner, the '513 patent might not have issued, or the claims might have been restricted in scope.

The '513 patent, if valid, would be unenforceable.

B. Inequitable Conduct in Connection with the '257 Patent

During the prosecutidn of the application for '257 method patent, Allied failed to tell the Patent Office that Allied thought that the structure of the nozzle lip was critical to the Narasimhan process, although Allied did tell the Patent Office that it was critical to the Narasimhan apparatus, to overcome a rejection in connection with a claim of the '571 patent. (The '571 patent is not in issue here.) Dr. Narasimhan's testimony shows that he thought that the width of the lips supporting the melt was critical to his invention. Allied took the position that the width of the lips of the nozzle was critical to the Narasimhan invention when the Patent Department told Wellslager that this was the distinction between his idea and the Narasimhan invention. Allied now takes the same position in its brief here.

During the prosecution of the '257 patent application Allied's attorneys must have believed that this aspect of the invention was critical to the process, as well as the apparatus.

There *is* no clear and convincing evidence of intentional inequitable conduct at the Patent Office in connection with the '257 patent. By failing to disclose that the structure of the nozzle was critical to the invention, Allied may have wanted to obtain a broader patent, but the critical structure of the nozzle is read into the claims *from the specification,* so that Allied in fact did not obtain a patent broader than the invention.

C. <u>Inequitable Conduct in connection with the '739 Patent</u>

During the prosecution of the application which issued as the '739 patent, Allied advised the Patent Office that the Narasimhan process was patentably distinct from prior art processes for casting amorphous metal because the Narasimhan process could produce strips having identical isotropic tensile strength, and these strips therefore were superior to the strips produced by prior art casting processes. The specification of the '739 patent distinguishes prior art wide amorphous strip described in U.S. Patent 3,862,658 to Bedell by stating that such strip had anisotropic properties. Allied had no test results to support such an assertion.

The specification of the '739 patent states that strip made in accordance with the Narasimhan process has isotropic tensile properties because it has "identical" tensile strength in both the transverse and longitudinal directions. Allied had no proof of this, although Allied's attorneys may not have realized this at the time the application was filed. Allied may have assumed that Dr. Narasimhan had tested the strip. Apparently, he had not tested the strip for tensile strength but assumed by looking at it and "bending it over itself" that it was amorphous (TR 780) and that *it* had isotropic tensile strength. *The* '739 patent (Cols. 2 and 3) suggests that the amorphous *strip* made under the '658 patent to Bedell was described in the '739 patent as having anisotropic properties because the product was rolled and presumably would have uneven thickness. The test recited in the specification is one *in* which a strip is pulled in one direction and then in another direction, and has equal tensile strength. A product with uneven thickness would be expected to *fail* such a test.

Allied's attorneys prosecuting the '739 patent application could have argued that all amorphous metal has isotropic tensile strength by *definition,* but they did not. They suggested that a standard tensile strength test had been made .to show that the product had isotropic tensile strength.. Their failure to realize that Dr. Narasimhan had not tested the strip he made may have been inadvertent. The failure to check whether *tests* had been made to support the conclusion that the Bedell amorphous strip had isotropic tensile properties may have been *based* on the knowledge that Bedell's strip *was* rolled and was uneven in width. It would be expected to have unequal tensile strength in two directions because the material would be likely to tear at the points where the width was narrow, or where there were holes.

If Allied did not realize that no tests had been made by Narasimhan to show isotropic tensile properties, this would explain why Allied never informed the Patent Office that it was impossible to test the same sample for strength in both directions without destroying the sample.

Using standard tests for isotropic tensile strength, the original sample is destroyed when tested in one direction, so the same sample could not be tested in the other direction. When any two samples are tested, Allied never has been able to produce test results showing <u>identical</u> strength in both directions.

Allied represented to the Patent Office that such tests had been made and that the results were identical. This representation by Allied was material. Had the Examiner realized that no tests had ben made to determine whether the Allied strip had isotropic tensile strength, the Examiner might have asked what proof there was that the prior art Bedell strip was anisotropic. Without the assertion by Allied that the prior art strip was anisotropic, Allied could not distinguish between strips made by the Narasimhan process and prior art amorphous metal strips at least 7 mm wide. The patent then might have been found invalid in light of the prior art.

Some courts have held that misrepresentations to the Patent Office concerning tests that supposedly demonstrate the superiority of the claimed invention over the prior art are enough to render a patent unenforceable.

Monsanto Co. v. Rohm & Haas Co., 312 F. Supp. 778 (E.D. Pa. 1970), aff'd 456 F.2d 592 (3d Cir.), cert. denied, 407 U.S. 934 (1972). In the Monsanto case, the district court stated:

> [Title Patent Office cannot possibly have a detailed technical expertise *in* every scientific area without relying to some degree on the scientific candor of patent applicants. It cannot be expected to perform tests and experiments to determine whether an applicant's alleged invention is in fact an invention. Further, since patent application proceedings are not ordinarily adversary proceedings, the patent office must rely on the tests and experiments and good faith of the applicant.

312 *F. Supp.* at 793; see also Dresser Industries v. Eltra Corp., 432 F. Supp. 153, 194 (N.D. Ohio 1977). Other courts have held to the contrary.

In the instant. the above misrepresentations appear to be inadvertent, so that the other elements necessary to prove inequitable conduct are not found.

Another possible misrepresentation on the part of Allied is raised by respondents. When the Examiner advised Allied that claims to the wide amorphous strip had to be placed in a separate patent application because such strips could be made by processes materially different from the Narasimhan process, Allied acquiesced *in this* position without traverse. If the Allied attorneys involved in the prosecution of the patent believed that there was no other process that could produce wide amorphous metal strip, they had an obligation to inform the Examiner of *this fact.* By not traversing the Examiner's position, Allied obtained a separate strip patent which issued more than 18 months after the method patent. This would have the effect of extending Allied's patent monopoly, if both patents were valid.

Since Allied had claimed that the Narasimhan process was the only process capable of making wide strip amorphous metal and had informed the Patent Office of the most pertinent prior art of which it was aware, it had met its burden of disclosure to the Patent Office on this point. If the Examiner thought that wide amorphous metal strip could be made by other processes, the '739 patent would not be unenforceable merely because Allied disagreed with the Examiner but failed to oppose his position.

It is found that the elements necessary to establish inequitable conduct in connection with the prosecution of the application for the '739 patent have not been proved. Although there were material misrepresentations to the Patent Office, there was no evidence of an intent to mislead the Patent Office or of gross negligence representing such reckless disregard for the truth as to be tantamount to bad faith. It is found that if the '739 patent were valid, it would be enforceable.

D. Patent Misuse

Under Section 337(c) of the Tariff Act of 1930, all legal and equitable defenses may be raised in a Section 337 proceeding.

The patent laws of the United States grant the patentee certain legal rights. To the extent that these practices are authorized under the patent law, they are *also* legal under the antitrust laws. If, however, a patentee oversteps the practices expressly permitted by the patent law, an illegal restraint of trade or patent misuse may be found. If a patentee misuses the patent, the patent may be unenforceable.

E. <u>The due process defense of Nippon Steel</u>

Nevertheless, the Nippon Steel respondents were added as respondents only on September 14, 1983, five months after the investigation was begun. Although the Commission designated the hearing more complicated, it set a deadline of May 13, 1984, for the initial determination to be filed, reserving five months for the Commission to review the case. The Nippon Steel respondents argue that they had only four months for pretrial discovery, and this was not enough time to prepare for trial. The Nippon Steel respondents argue that they were deprived of an opportunity to cross examine witnesses deposed before they were added to the investigation. There was nothing, however, to prevent them from examining the same witnesses again.

They argue that they were denied an opportunity to make their own selection of Allied documents, rather than relying upon the selection made by other respondents. Every time this issue was raised Allied was ordered to produce all relevant documents to the Nippon Steel respondents so that they could make their own selection. If this was not done, Nippon Steel could have filed a motion for sanctions. Discovery continued throughout the five—week trial, and was not cut off until the hearing closed.

It is possible to deny due process to a respondent who does not have enough time for adequate discovery and preparation for trial. This was a complicated case, and it is difficult to *say* whether the Nippon Steel respondents had adequate time to prepare for trial. Other significant facts might have been uncovered if the Nippon Steel respondents had been given more time for discovery. It *is* not clear why Allied waited so long to add these respondents, but Nippon Steel was aware of the case and could have moved to intervene at any time. These respondents knew they could be affected by an exclusion order regardless of whether they participated as parties.

The Nippon Steel respondents probably had too little time to prepare for trial. All parties were represented by excellent counsel, however, and perhaps due to the quality of the representation, in my opinion all parties received a fair hearing.

DOMESTIC INDUSTRY

Allied contends that the unfair acts of the respondents have the effect or tendency to destroy or to injure substantially an industry efficiently and economically operated in the United States, or in the alternative, to prevent the establishment of such an industry. The domestic industry has been defined by the Commission as that portion of the facilities of the patentee and his licensees devoted to the lawful manufacture and sale of products covered by the patents in issue. (See Schaper Manufacturing Co. v. U.S. International Trade Commission, 717 F.2d 1368 (Fed. Cir. 1983).)

Metglas Products is an unincorporated operating entity or unit of Allied Corporation. (TR 2445, 2484-2485). It has responsibility for commercialization of Allied's amorphous metal alloy technology. *Its* independ-. eat distributor Permag Corporation purchases Allied's magnetic alloys and resells them in small quantities to individual customers and is not part of the domestic industry. TDK *sells tape heads* in the United States under an Allied license agreement (Allied *Ex.* 26). The activities of Metglas Products and the licensed activities of TDK constitute the *domestic* industry.

The '513 patent *is* practiced by Allied. The composition of amorphous metal alloys that are sold by Metglas Products fall under this patent. The '257 process patent *is used* by Metglas Products for manufacturing generally amorphous metal alloy strip which is typically wider than 7 millimeters. The record does not show whether the '739 patent is being practiced by Allied because it *is* impossible to prove that the strip produced has identical tensile strength *in* any direction.

The markets in which amorphous metals are now sold are primarily the power electromagnetics, pulse power, electronics, security strip, and brazing markets.

1. Power Electromagnetics

The power electromagnetics market covers the use of amorphous metal alloy strip or ribbon to make the magnetic core of transformers used by utilities to step down the electric voltage *as* it flows from the generating station to individual customers. This market also includes power transformers which are used at the generating plant.

Electric Power Research Institute (EPRI) is a research organization that *is* funded by about 400 utilities. EPRI is participating in a joint program with Allied to develop amorphous metal alloys to be used in transformers.

The replacement market for existing silicon steel core transformers has the potential of being as large as the market for new installations and through the use of amorphous metals the market in the United States could double. The distribution transformer industry is a $1 billion—a—year industry. Twenty million distribution transformers are presently in service and one million new transforiers are installed every year. (Allied Ex. 236).

This market *is* already in existence, but there is an excellent chance that it will expand enormously within the next few years.

Replacing silicon steel cores with amorphous metal cores could save utilities $1.5 billion in operating costs over a 10—year period. The cost of the initial replacement cost is high unless the transformer already *is* scheduled for replacement. Replacement with amorphous core transformers *also* would reduce the need to build new generation facilities, saving about $2 billion in capital investment. (Allied Exs. 67 and 70).

Some utilities faced with high plant and fuel costs are willing to pay a premium of as much as 25Z for more efficient, lower Loss amorphous core transformers. (Allied *Exs.* 602 and 251).

Some utilities are replacing old, inefficient transformers with more efficient silicon steel transformers. (TR 3308).

(TR 3312). There *is* already a significant market among utilities for amorphous core transformers, with large growth potential, if the price to the utilities is low enough to give them a saving if they buy amorphous core transformers.

The price of, amorphous metal is an important factor in impending decision as to whether to commercialize amorphous core transformers. Amorphous metal *is* competing against silicon steel transformer cores that are cheaper. (TR 114; Allied Ex. 235). Silicon steel currently sells for approximately per pound. (TR 3211). Estimates of the price at which amorphous metal will achieve commercial penetration levels range between (TR 3210-3211) and per pound. (Ex. E-125 at 34-36, 178). If amorphous metal sold for per pound, it would penetrate a substantial portion of the market. (Ex. E-133). There *is* evidence that amorphous metal transformers would be at a breakeven point with the best silicon steel transformers if amorphoui metal sold for per pound. (Staff Ex. 17).

As production costs for amorphous metal decrease, and utilities' evaluations of energy losses increase, market penetration should increase. (Allied Ex. 236 and 258). The raw materials currently *used* by Allied to produce transformer material cost per pound, but Allied *is* working to reduce *its* costs. (Rasps' Ex—I93, Staff Ex. 9, TR 172-174, 241-242, 2579—2580)..

Allied has offered to sell amorphous metal to for commercial transformer production at a pcice of to per pound, and has replied that Allied's price *is* too high. (TR 144). also wants a second source for amorphous metal to assure adequate supplies and to provide price competition. Allied's position is that it can assure adequate supplies by constructing a dedicated facility on or adjacent to plant. (TR 176, Resps' Ex. E-68).

If Allied lowers its price, some share of the profit could go to the transformer manufacturers and still give real savings to the utilities, thus giving them an incentive to replace their old transformers. A lower cost for amorphous metal probably would result in a decision to commercialize the new transformers.

Other transformer manufacturers, such as are also developing amorphous core distribution transformers. The commercial introduction of these transformers would be likely to speed up the introduction of amorphous transformers into the marketplace by

Because power transformers are *so* much larger than distribution transformers, fewer power transformers are produced. (Staff Ex. 28). The dollar revenue potential for power transformers is roughly equivalent to that for distribution transformers. (Staff Ex. 28).

EPRI, Allied, and Westinghouse entered into an agreement in August, 1982, which was completed on December 31, 1983, to develop amorphous metal power transformers.

(Allied Ex. 246). The *loss* evaluation for these transformers indicates that practically all sizes of transformers will show a lower total owning cost because of the lower core *losses* of amorphous metal. (Allied Ex. 252).

Amorphous substation transformers are expected to be in operation by 1986. (Ex. E-125).

2. Pulse Power Market

The pulse powei market refers to an application where the amorphous metal alloy material is used in a very high rate of delivery of energy, typically for particle accelerators and laser-types of applications. (TR 2766).

Some of Metglas Products' customers in the 'pulse power field are Sandia National Laboratories, , Lawrence Livermore National Laboratory, Lawrence Berkeley. Laboratory, and All of these customers are government agencies, except for and which are private companies. (TR 2739). 1983 sales to Allied's customers in the pulse power market were kilograms for The average price for the amorphous metal alloy sold by Allied in this market was per pound.

3. Electronics Market

Metglas Products already *sells* amorphous metal alloy strip for various electronics applications, including tape wound cores (TR 2738), and electronic cores. (TR 2742-2744).

The electronics area also includes *sales* of amorphous metal alloy strip for use in a bone growth stimulator device. Sales are made also for *use* in recording heads or tape heads. (TR 2739-2740).

In 1983, Allied sold kilograms of amorphous metal in this market for . (Allied Ex. 610). Allied's average price for amorphous alloys in *this* market is per pound.

4. Security Strip Market

In Allied entered into the agreement with 3M,

5. Brazing Market

Metglas Products' brazing *foils* are described in the brazing catalogue. (Allied Ex. 16). The brazing foils are identical to compositions of conventional alloys that are available either in powder or paste form.

These silver brazing compositions are used to braze copper to copper, for example for automobile radiators, copper to iron, and iron to iron. (IT. 102-103).

In 1983, Allied sold kilograms of amorphous metal in this market for (Allied Ex. 610). The average price for brazing foil was per pound.

Structure of Metglas Products

Metglas Products was organized in 1978. In that year Allied entered into the development contract with EPRI. In 1980, Metglas Products acquired the facilities at Parsippany and began the construction of a continuous casting line.

In 1980, various sales representatives were employed, existing casting machines were transferred from the laboratory to the Parsippany plant, and by mid-1981, the continuous casting line was in operation. Metglas Products had a controller, a manufacturing department, a quality control facility and procedure, and engaged in advertising and promotion. By 1980, Metglas Products was manufacturing amorphous metal alloy strip. An enterprise may be described as an operating business when *it* has a product ready to be *sold* to customers, *is* actively marketing that product, and has management, financial, and control capabilities. (TR 4397-4398).)

Allied's sales of amorphous metal alloys increased from $500,000 in 1980 to $1,400,000 in 1983.

Metglas Products already has all of the characteristics of an operating business unit within Allied Corporation. Since 1980, Metglas Products has been an established domestic industry within the meaning of Section 337.

Allied has made a substantial investment to improve the efficiency of the casting process for amorphous metal strip and to develop specific compositions to meet the needs of customers.

In 1980, Allied invested , to build the amorphous metal alloy manufacturing facility at the Parsippany plant. In 1983, Allied spent to purchase the facility constructed jointly by Allied and EPRI to manufacture amorphous metal alloy ribbon for distribution transformers.

The investment by Allied in Metglas Products still exceeds the revenue derived from the sale of amorphous metal alloys, and Metglas is not yet profitable. This *is* a new field of research, and the research required is expensive. If an industry always expects immediate profitability, much of the research expenditure necessary *for* developing important new technology will not be done at all, unless it is done by the government of *this* country or a foreign nation. It is reasonable to risk large research expenditures when the return also is expected to be large. Until the technology for making amorphous metals improved, which has taken years, the markets for using the new product could not be developed. Instant profitability should not be the measure of efficiency in a company that is looking towards the future and is ready to spend the necessary money to create a significant product and then a demand for it.

Allied's capacity *is* adequate

Allied has the capacity to meet expanded demand for amorphous metals. The continuous casting machine has the potential capacity for producing tons a year of amorphous metal alloy ribbon. (TR 108-109). With further development, the continuous casting process using 12—inch wide ribbon would have a maximum daily capacity as high as tons, assuming there is *sufficient* melting capacity to provide that material. (TR 343). The batch casting machines have a capacity of about pounds per batch. Metglas Products has five batch casting machines. Ckllied Ex. 217). The present capacity of Metglas Products, assuming 90% operation of all of its current production casting machines, *is* about tons per day of amorphous metal alloy. (TR 342).

Allied's costs are declining

Allied is attempting to reduce its costs for making amorphous metals. Metglas Products *is* negotiating with and others in an attempt to obtain reductions in the cost of raw materials. (TR 424-425, Allied Ex. 55). When amorphous metal ribbon *is* tested according to the specifications and it does not pass the test, and it *is* either sold for other purposes (such as brazing), or it *is* melted and reprocessed.

<u>Allied's prices</u>

Allied's prices at this time are not unreasonable in view of Allied's costs and its desire to get back its past' investments, but more price reductions may be necessary if the market for amorphous metals *is* going to expand greatly, because lower costs to companies using these metals, for example, in transformers, will be required to meet competition from products not using amorphous metals.

The tletglas -price for amorphous metal alloy strip depends upon the market in which it is being sold. For large quantities of amorphous metal alloy strip for the distribution transformer market under the contract, the price has been per pound. In the smaller quantity sold (not part of the project), the same alloy was priced at per pound. In 1983, the average price of amorphous metal alloy sold by Allied for electronics applications was per pound, for brazing foils it was per pound, and for pulse power applications it *was* per pound.

Allied will have to lower the price it is now asking for amorphous metal in its negotiations with if Allied *wants* to sell a substantial amount of amorphous metal for the transformer market before the '513 patent expires, if that patent is valid. Otherwise, there is a real possibility that the potential of an enormous. transformer market for amorphous metals will be delayed until a time when the patent expires and other producers can compete with Allied, and bring the prices down. The positions taken by Allied and in the current price negotiations are probably not the final positions that will be taken by either party at the end of the negotiations, later this year.

Allied is not investing an excessive amount of money compared to the potential scope of returns, if Allied is willing to have price flexibility before the patent monopolies expire in order to get maximum exploitation of *its* patents.

It is found that Metglas Products is an existing industry efficiently and economically operated in the United States, with good potential for future profitability.

INJURY

It *is* found that if the respondents have engaged in any of the alleged unfair acts, these acts have the tendency to injure substantially the domestic industry for the following reasons:

ALL of the respondents except TDK engaged in "sampling" practices. It is not necessary to prove that respondents sold amorphous metals in the United States. "Sampling" practices have enabled respondents to develop products acceptable to customers before the patents in issue expire. The practice of "sampling" takes away Allied's legitimate head start in exploiting its valid patents during the patent monopoly period. The respondents have saved the time it would have taken them to develop a product acceptable to a particular consumer if they had started to offer samples of their products to prospective customers only after a patent had expired.

1. Vacuumschmelze and Siemens

In March, 1983, VAC sold pounds of amorphous metal for (Allied Ex. 440B).

(Allied's *Exs.* 324, 325; Staff *Ex.* 7).

These orders followed nearly four years of technical discussions and sampling activity between and VAC. (Allied Exs. 440B and 319). Sampling activities began in November 1979.

Allied initially was unwilling to sell amorphous metal strips , because Allied wanted to sell finished wanted to develop its own usingg-amorphous metals purchased from Allied. At the present time Allied *is* willing to develop amorphous metal materials suitable for use in and sell these materials to . ' Until recently, however, was unable to purchase amorphous metals from Allied suitable for use in its . VAC's past sales did not cause injury to Allied because Allied at first did not want to sell amorphous metals for use in and later Allied had agreement with relating to amorphous metals suitable for use in

would prefer to purchase amorphous metal from multiple sources rather than a single supplier. (TR 4678-4679). This would be likely to make it more difficult or at least more costly for Allied to enter into a development contract with , now that Allied is willing to sell amorphous material suitable for *use in* to

. (TR 4669-4670, 4684). Specialty products such as require only batch-type manufacturing facilities. (TR 3512, 3640-3643). If VAC's activities *with* continue, they probably will result in Allied losing future sales to VAC.

VAC apparently intends to try to sell amorphous metals to other potential purchasers in the industry, including and VAC has discussed supply arrangements with these companies and has sent samples to them. (Allied *Exs.* 312; 440A, and 440B, and *Staff* Ex. 7).

VAC's sampling activities *also* threaten Allied's revenues from tape head applications. TDK Corporation manufactures and sells tape heads containing amorphous metal under a license agreement with Allied. (TR 3109-3110, Allied Ex. 26). The license grants TDK the exclusive right to make, use, and sell amorphous metal tape heads in Japan and to export these tape heads to the United States. (Allied Ex. 26 at 2-3, 5). Under this license, TDK is required to pay Allied a royalty of IX of net sales of amorphous metal tape heads. (Allied Ex. 26). VAC has provided samples *of* amorphous metal to for evaluation. (Allied *Exs.* 305, 327.. and 440B). If)/ buys from VAC, it will result in lost sales to TDK, and lost royalties to Allied.

The activities of Vacuumschmelze in exporting amorphous metals to the United States has the tendency to injure substantially the domestic industry in the future.

2. TDK

TDK sent its first samples of amorphous metal to Lawrence Livermore National Laboratory ("LLL"), a laboratory owned by the U. S. Government, in the spring of 1982 (TR 3114, 3123-3125, 3146-3150, TR 4345-4346; and TDK Ex. T-29). TDK sold a 10 kilogram sample to LLL in October, 1982, for $1,000. (TR 3115, 3146; TR 4346-4350, TDK Ex. T-1). TDK quoted a $17,000 price for 170 kilograms on January 3, 1983, but withdrew the quote and never made this sale because of *this* investigation. (TR 3116, 3135, 4352-4371, TDK Exs. T-6, T-12, T-I3, T-14, T-15, T-20; Allied Ex. 44).

LLL has purchased amorphous metal from Metglas Products for use in pulse power applications (TR 2757), and Allied expects to sell large quantities of amorphous metals for pulse power applications during 1984. (Respondents' Ex. E-75). It is LLL's policy 'to purchase amorphous metal from multiple sources, rather than a single supplier. (TDK Ex. T-26 and T-27). LLL has demonstrated a continued willingness to purchase from TDK. (TR 43534-4354, 4368; Allied Ex. 44). TDK has disregarded one Allied request to stop importing amorphous metal for pulse power applications. (TDK Exs. T-3, T-4). TDK indicated that it would continue to sell amorphous metals to LLL if this investigation were not pending. (TR 3135; Allied Ex. 44, TDK Ex. T-20).

The record shows that LLL needed a special type of thin magnetizable amorphous metal for use in pulse power testing. LLL tried to obtain this thin amorphous metal from Allied. Allied did not want to develop a thin amorphous metal product just for LLL unless a large market for this product could be expected. At first, Allied declined to sell a thin amorphous metal to LLL. LLL then was able to obtain this product from TDK, and LLL gave Allied a sample of the product made by TDK. Only at that time did Allied decide to develop a thin magnetizable amorphous metal for LLL.

The amorphous metal given or sold to LLL by TDK in the past did not cause any injury to Metglas Products. Metglas did not have this product available, and it did not want to develop it because the potential market did not appear to be large enough to warrant the expense of developing a new product. After Allied saw that TDK had made the product, it developed the same product and sold it to LLL. Moreover, once the product was in existence, the market for it began to grow. TDK was responsible for the growth of the market, not for sales lost by Metglas. In fact, TDK is no longer selling this product to LLL (although TDK would like to sell it and LLL would like to buy it), .so Metglas now is filling the order that TDK would have had.

If no exclusion order is *issued,* however, TDK is ready and able to fill the future demands of LLL for this product, and LLL would prefer to buy from TDK and from Allied, so that it would have a second source and potential price competition. There is, therefore, a tendency that TDK would injure substantially the domestic injury in the future *if* no exclusion order *is* issued. TDK is not willing to say that it will not resume sales of amorphous metals to LLL in the future.

3. **Nippon Steel Corporation**

4. **Hitachi**

Hitachi Metals' Magnetic & Electronic Materials Research Laboratory ("HMRL") has casting machines capable of producing amorphous metal.' (Allied Ex. 514), but only machine No. has the capacity to produce amorphous metals in the volume required for commercial use. (Allied Ex. 514).

Although Hitachi Metals' existing capacity *is* insufficient to produce large volumes of amorphous metal, it could increase production capacity quickly.

At the present time Hitachi is making amorphous metal with a cobalt base, a product not suitable for use in distribution transformers, but Hitachi could produce amorphous metals alloys suitable for use in these transformers very quickly if allowed to sell to this market in the United States.

In summary, Nippon Steel and the Hitachi respondents. have sent samples of amorphous metals to and Nippon Steel has sent samples to VAC has made sales to and has sent samples to TDK is ready to sell to LLL, and LLL is anxious to buy from TDK.

The exportation by all of the respondents of amorphous metal alloys to the United States in connection with sales or sampling of these products to present customers or potential future customers has the tendency to injure the domestic industry substantially. Large markets *for* amorphous metals are developing, and respondents have been able to prepare their products to meet the specifications of future purchasers by engaging *in* sampling procedures during the lifetime of the Allied patents. It would have taken a considerable amount of time after the Allied patents expired before respondents could begin competing with Allied, if sampling and evaluation of the samples had not taken place prior to the expiration of the patents.

CONCLUSIONS

After consideration of the evidentiary record and the arguments of the parties, it *is* found that TDK Electronics Corporation, TDK Corporation, M}I&W International Corporation, Vacuumschmelze GmbH, Siemens Corporation, Hitachi Metals, Ltd., Hitachi Metals International, Ltd., Nippon Steel Corporation, and Nippon Steel, Inc. have engaged in unfair acts violating Section 337 of the Tariff Act in connection with the importation into the United States of articles made by a process that would infringe Allied's '257 patent if the process were used in the United States, and that these unfair acts have the tendency to injure substantially the domestic industry. Hitachi, Ltd. *is* dismissed as a party.

The record in this case consists of all exhibits identified in the following exhibits of the parties: Allied Ex. 611, Respondents' Exs. P-2000 and E-0, TDK Ex. 28, Staff Ex. 32, and the transcript of the testimony at the hearing, and all papers and requests filed in this proceeding-g

Janet b. .Saxon
Janet D. Saxon
Administrative Law Judge

Issued: May 14, 1984

1/ Pursuant to Section 210.53(h) of the Commission's Rules the initial determination shall become the determination of the Commission unless a party files a petition for review of the initial determination pursuant to Section 210.54, or the Commission pursuant to Section 210.55 orders on *its* own motion a review of the initial determination or certain issues therein. For computation of time, see Section 201.14. For computation of additional time after service by mail, see Section 201.16(d).

"Exhibit A"

FINDINGS

1. On March 11, 1983, complainant Allied Corporation filed a complaint with the U.S. International Trade Commission alleging violations of 19 U.S.C. Section 1337 and 19 U.S.C. Section 1337a.

2. On April 13, 1983, the Commission published a notice of investigation initiating an investigation to determine whether there is a violation of Section 337 of the Tariff Act of 1930, as amended, in the unlawful importation of certain amorphous metal alloys and amorphous metal articles into the United States, or in their *sale,* by reason of alleged (a) infringement of the claims•of U.S. Letters Patent No. 3,856,513; (b) infringement of the claims of U.S. Letters Patent No. 4,331,739; and (c). infringement of the claims of U.S. Letters Patent No. 4,221,257, the effect or tendency of which is to destroy or substantially injure an indUstry, efficiently and economically operated, in the United States.

3. The Commission named nine respondents in the original notice and amended the notice of investigation on September 14, 1983 to add two new respondents, Nippon Steel Corporation and Nippon Steel, Inc. An unopposed motion to terminate another respondent, Hitachi Magnetics Corporation, named by mistake, was granted by Order No. 22 (initial determination).

4. The following ten companies remain as respondents in this case:

TDK Corporation
13-1, 1 Chome
Nichonbashi, Chuo-ku
Tokyo 103, Japan

TDK Electronics Corporation
12 Harbor Park Drive
Port Washington, New York 11050

MH&W International Corporation
14 Leighton Place
Mahwah, New Jersey 07430

Vacuumschmelze GmbH
Gruener Weg 37
D-6450 Hanau 1, West Germany

Siemens Corporation
186 Wood Avenue South
Iselin, New Jersey 08830

Hitachi, Ltd.
New Marunouchi Bldg.
5-1, 1 -chome, Marunouchi
Chiyoda-ku
Tokyo, Japan

Hitachi Metals, Ltd.
Kishinoto Bldg.
2-1, Marunochi 2 -ehome
Chiyoda-ku
Tokyo, Japan

Hitachi Metals International, Ltd.
1 Red Oak Lane
White Plains, New York 10604

Nippon Steel Corporation
6-3, Ote-Machi 2-Chome
Chiyoda-ku
Tokyo 100, Japan

Nippon Steel, Inc.
345 Park Avenue
New York, New York 10154

5. On January 25, 1984, the Commission decided not to review an initial determination amending the notice of investigation to add "prevention of establishment of an industry in the United States" to the scope of the investigation.

6. Complainant, Allied Corporation (hereinafter Allied), *is* a corporation organized and existing under the laws of the State of New York with its principal place of business located at Park Avenue and Columbia Road, Morristown, New Jersey 07960. Allied is a diversified manufacturer of a variety of products, and its total sales in 1982 were over six billion dollars. (Allied Ex. 15).

7. Hitachi Metals, Ltd. is a Japanese corporation organized under the laws of Japan and located at Chiyoda Building, 1-2, Marunouchi 2-chome, Chiyoda-ku, Tokyo, Japan. (Allied *Ex.* 656).

8. Hitachi Metals International, Ltd. is a domestic corporation organized under the laws of the State of New York and located at 1 Red Oak Lane, White Plains, New York 10604. Hitachi Metals International, Ltd. is a subsidiary of Hitachi Metals, Ltd. (Allied *Exs.* 514 and 656).

9. Hitachi, Ltd. is a Japanese corporation organized under the laws *of* Japan and located at 6, Xanda-Surugadai 4-chome, Chiyoda-Xu, Tokyo, Japan. Hitachi, Ltd. owns about   of the stock of Hitachi Metals, Ltd. (Ex. P-1200 and Allied Ex. 656).

10. Siemens Capital Corporation was incorporated in Delaware on September 16, 1968. The main offices of Silhens Capital Corporation are located at 767 Fifth Avenue, New York, New Yhrk 10153. (Allied Exs. 516 and 656).

11. Siemens Corporation was incorporated in Delaware on January 14, 1954 as Siemens America, Inc. Siemens Corporation was merged into Siemens Capital Corporation on October 1, 1982. (Allied Ex. 656).

12. Vacuumschmelze GmbH (hereinafter VAC) is a German corporation with *its* main offices located at Cruener Weg 37, D-6450 Hanau 1, Federal Republic of Germany. (Allied Ex. 656).

13. VAC and Siemens Capital Corporation share office space and facilities at 186 Wood Avenue South, Iselin, New Jersey. (Allied Ex. 515).

14. Siemens Capital Corporation disburses funds to the employees of VAC in the United States, and bills VAC periodically. Siemens Capital Corporation acts as the importer of record for products of VAC shipped to the United States. (Allied Ex. 516).

15. Nippon Steel Corporation *is* a corporation organized under the laws of Japan, with its principal place of business located in Tokyo, Japan. (Allied Ex. 656).

16. Nippon Steel, U.S.A., Inc. is a wholly owned subsidiary. of Nippon Steel Corporation. (Allied Ex. 656).

17. TDK Corporation is a corporation organized under the laws of Japan, with its principal place of business at 13-1, 1-chome, Nihonbashi, Chuo-ku, Tokyo 103, Japan. (Allied Ex. 656).

18. TDK Electronics Corporation (erroneously named in the Notice of Investigation as TDK Electronics Co., Ltd.) is a corporation organized under the laws of the State of New York, with its principal place of business at 12 Harbor Place, Port Washington, New York 11050. TDK Electronics Corporation is a subsidiary of TDK Corporation. (Allied Ex. 656).

19. MH&W International Corporation is a corporation organized under the laws of the State of New Jersey, with its principal place of business at 14 Leighton Place, Mahwah, New Jersey 07430. (Allied Ex. 656).

20. MHZW International Corporation *is* the exclusive sales agent for TDK Corporation in the area *of* ferrites and microwave devices in the United States and Canada. (Allied Ex. 656).

JURISDICTION

21. The notice of investigation instituted an investigation of certain alleged unfair practices of respondents involving the importation into or the exportation to the United States of , certain amorphous metal alloys.

22. The alleged unfair practices include infringement of U.S. Letters Patent No. 3,856,513 (the '513 patent) which is a product patent, and U.S. Letters Patent No. 4,331,739 (the '739 patent), which is also a product patent. The Commission has jurisdiction over the subject matter of the importation of•products alleged to infringe these patents under Section 337 of the Tariff Act of 1930. The alleged unfair practices also include infringement of U.S. Letters Patent No. 4,221,257 (the '257 patent), which is a process patent. Under 19 USC Section 1337a the Commission has jurisdiction under SectiOn 337 of the Tariff Act of 1930 over the importation of products produced under a process covered by claims of an unexpired U.S. patent.

23. All parties in this case have appeared and litigated the issues in this case. The Commission has personal jurisdiction over all of the parties in this case.

24. The Commission has alleged violations of Section 337 on the part of all the respondents, and therefore the Commission has subject matter jurisdiction in this ease. The Commission has subject matter jurisdiction in connection with the allegations of unfair practices by TDK Corporation, TDK Electronics Corporation, -and MIMW even though these respondents sold amorphous metal alloys only to the United States Government at its request.

VALIDITY OF THE '513 PATENT

25. Allied alleged infringement of UTZ. Patent No. 3,856,513 (Ex. P-443; Allied Ex. 18), issued on December 24, 1974, naming as inventors Ho-Sou-Chen and Donald E. Polk. The '513 patent is based on Application Serial No.318,416, filed on December 26, 1972. (Ex. P-444).

26. Dr. Polk graduated with a Ph.D. from Harvard University in 1971. *(Ex.* P-1224, Polk Dep. TR 16). Dr. Chen graduated with a Ph.D. from Harvard University in 1967. (Ex. P-I210, Chen Dep. TR 10-11). Both Drs. Polk and Chen had the same thesis advisor, Professor. Turnbull. (Ex. P-1210, Chen Dep.TR 11-12; Ex. P-1210A, Chen Dep. TR 171, Ex. P-77; Ex. P-215). The separate thesis work of Drs. Chen and Polk was concerned with amorphous metal alloys. (Ex:P-1210, Chen Dep. TR 12-13, 49-50; Ex. P-1224, Polk Dep. TR 17-18).

27. Dr. Chen joined Allied Corporation in June,*1971. (Ex. P-1210, Chen Dep. TR 61). Dr. Polk joined Allied Corporation in August, 1971. (Ex. P-1224, Polk Dep. TR 27).

28. The '513 patent relates to amorphous metal alloys and articles manufactured from those alloys.. An amorphous metal alloy differs from a crystalline metal alloy in that it exhibits no long range order in *its* atomic arrangement. (Ex. P-721, Ex. P-443, col. 2, lines 21-23). For practical industrial applications, metallic alloys are usually formed in the

amorphous, or glassy, state by rapid cooling from a.molten high temperature state, such as by quenching against a cool_surface. (Turnbull TR 1857).

29. The amorphous state is a metastable state and has a higher energy than the crystalline state. The thermal stability of an amorphous alloy is dependent on the crystallization temperature of the particular alloy. The glass transition temperature is the temperature below which an alloy must be cooled to form a molten alloy into an amorphous or glassy material, or the temperature at which the atoms in the amorphous material first begin to rearrange themselves prior to becoming crystalline. The crystallization temperature is defined as the temperature at which the amorphous material begins to exhibit the onset of crystallinity, i.e., long range atomic order. The higher the crystallization temperature or the glass transition temperature, the more stable the amorphous state. Since not *all amorphous alloys exhibit an observable glass transition temperature, however, the crystallization temperature is usually used as the measure of-the stability of the amorphous state of the alloy. (Grant TR 2869-2870, 5511-5519; Turnbull TR 1863-1866, 1876-1878; P-1224, Polk Dep.TR 106-108).

30. The alloy composition determines the ease with which the alloy can be formed in the amorphous state as well as the thermal stability of the resulting amorphous alloy. (Ex. P-443, col. 2, lines 4-7). The thermal stability and the ease of formation of a given alloy are not related. (Ex. P-748). A given composition may be thermally stable, but very difficult to form in the amorphous state, and vice versa. (Turnbull TR 5666).

31. A variety of methods are used to obtain some indication of whether an alloy is, at least to some extent, amorphous. Examples of such methods include X-ray diffraction, differential scanning calorimetry, and 'transmission electron microscopy. (Maddin TR 4837-4841; Grant TR 5520, 5527).

32. To obtain amorphous metal articles of manufacture, such as wires, sheets or ribbons, it is necessary to be *able* to form the article in an amorphous state by liquid quenching from the melt. (Ex. P-444, Amendment of May 13, 1974, at p. 8).

33. Amorphous metal alloys have different mechanical, electrical .and magnetic properties depending upon their composition. (Ex. P-11; Ex. P-169 at p. 1553, col. 2). Some amorphus metal alloys are more useful in magnetic applications than others. (Ex. P-169). The properties of the amorphous metal alloys change.as the amount of crystalline material included increases. (Grant TR 2927-2928).

34. Claim .1 of the '513 patent claim "a metal alloy of the formulas M_aYbZ_e which *is* at least 50 percent amorphous and-wherein H is a metal selected from the group consisting essentially of iron, nickel, chromium, cobalt, or vanadium or a mixture thereof, Y *is* a metalloid selected from the group consisting of phosphorous, carbon and boron or a mixture thereof, and Z *is* an element selected from the group consisting of aluminum, silicon, tin, antimony, germanium, indium, and beryllium and mixtures thereof, "a", "b" and "c" are atomic percentages ranging from about 60 to 90, 10 to 30 and 0.1 to 15 respectively with the proviso that a plus b plus c equals 100." (Ex. P-443, col. 10, lines 14-26).

1. <u>Section 103</u>

35. As of the date of the invention disclosure for the '513 patent application, August 16, 1972, (Ex. P-217) it was known in the art that amorphous alloy systems could be made from transition metals by the addition of non—metal glass formers. (Ex. P-249). Iron, nickel, cobalt and manganese, as well as platinum and palladium, were known transition metals to which glass formers had been added to form amorphous metal alloys directly from the melt by liquid quenching. (Ex. P-394; Ex. P-1015; Ex. P-1017, Ex. P-245).

36. Glass formers were identified and grouped in one category as phosphorous, boron, carbon, silicon, and germanium. (Ex. P-374 Ex. P-394, Ex. P-1013, Ex. P-1015; Ex. P-249).

37. At the time of the invention, Chen and Polk took known liquid quenched iron and nickel based alloy systems and added other known glass formers, such as silicon, germanium, and antimony. (Grant TR 2909-2914; Ex. P-1015, Ex. P—I017, Ex. P-249).

38. Prior to the Chen and Polk MYZ invention, a limited number of amorphous, i.e., noncrystalline or glassy, metal alloys had been prepared. (Grant TR 3772-3774).

39. The preparation of an amorphous metal alloy by liquid quenching from the melt was first achieved by Pol Duwez at the California Institute of Technology; the first amorphous--metal alloy thus prepared by Professor Duwez was a gold—silicon alloy. (Turnbull TR 1860-1861; Grant TR 2844-2851).

40. The initial work on rapid solidification of amorphous metal alloys was carried out on a scientific level and not *as* an industrial deirelopment project at universities, particularly California Institute of Technology, Massachusetts Institute of Technology, Harvard, the University of Pennsylvania, and also at the Battelle Memorial Institute. Industry also began to develop an interest in this area and research *was* carried on at Allied Corporation, General Electric Company, IBM and Bell Telephone Laboratories, among others. There was also research in amorphous metal alloys in England, India, the Soviet Union and other locations. (Grant TR 2853-2854).

41. Those working in the area of amorphous metals in the late 1960s and early 1970s were highly educated and were predominantly Ph.D. graduates. (Grant TR 2857). Thus the level of skill in the art was high.

42. By the date of the filing of the '513 patent application, prior art references available to a person of ordinary skill in the metallurgical arts included at least the following: W. Felsch, "Ferromagietische eigenschaften amorpher Kobaltschichten," Zeitschrift fur Angewandte Physik (1970-1971) (Ex. P-3880; W. Felsch, "Schichten aus amorphem Eisen," Zeitschrift fur Physik, Ed, 195, 201-214 (1966) (Ex. P-1013); Duwez and Lin, "Amorphous Ferromagnetic Phase in Iron-Carbon-Phosphorous Alloys," Journal of Applied Physics, 38, 4096-4097 (1967) (Ex. P-1017); the Campbell Memorial Lecture of Professor Duwez entitled "Structure and Properties of Alloys Rapidly Quenched from a Liquid State," and published in Transactions of the ASH, 60, 607-633 (1967) (Ex. P-1015); Yamaguchi and Nakagawa, "Amorphous Ferromagnetic Fe-P-B Alloys

Prepared by a New Technique of Splat Cooling," Japanese Journal of Applied Physics, 10, 1730 (1971) (Ex. P-394); and Duwez, "Liquid Quenched Metallic Metastable Alloys," Fizika, Vol. 2, Supplement 2 (1970) (Ex. P-249). (Grant TR 2858-2896).

43. None of the above references was cited during the prosecution of the '513 patent, either by the Examiner or by the inventors. (Ex. P-444).

44. In 1966, an article entitled "Schichten aus amorphem Eisen" appeared in Zeitschrift fur Physik Ed. 195, 201-214 by W. Felsch. (Ex. P-1013). This described research work on the formation of iron—silicon glassy alloys by evaporation condensation techniques. Felsch showed that silicon additions to iron in amounts from 0.5 to 10 atom percent silicon (far below the eutectic) were extremely effective in increasing the glass transition temperature, a measure of glass stability, from about 40° Kelvin to about 240° Kelvin, an increase of about 200°. This research work demonstrated the effectiveness of adding silicon to iron in producing an amorphous alloy. (Grant TR 2858-2859).

45. In 1970, Felsch published another article, detailing his research on the preparation of cobalt—silicon amorphous alloys by evaporation condensation techniques. (Ex. P-388). The article also shows that as the concentration of silicon is increased from 1 to 6 atom percent (far below the eutectic), the crystallization temperature increases from about 67° Kelvin to•about 242° Kelvin. This increase demonstrates that silicon

is also a powerful crystallization temperature increaser and an effective glass former with cobalt. (Grant TR 2860-2861).

46. A person with ordinary skill in the art, reviewing the disclosures of the Felsch references in light of the phase *diagrams* of cobalt—silicon and iron—silicon ("M" and "Z" elements in the '513 patent) found in Hansen's standard reference Constitution of Binary Metal Alloys, would conclude that the glass and crystallization temperatures of iron—silicon or cobalt—silicon alloys would continue to increase as the amount of .("Z" element) silicon increased towards the eutectic composition of the binary alloy MZ system.. (Grant TR 2861-2865; Ex. P-735).

47. The 1967 Duwez and Lin article discussed the preparation of alloys by rapid cooling from the liquid state. (Ex. P-1017). These alloys included alloys of the noble metals in combination with glass formers such as silicon, germanium and antimony (all "Z" elements within the '513 definition). The alloys formed in the amorphous state within a rather narrow range of concentrations in the vicinity of the eutectic composition. This publication recognized Turnbull in a 1961 article as the source of the "deep eutectic" guideline for amorphous compositions. Duwez and Lin also discussed the iron—phosphorous—carbon (a '513 patent "MY" alloy) ternary system which was capable of being quenched from the melt into an amorphous state, as well as alluding to a noble metal liquid quenched alloy system, again using silicon, e.g., gold—silicon—germanium (AuSiGe), a noble metal with the '513 "Z"

elements silicon and germanium. (Grant TR 2874-2879). Duwez and Lin also note that platinum-antimony (Pt-Sb) alloys were prepared by melt quenching. (Ex. P-1017).

48. The first series transition metals include vanadium, chromium, manganese, iron, cobalt, nickel (all "H" elements except manganese); the so-called noble metals are among the second and third series transition metals and include palladium, silver, rhodium, platinum and gold. The noble metals are less reactive than the other transition metals. (Grant TR 2875-2877).

49. The materials combined with the transition metals of the Duwez and Lin article--namely, silicon, carbon, phosphorous, germanium, and antimony (both "Y" and "Z" '513 elements)--are nonmetals and semi-metals or metalloids, generally classified collectively as "glass formers." (Grant TR 2878-2879).

50. The Campbell Memorial Lectures are given annually under the auspices of the American Society of Metals by people who have done outstanding work *in* a particular field. The 1967 lecture, given by Professor Duwez, was based on the work he had initiated in the field of amorphous metal research. In the lecture (Ex. P-1015), Professor Duwez set out a series of'observations and guidelines for the formation of glassy alloys. The glass formers to be added to the transition and noble metals were listed by Duwez all in one category and include most *of* the '513 "Y" and "Z" elements: carbon, boron, silicon, phosphorous, and germanium. (Grant TR 2880-2882).

51. Other observations of Duwez were that for a binary system, the alloy composition chosen should be near the composition of the eutectic point, preferably a deep eutectic point, and generally tended to be near a composition having 80 atomic percent transition metal and 20 atomic percent glass former, i.e., metalloids or nonmetals. (Grant TR 2880-2882).

52. In the Campbell Memorial Lecture (Ex. P-1015), Professor Duvez discussed two approaches to the synthesis *of* amorphous ferromagnetic alloys by liquid quenching. In the first approach, a limited number of ferromagnetic atoms were introduced into an amorphous structure using palladium-silicon alloys as a base. Iron, cobalt, and nickel ('513 "M" elements) were substituted for the palladium (pd), keeping the concentra tion of silicon (a '513 "Z" element) constant at 20%. In the second approach, large percentages of the ferromagnetic element iron or nickel were added to phosphorous and carbon, forming an "MY" '513 compound (Fe-P-C and Ni-P-C). Duvez *in* this one article acknowledged the addition of an "M" element iron (Fe) to-a "Z" element silicon in FePdSi, as well as acknowledging the addition of "Y" elements "PC" to the "H" elements "Fe" and/or "Ni". (Grant TR 2882-2884).

53. The first important international conference on rapid solidification, referred to *as* RQ-1, was held at the University of Zagreb in Yugoslavia in 1970. This first conference was attended by about 50 people and generated tremendous interest. (Grant TR 2854-2855).

54. At the RQ-I conference a paper was given by Professor Duwez which subsequently was published as an article entitled "Liquid Quenched Metallic Metastable Alloys" in Fizika, Volume 2, Supplement 2 (1970), as pait of the con ference proceedings. (Grant TR 2855; Ex. P-249).

55. In the 1970 Fizika article (Ex. P-249), Professor Duwez also observed that ternary (three element) alloys or quaternary (four element) alloys are in general easier to quench into an amorphous state than binary (two element) alloys, providing the binary alloys have deep eutectics. This theory was called by Professor Duwez the "confusion principle." Another observation was that the amorphous alloys obtained by liquid quenching, which had been recorded in the literature to date, always contained a transition metal (the '513 "He elements) as a major constitutent from about 70 to 80 atom percent and a nonmetal such as boron, carbon, silicon, germanium, arsenic and phosphorous, again listing the subsequently separated '513 "Y" and "Z" elements all in one category. (Grant TR 2893-2896).

56. In 1971, a year after the publication of Professor Duwez article in Fizika, Yamaguchi and Nakagawa published an article in the Japanese Journal of Applied Physics describing the preparation of new amorphous alloys by a new technique of splat cooling. (Ex. P-394). These alloys included Fe80P13137, Co73 P15312 .Fe761117C7 and Ni75P15310•

57. Dr. Polk, a co-inventor of the '513 patent, published articles indicating his understanding and adoption of Professor Duwez' guidelines for formation of amorphous metal alloys. (Ex. P-374; Ex. P-378). Specifically,

in an article published in 1971 in Acta Metallurgica, 19, 1295, Dr. Polk and co-workers noted that glassy alloys formed by liquid quenching generally fell within the composition ranges 75-83 atomic percent noble or transition metal (the '513 "H" category) and 25-17Z metalloid, which he described as boron, carbon, silicon, germanium and phosphorous. (He did not distinguish between "Y" and "Z" elements as in the '513 patent.) (Ex. P-374). In another article, published in 1972 in Acta Metallurgica, 20, 485, he listed systems Which at that time had been produced in the glassy state. (Ex. P-378). In discussing the behavior of ternary alloys, he noted that all of the ternary alloys showed deep eutectics near 80Z transition metal.

In late 1971, Dr. Polk, a recent Ph.D. graduate, joined Allied Corporation. The first entry in his laboratory noteboOk, dated October 6, 1971, states:

> An investigation will be made having as its primary object the formation of metallic glass wire directly from the melt. Various metallic alloys 'which have in common a composition which is about BOZ transition or noble metal, and 20 atomic percent metalloid have been shown to exist as metastable glasses. These alloys are generally in the vicinity of eutectics and hence have the advantage that spinning can proceed at lower temperatures (the deep eutectic guideline)... Iron-carbon-phosphorous alloys (Fe-P-C, the '513 "MY" category) have previously been shown to form glasses directly from the melt. This study will concentrate primarily on iron based alloys (containing other metals" and metalloids) and will seek to determine which alloys are most suitable for spinning into • glass. Alloying elements to be considered include Cr, tin, Co, Hi, Cu and Al and metalloids such as B, C. Si, P & S (members of the subsequently. identified '513 "Y" and "Z" categories). (EMPlasis added).

(Ex. P-216).

59. The program set out on page 1 of Dr. Polk's notebook follows the guidelines suggested by Dr. Duwez and others in the references discussed above. No separation is made into "M", "Y" and "Z" classifications, and all the known metalloids are grouped together. (Grant *TR* 2897-2904). The listing of the elements reads horizontally from the periodic table. Moreover, Dr. Chen testified that in his earlier work on amorphous alloys he had substituted germanium for silicon in the gold-silicon system because it was next to silicon the periodic table. (Ex. P-1210, Chen Dep. TR 51-52). Silicon was also used because of its position on the periodic table. (Ex. P-1210).

60. The 1971-72 annual report of Dr. Polk (Ex. P-222) stated that past experience had shown that the best glass forming alloys for easy quenching were about 80 atomic percent metal, 20 atomic percent metalloid. The report further stated:

> The phase diagrams have been found to serve as an indication of which binary systems are likely to be glass formers as a binary alloy or-with the addition of a third element. Typically, there is a eutectic at about 20 atomic percent metalloid which is abnormally deep when plotted on a reduced temperature scale.

The report also recognized the "confusion principle" guideline of Professor Duwez, stating:

> Generally, suitable ternaries are better glass formers than the related binaries, etc. The primary reason for *this* is presumably the destabilization of crystalline phases when additional elements are added while entropic effects can stabilize the amorphous phase.

The metalloids stated by Dr. Polk to be of interest included boron, carbon, silicon, phosphorous, sulfur, germanium, arsaic and antimony, all listed by him without *division* into "Y" and "Z" categories. These metalloids were those known in the prior art to be glass formers. (Ex. P-222; Ex. P-249; Ex. P-1017). The report also stated that addition of silicon to Fe—P—C based alloys "was found to thermally stabilize the alloys, possibly partially because of the silicon *oxide* skin on the specimen." (Ex. P-222). This agrees with Dr. Turnbull's assessment that Felsch taught stabilization by inclusion of iron with silicon. (Turnbull TR 5590; Ex. P-1013).

61. Dr. Chen and Dr. Polk thus followed the teachings of the prior art in the amorphous metal alloys they actually prepared. These alloys contained between 70 and 83Z metal including iron, cobalt and nickel and about 17-30Z nonmetals or metalloids, including phosphorous, silicon, boron, carbon, germanium and antimony. (Grant TR 2897-2901, 2906-2908).

62. The MYZ formula set forth in the '513 patent is not found in the prior art. Chen and Polk did not prepare any amorphous metal alloys that were not within the prior art teaching. The amorphous metal alloys made by Chen and Polk are included in the prior art teaching as predictably easy to make amorphous as well as within the MYZ formula.

63. One stated object of the invention of the '513 patent was to provide amorphous metal alloy compositions which are readily quenched to the amorphous state and have increased stability. (Ex. P-433, col. -2, lines 58-60). The specification of the '513 patent states that selected alloys of the kind disclosed may be "more readily quenched in the amorphous state" and are "more stable" than known Fe-Ni-Co-based alloys. (Ex. P-443, col. 3, lines 47-51).

64. The specification of the '513 patent further states that:

> (t)he compositions within the contemplation of the piesent invention can be obtained in the form of ribbons or strips using the apparatus described in the above-mentioned references, Pond and Naddin, or that of Chen and Miller, or other techniques which are similar in principle. Further, wide strips or sheets can be obtained with similar quench techniques when the molten metal is squirted as a sheet, for example, rather than with an approximately round cross section. Additionally, powders of such amorphous metals where the particle size ranges from about 0.0004 to 0.010 inch can be made by atomzing the molten alloy to droplets of this size and then quenching these droplets in a liquid such as water, refrigerated brine, or liquid nitrogen.

(Ex. P-433, col. 3, line 58 - col. 4, line 4). The amorphous metal ribbons, strips and sheets are made by melt quenching techniques.

65. The specification of the '513 patent further states:

> In addition to the novel amorphous compositions described herein, the invention contemplated a novel article of manufacture in the form of amorphous metal wires of these alloys and others of the transition metal-metalloid type.

(Ex. P-443, col. 4, lines 17-20). These wires are made by melt quenching techniques. (Ex. P-443, col. 5, lines 48-65).

66. The '513 specification refers to liquid quenching in the "Background of the Invention" section: col. 1, line 31, line 40, and line 55; col. 2, line 12, and lines 60-61; col. 3, line 10, line 48, and lines 64-66; col. 4, line 24, line 39, line 53, and line 62; col. 5, line 38, and lines 48-66; col. 6, line 14, and Examples 1-17. (Ex. P-443; Allied Ex. 18).

67. Allied represented to the Patent Office that the essence of applicant's teaching was in ease of formation from the liquid melt and overcame the patent examiner's rejection of certain claims of the '513 patent based at least in part upon this representation. (Ex. P-444, Amendment of May 13, 1974, at 6).

68. In the first Office Action issued by the Patent Office during the prosecution *of* the '513 patent, the Examiner rejected claims 1-5 (originally claims 1, 2, 4, 6, 8 of the application) of the '513 patent under 35 U.S.C. 103 as unpatentable in view of U.S. Patent No. 3,427,154, issued February 11, 1969, to Nader. (Ex. P-444, Office Action of February 22, 1974). The Mader prior art reference was directed to vapor deposition of amorphous alloys. To counter *this* rejection, Allied argued:

> Moreover, the essence of applicants' teaching is to disclose and teach compositions which are unique in that they be easily obtained in the amorphous state. The alloys designated by applicants may be obtained by lower quench rates and thus enabling them to be produced with greater (more useful) thicknesses than other alloys processes. Mader, it is seen, teaches production, i.e. quenching of alloys by vapor deposition, a process which provides a quench rate which is unusable in cooling a liquid. The compositions listed by Mader are not glass forming when quenched from a melt. Vapor deposition and melt quenching are differences in *kind* . . . While vapor quenching as taught by Mader involves a means for production of amorphous compositions, it is apparent to one skilled in the art that it is entirely impractical and reasonably unrelated to the teaching provided by applicants of specific metal alloy amorphous compositions; compositions which can be made available in practical quantities from a melt of the desired compositions. (Emphasis added).

(Ex. P-444, Amendment of May 13, 1974, at 6-7).

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70. The purpose of the research upon which the invention disclosure of August 16, 1972, was based had "as its primary object the formation of metallic glass wire directly from the melt" and the determination of "which alloys are most suitable for spinning into a glass." (Ex. P-216, at 1; E P—I210, Chen Dep. TR 85-88).

71. The '513 patent claims read literally cover amorphous alloy compositions having no phosphorous ("P") as a "Y" metalloid. The '513 claims read literally cover alloy systems in which boron alone or carbon alone, without phosphorous, are "Y" metalloids which can be combined with an H and a Z element as defined by claim 1 of the '513 patent.

72. The only contemporaneous documentary evidence of any experimentation carried out by Dr. Ho—Sou Chen and Dr. Donald E. Polk, named inventors of the '513 patent, relating to the subject of that patent, is found in their laboratory notebooks (Ex. P-216; Ex. P-218), the invention disclosures (Ex. P-217), Dr. Polk's internal Allied Corporation annual report for August, 1971, to August, 1972, (Ex. P-222), and in two publications of the inventors dated in 1974 (Ex. P-253; Ex. P-81).

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74. **None of the alloys in the Chen and Polk notebooks, later classified in the '513 patents *as* "MYZ" alloys, have chromium as the sole or major elements subsequently identified as an "M" ingredient (e.g. Cr-P-C-Si); none of the alloys of the Chen and Polk notebooks, later classified in the '513 patent as "MU" alloys, have vanadium as an element subsequently identified as an [ft]e ingredient (e.g. V-P-C-Si). (Grant TR 2910-2911; Ex. P-216; Ex. P-218; Ex. P-1210A, Chen Dep. TR 33-37).**

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81. All of the alloys specifically exemplified in the '513 patent specification contain phosphorous in amounts between 10% and 18%.

82. None of the alloys specifically exemplified in the '513 patent specification contains vanadium as the sole or major constitutent. (Ex. P-443). All of the alloys specifically exemplified in the '513 patent specification contain four or more constitutent:; no ternary alloys are exemplified. (Ex. P-443).

83. There is no documentary evidence that either inventor ever prepared an alloy system that contained boron alone,• carbon alone, or boron in conjunction with carbon as the elements subsequently identified as."Y" elements. (Ex. P-216; Ex. P-217; Ex. P-218; Ex. P-222). All their experimental work was limited to phosphorous-containing alloy systems. (Grant TR 2900-2901; 2906-2907). There *is* no evidence in the record, other than the patent itself, that the inventors intended to have boron alone, carbon alone, or boron and carbon alone, as elements subsequently identified as "Y" metalloids.

84. There is no documentary evidence history that either inventor ever prepared an alloy system which contained vanadium, germanium, indium, tin, beryllium, or antimony, or contemplated a system which contained beryllium. (Ex. P_216; Ex. P_218; Ex. P-222; Ex. P-253; Ex. P-81; Grant TR 2901-2904).

85. There *is* no documentary evidence reflecting the origin of the ranges claimed in claim 1 of the '513 pate'nt or that either inventor ever performed experiments to determine whether compositions containing elements subsequently identified as "H", "Y", and "Z" constitutents would form amorphous metal alloys within the ranges claimed in claim 1 of the '513 patent. (Ex. P-216; Ex. P-217; Ex. P-218: Ex. P_222; Ex. P-253; Ex. P-81).

86. The entire teaching in the '513 patent of the "H", "Y", and "Z" constituents and ranges claimed in claim 1 are set forth substantially as claimed in column 3, lines 21 to 42, of the specifiCation without any further explanation. The only other discussion of the "H", "Y" and "Z" constituents and ranges can be found in column 6, lines 42 to 58, which set forth the same constituents for "M", "Y", and "Z" with much narrower ranges for the preferred embodiment of the invention. (Ex. P-443).

87. There is no support in the specification of the '513 patent for the limitation "at least 50 percent amorphous" for the "MYZ" elements in claim 1. (Ex. P-443). This limitation was added during the prosecution of the patent, in the Amendment dated Hay 10, 1974, in response to a rejection

of the Examiner based on indefiniteness. (Ex. P-444). The only mention of the "at least 50 percent amorphous" limitation in the specification *is* with respect to the metal wire of claim 6, compristhg an alloy of composition TX. (Ex. P-443, col. 6,.lines 24-34).

88. Claim 1 of the '513 patent claims a large number of alloys (Grant TR 2924-2925). The patent specification and file wrapper assert that these alloys can be readily quenched from the melt to a stable amorphous state. (Ex. P-443; Ex. P-444).

89. Claim 3 of the '513 patent claims the alloys of claim I "wherein up to about one-fourth of the metal H is replaced by elements commonly alloyed with iron or nickel." Examples of such elements- are given in the specification as No, Ti, Mn, U, Zr, Hf and Cu. (Ex. P-443, col. 4, lines 15-16).

90. Niobium *is* among those elements which are commonly alloyed with iron. (Turnbull TR 2240-2243).

91. There *is* no support in the specification of the '513 patent for the limitation "up to one-fourth of the metal H" as claimed in claim 3. (Turnbull TX 2340-2341).

92. The record *is* silent as to the person who *first* categorized the known glass formers P,B, C, Si,Ge and Sb into "Y" and "Z" categories. There was no evidence that anyone, with the exception of Allied for the purposes of the '513 patent, had ever categorized the glass formers into "Y" and "Z"

categories. (Grant TR 2925-2926; Turnbull TR 5692-5696). The record shows that subsequently the inventors, as well as Drs. Turnbull and Duwez, classified the "Y" and "Z" *glass* formers in one group. (Ex. P-11; Ex. P-721; Ex. P-725).

93. Allied has subsequently, in publications as well *as* in *its* patent, classified C-P-B-Si-Ge etc. as metalloids and glass formers in one category without distinguishing them as "Y" and "Z" categories. (Ex. P-11; Ex. P-169; Ex. P-348; Ex. P-359).

94. There is no alloy set forth in any of the inventors' notebooks, which corresponds to any of the examples in the patent. (Ex. P-688, Response to Interrogatory 115 of NSC).

95. Both Dr. Chen and Dr. Polk acknowledged that Allied Corporation did not own equipment for making amorphous alloys using the Pond-Naddin method. The patent suggests that amorphous alloys have been made by this method in Example 3. (Ex. P-1210, Chen Dep. TR 139-140; Ex. P-1224, Polk Dep. TR 134).

96. Neither Dr. Chen nor Dr. Polk performed the flash evaporation examples set forth in Examples 18-24. (Ex. P-I210, Chen Dep. TR 79, 134; Ex. P-1224, Polk Dep. TR 129-130, 134-136; Ex. P-1224A, Polk Dep. TR II-229r-230; Ex.P-1226, Cline Dep. TR 50-51).

97. The difference between the claims of the '513 patent and the prior art are the addition of known glass formers such as silicon, antimony, germanium, to known iron-phosphorous-carbon, iron-phosphorous-boron, and nickel-phosphorous-boron systems. (Grant TR 2910-2916).

98. A researcher with ordinary skill in the art in 1971 who wished to develop iron-based alloys for the formation of metallic glass wire directly from the melt would know that the following iron-based amorphous alloys containing "HY" and "HZ" elements had been previously prepared by melt quenching: iron-palladium-silicon, iron-phosphorous-carbon and iron phosphorous-boron. (Ex. P-1015; Ex. P-1017; Ex. P-394).

99. The researcher also would be aware of other amorphous alloys containing "HY" and "HZ" elements of first transition series metals, that had been formed by melt quenching, including cobalt-palladium-silicon, nickel-palladium-silicon, cobalt-phosphorous-boron, nickel-phosphorous-boron, cobalt-phosphorous, nickel-phosphorous, nickel-platinum-phosphorous, nickel-palladium-phosphorous, manganese-phosphorous-carbon, nickel-sulfur and nickel-boron. (Ex. P-394; Ex. P-1015; Ex. P-245). .

100. The researcher also would be aware that the addition of silicon to iron and cobalt substantially increased the crystallization temperature of the resulting amorphous alloy, and hence the thermal stability. (Ex. P-388; Ex. P-1013).

101. From an examination of the phase diagram of the binary iron, cobalt and nickel-silicon systems, the researcher would know that these alloys had good eutectic phase diagrams. (Ex. P-735).

102. The scope of the claims *of* the '513 patent extends beyond the alloy systems worked on by the inventors, r5th with respect to the constituent elements and the ranges of the atomic percentages of the constituent elements in the alloy compositions.

103. During the prosecution and pendency of the '513 patent in the Patent Office, Allied was aware that an alloy system within the scope of the "H_aYbZ_e" claimed categories was understood by the inventors to *be* fully crystalline. (Ex. P-222; Ex. P-253, p. 172).

104. This fact was known, or should have beep known, to the patent attorneys handling the filing and prosecution of the '513 patent. (Ex. P-1224A, Polk Dep.•TR II 64-65).

105. Allied did not disclose information to the Patent Office about the inoperability of compositions within the scope of the claims, although it was known to the inventors and should have been known to their attorneys while the application for the '513 patent was pending. (Ex. P-444).

106. Allied, in attempting to overcome a rejection of the Examiner on the overbreath of its claims, asserted that the applicants had conducted "rigorous experimentation" necessary to set forth the elements of the formula "H", "Y" and "Z" and the proportions recited in the claims. (Ex. P-444).

107. During the prosecution of the '513 patent application, the Examiner rejected claims 1 and 3 (claims 1 and 4 in the application as filed) "under 35 U.S.C. 112 in that the 'specification is non-enabling to support claims of the present scope which read on a plethora of alloys to be 'amorphous' but not disclosed, contemplated or discovered without undue, rigorous experimentation." (Ex. P-444, Office Action, of February 22, 1974, at p. 2).

108. To counter this rejection, Allied argued in an amendment to the Patent Office:

> The alloy combinations and proportions have been carefully selected after much experimental effort to provide a useful teaching to the art.
>
> * * *
>
> The specification describes the compositions that may be utilized by those skilled in the art to obtain the desired quenching conditions. As a matter of actual fact, the specific alloy combinations claimed by applicants obviate any undue experimentations because in naming the metals of the formula H, Y and Z and the proportions recited, the rigorous experimentatW *has* actually been conducted by applicants.

(Ex. P-444, Amendment of Hay 3, 1974, at pp. 3-5).

109. Dr. Chen had been employed by Allied Corporation in June, 1971; between March and April of 1972, he had decided to return to Bell Labs. (Ex. P-A, Chen Dep. 11/18/83 TR 137-138). His last notebook entries are

dated in 1972. (Ex. P-1210, Chen Dep.TR 67-68). Dr. Polk had been employed by Allied Corporation for approximately one year at the time the invention disclosure for the '513 patent application was filed (Ex. P-1224, Polk Dep. TR 27; P-217); the application itself was filed in the Patent Office some four months later on December 26, 1972. (Ex. P-444).

110. The evidence indicates that only about 33 alloy systems were tested, and that all were limited to additions of silicon and aluminum to high phosphorous containing systems, and that no program of rigorous experimentation was **carried out by the inventors to determine the ease of forming amorphous metal alloys by liquid quenching from the melt for the wide range of "MYZ" alloys claimed in claim 1 of the '513 patent. (Grant TR 2901-2914; Turnbull TR 2272-2273; Ex. P-443; Ex. P-216;** Ex. **P-218; Ex. P-222).**

111. At a minimum, no program of rigorous experimentation was carried out on: a) chromium, vanadium "M" alloys; b) alloy systems with "carbon" alone or boron alone or carbon and boron *as* **"Y" elements; or** c) **alloy systems with tin, antimony, germanium, indium, or beryllium. (Ex. P-216, P-218).**

112. Of the alloys apparently prepared by Dr. Chen and Dr. Polk, some could not be made amorphous by melt quenching methods available to them and they knew of this fact. These crystalline alloys included at least Feye 18A14 and Ni781^{2}18A14. (Ex. P-216; Ex. P-218; Ex. P-253).

113. In his annual report for August, 1971, to August, 1972, Dr. Polk stated: "Alloys of composition $(Fe_{100-x}Ni_x)_{70}18A14$ were quench rolled. The pure iron and pure nickel *alloys* had very well.defined crystallinity. (Fe87Ni13)78P1014 and (Fe13Ni87)781[1]18A14 had diffraction patterns which were markedly less crystalline while $(Fe50Ni50)78P18A1_x$ was only slightly crystalline." (Ex. P-222, at 7). August 1972 was the month the '513 invention disclosure document *was* submitted.

114. Dr. Polk, in using the term "well—defined crystallinity" in the internal Allied report, was equating this term with "fully crystalline." (Ex. P—I224A, Polk Dep. TR II-91).

115. In a publication (Ex. P-253) approved by the Allied Patent Depart ment (Ex. P71224A, Polk Dep. *TR* 11-88), submitted to the Journal of Non—Crystalline Solids on December 19, 1973, during the pendency of the '513 patent application in the Patent Office and published in 1974, presumably prior to the issuance of the '513 patent on December 24, 1974, the inventors stated: "The stabilization of the amorphous phase upon mixing Fe and NI, discussed previously for $(Fe_x tiii_{-x})$ *77P1436A13, appears to* be a general effect. Though quenched Fe78118A1A and $Ni78P_{18}Al_4$ were fully crystalline, quenched Fe39Ni39P18A4 *was* primarily amorphous." (Emph*asis* added). (Ex. P-253).

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118. Following this failure, Allied decided to attempt to prepare the required alloys by'sputtering. (Ex. P-207; Ex. P-209). Sputtering is not liquid quenching, and is a technique requiring special equipment and very high energies, resulting in very thin films which are adhered to a substrate. (Grant TR.3011-3013, 3024-3026). The Massachusetts Institute of Technology, a private consultant (Mr. Lane), and Varian Associates were asked by Allied to assist in making the requested alloys by sputtering. (Ex. P-207; Ex. P-209; Ex. P-1217A, DeCristofaro Dep. TR 106-107).

119. During March of 1980, sputtering facilities were identified by Allied and attempts to make sputtering targets for these three "MYZ" alloys by the technique of arc melting failed. At least two other companies,

Varian Special Metals and Fiber Materials Associates, were asked by Allied to make the sputtering targets by powder metallurgy, hot pressing techniques. Both companies told Allied they were reluctant to hot press the phosphorous-containing alloys.. (Ex. P-209; Ex. P-1217A, DeCristofaro Dep. TR 106-109).

120. During March of 1980, magnetron sputtering facilities were identified at Millis' Research Inc. for possible magnetron sputtering of the "MYZ" alloys. Millis's sputtering gun, however, required a six-inch diameter target for each "MYZ" alloy composition; such targets were reportedly difficult to fabricate. Accordingly, a search was instituted to seek a sputtering gun which would accept a smaller target. (Ex. P-209; Ex. P-1217A, DeCristofaro Dep. TR 106-109).

121. Because of the sputtering problems, in April of 1980, an attempt was made at the California Institute of Technology to liquid quench, by the Duwez splat quenching gun technique, the Fe-C-Sb and Cr-P-Al alloys. The splat quench techniques failed to make the Fe-C-Sb and Cr-P-al alloys amorphous. It was reported that the V-B-Ge "MYZ" alloys could not be melted in the splat quench apparatus. (Grant TR 3023-3026; Ex. P-210; 1 Ex. P-1217A, DeCristofaro Dep. TR 125-127).

122. In May and June of 1980, sputtering again was considered and GTE Sylvania was asked by Allied to make the sputtering targets of the requested "MYZ" alloys. (Grant TR 3026-3029; Ex. P-211; Ex. P-1217A, DeCristofaro Dep. TR 127-129).

123. On July 3, 1980, it was reported that glassy films of the Cr-P-Al, Fe-C-Sb and V-Ge-B HYZ alloys were made by physical sputtering. The deposition of sputtered films on water cooled metallic glass (amorphous) substrates were reported *as* successful. (Ex. P-1172, Ex. P-1217A, DeCristofaro Dep. TR 131-133).

124. These chromium-phosphorous-aluminum, iron-carbon-antimony and vanadium-boron-germanium alloys are within the compositional ranges *of claim* 1 of the '513 patent, but, as shown by Allied's experimental program, they are not easily quenched to the amorphous state and cannot be formed by melt quenching. (Ex. P-207 through Ex. P-213; Ex. P-1172; Ex. P-1217A, DeCristofaro Dep. TR 104-109, 125-131).

125. Extensive research and experimentation was necessary by Allied in order to prepare these "HYZ" alloys. The specification of the '513 patent does not teach a person of ordinary skill in the amorphous metals art how to make amorphous alloys without undue experimentation in the iron-carbon-antimony, chromium-phosphorous-aluminum and vanadium-boron-germanium alloy systems as claimed in claim 1 of the '513 patent.

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128. Fe—C—Si alloys within the scope of claim 1 of the '513 patent, having less than 1% Si, could not be made amorphous by Allied's 1981 casting techniques. (Ex. P-174, Ex. P-1220B, Rasegawa Dep. TR 157-161). If these Fe—C—Si alloys could not be melt quenched in 1981, they could not be made by melt quenching techniques available in 1972.

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132. Extensive research and experimentation vas necessary in order to prepare these "lin" alloys by cryosputtering. (Ex. P-323; Ex. P-1218, Liebermann Dep. TR 119-120). The specification of the '513 patent does not teach a person of ordinary skill in the amorphous metals art to make, without undue experimentation, amorphous alloys in the iron-carbon-silicon and iron-carbon-aluminum alloy systems as claimed in claim 1 of the '513 patent.

133. These iron-carbon-silicon and iron-carbon-aluminum alloys cannot be prepared in the amorphous ntate by melt quenching techniques. (Ex. P-323; Ex. P-733; Ex. P-1218, Liebermann Dep. TR 120).

134. Allied consistently has taken the position in the Patent Office, in seeking later patents on specific alloy systems, that the '513 patent was merely a "shotgun approach" to amorphous metal technology (Ex. P-437, Amendment of October 23, 1978, at 4; Ex. P-8, Amendment of July 21, 1976, at 6; Ex. P-I2, Amendment of June 28, 1976, at 4; Ex. P-17, Amendment of January 30, 1978, at 5; Ex. P-19, Amendment of August 15, 1978, at 4; Ex. P-30, Amendment of September 25, 1978, at 5, Amendment of June 28, 1979,

at 5; Ex. P-36, Amendment of October 22, 1980, at 3), and that the specific alloy systems which Allied then sought to patent could not be defived from the teachings of the '513 patent without "undue" or "an inordinate amount" of experimentation (Ex. P-12, Amendment of February 12, 1976, at 6, Amendment of June 28, 1976, at 4; Ex. P-437, Amendment of October 23, 1978, at 3; Ex. P-8, Amendment of July 21, 1976, at 6; Ex. P-17, Amendment of January 30, 1978, at 4; Ex. P-19, Amendment of August 15, 1978, at 4; Ex. P-13A, Amendment of February 10, 1976, at 5; Ex. P-25, Amendment of July 18, 1977, at 4; Ex. P-30, Amendment of September 25, 1978, at 3-4, Amendment of June 25, 19/9, at 5; Ex. P-36, Amendment of October 22, 1980, at 3), and that the '513 patent "teaches away" from the specific alloy systems disclosed in the later patents. Several of these alloy systems are within the now asserted coverage of the '513 patent claims (P-38, Amendment of March 25, 1982, at 3-4).

135. For example, on June 6, 1975, six months•after the issuance of the '513 patent, Allied sought to patent specific "MYZ" compositions within the range of the '513 patent claims, but without phosphorous as a "Y" metal-

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loid, e.g., Fe77(315C5)(Si1Al2). (Ex. P-11). During the prosecution of U.S. Patent No. 4,052,201 to Polk et al. (a co-inventor of the '513 patent), Allied, in countering the Examiner's rejection of the '201 patent claims in view of the '513 patent, argued that the "amorphous alloys specifically disclosed by (the '513 patent) ... do not include boron as the major or sole metalloid..." Allied took the position that "even with (the '513 patent) ... before him, it would take undue experimentation for one skilled in the art to derive the specific boron-containing alloys claimed by applicants." (Ex. P-12, Amendment of February 12, 1976, at p. 6, Amendment of June 28, 1976, at p. 4).

136. Allied further stated with respect to the Examiner's rejection:

> It is pointed out that none of the examples of (the '513 patent)... involve alloys containing boron as the major or sole metalloid element. Moreover, there is no teaching in (the '513 patent) that eliminating phosphorous from a small group of metalloid elements (boron only or boron plus minor amounts of carbon, silicon and/or aluminum) substantially improves the resistance to embrittlement upon heat treatment...

(Ex. P-12, Amendment of February 12, 1976, at p. 6).

137. Recently, Allied again maintained the interpretation of the '513 patent as limited to two metalloid "Y" elements, one of which is phosphorous. U.S. Patent No. 4,389,262 to Tanner at al., filed December 31, 1980, is directed to a nickel-boron-aluminum (Ni-B-A1) "MYZ" amorphous metalalloy with "N" compositional ranges, as claimed in claim 2 of this patent, within the range of "N" components in claim 1 of the '513 patent. (Ex. P-37). Allied argued in order to overcome the rejection based on the '513 patent:

> The examples of the '513 Patent can be further distinguished from the alloy of the present invention in that all of the examples set forth in the '513 patent which have Al as one of the constituents have at least two metalloids from the "Y" elements (P, C, B). This further teaches away (emphasis added) from compositions claimed in the present application wherein only a single metalloid (emphasis in original), B, is claimed.

(Ex. P-38, Amendment of March 25, 1982, at 4).

138. The atomic percentages of aluminum (Al) in the '262 patent *is* defined as 5 to 25 atomic percent. (Ex. P-37). In an effort to overcome the Examiner's rejection based on the '513 patent, Allied argued:

> It should also be pointed out that there are no examples in the '513 Patent which have Al levels in the range of Al levels claimed by the present invention. The maximum level taught by the examples of the '513 Patent is 3% Al, while the present application claims a minimum of 5% Al. Thus, one skilled in the art would be led away from the present invention by the teaching of the '513 Patent. (Emphasis added).

(Ex. P-38, Amendment of March 25, 1982, at 3).

139. Allied further argued with respect to the '513 patent:

> Therefore the '513 Patent teaches away from the composition of the present invention (the '262 patent) since the examples in the '513 Patent indicate that Al levels substantially below those claimed in the present invention are effective. (Emphasis added).

(Ex. P-38, Amendment of March 25, 1982, at 5).

140. U.S. Patent No. 4,152,147 to Hasegawa et al. (Ex. P-173) is directed to an iron-boron-beryllium (Fe-B-Be) amorphous metal alloy system within the scope of the claims of the '513 patent. Encountering the rejection of the Examiner based in part on the '513 patent, Allied argued in the Patent Office:

> It is emphasized that none of the examples of (the '513 patent)...points to classification of alloys containing the specific ranges for iron, boron and beryllium called for by applicant's claims 1-6. Even with (the '513 Patent)... before him, it would take <u>undue experimentation</u> for one skilled in the art to derive the specific alloys claimed by applicant's ('147 Patent). .(Emphasis added).

(Ex. P-437, Amendment of October 23, 1978, at 3).

141. Allied further argued to the Patent Office, "Selection of applicant's ('147 patent) alloys and specific proportions from the <u>myriad of alloy compositions</u> taught by these patents would require <u>an inordinate amount of experimentation</u> by one having ordinary skill in the art." (Emphasis added). (Ex. P-437, Amendment of October 23, 1978, at 4).

142. The do'cumentary evidence in the record establishes that the actual work done by the inventors before the '513 applLcatIon was filed was limited to phosphorous-containing alloys.

143. In addition to ease of formation by quenching from the *liquid melt,* the '513 patent also teaches that the claimed amorphous alloys are more thermally stable:

> Selected alloys of the kinds disclosed above may be relatively more consistently and more readily quenched to the amorphous state than previously thought possible with known Pe-Ni-Co- based alloys. Moreover, these

> alloys are more stable; upon heating, they show the thermal manifestation of the glass transition (a sudden increase in the specific heat) while previously known Fe-Ni-Co- based alloys do not. Typically, amorphous *alloys* which show this thermal manifestation of the glass transition are more readily obtained in the amorphous state than amorphous alloys which do not.

(Ex. P-443, col. 3, lines 48-57).

144. U.S. Patent No. 4,152,147 to Hasegawa et al. expressly discloses that alloy compositions within the scope of claim 1 of the '513 patent are crystalline rather than amorphous:

> The concentration of Be (beryllium) is constrained by two considerations. Addition of about 2 atom percent beryllium results in an increase of greater than 20°C in both Curie and crystallization temperatures of the base iron-boron glassy alloy, while greater than about 10 atom percent beryllium results in formation of crystalline rather than glassy material. (Emphasis. added).

(Ex. P-173, col. 2, lines 52-58).

145. The '147 patent shows an initial increase in thermal stability, as measured by crystallization temperature, upon substituting small amounts of beryllium for boron. As the amount of beryllium is increased, however, the thermal stability decreases and becomes less than that of the pure iron-boron system. (Grant TR 2963-2966; Ex. P-173, Fig.1).

146. Claim 1 of the '513 patent claims alloys containing between 0.1 and 15% beryllium. (Ex. P-443, col. 10, lines 20-25). Within the range claimed as the invention, these alloys must demonstrate at least one objective of the invention.

147. The alloys of the '147 patent demonstrate decreased thermal *stability* where beryllium is greater than 6 atomic percent. (TR 2967-2969, Ex. P-173). These alloys do not exhibit the stated property of increased thermal stability of the '513 patent but are nonetheless within the range of claim 1 of the '513 patent. (Ex. P-443, col. 10, lines 20-25). Moreover, alloys having more than 10 percent beryllium are crystalline and not amorphous. Neither objective of the invention is demonstrated by this alloy. (Ex. P-173, col. 2, lines 56-58).

148. U.S. Patent No. 4,052,201 to Polk et al. shows in Table 2 that certain "MY" alloys may have higher crystallization temperatures, and therefore greater thermal stability, than "MYZ" alloys. (Grant TR 2978-2980; Ex. P-11, col. 6, lines•44-58).

149. The publication of Dr. Luborsky of General Electric shows that variations in composition in both the "M" and "Y" elements increase thermal stability by producing higher crystallization temperatures that are solely dependent upon changes in the compositional range of the "N" and "Y" components. (Grant TR 2980-2981; Ex. P-745).

150. Claim 1 of the '513 patent provides for "MYZ" alloys containing "2" in amounts from 0.1 atomic percent to 15 atomic percent; the "Z" elements claimed include beryllium. (Ex. P-443; col. 10, lines 20-25). Therefore, claim 1 reads upon some alloys that do not meet any objective of the invention.

151. The '262 patent to Tanner is directed to nickel-boron-aluminum alloys in which aluminum *is* present in amounts between 5 and 25 atomic per-cent. The ranges of nickel and boron claimed in claim 2 of the '262 patent are within those of "M" and "Y" in claim 1 of the '513 patent. (Grant TR 2971-2973; Ex. P-37).

152. The upper range limit of 15% for the Z constituent does not teach a person of ordinary skill in the art which alloy compositions within the prescribed range of claim 1 will or will not form amorphous alloys, or which alloy compositions outside the range of the '513 patent will form amorphus alloys. Therefore, the specification and claims of the '513 patent do not teach a person of ordinary skill in the art the ranges of atomic percentages of constituents that will result in amorphous alloys.

153. The specification of the '513 patent does not teach which alloys can be made by melt quenching, and does not teach'.how to make many of the alloys disclosed in the claims by any means. (Ex. P-443).

154. The examples in the '513 patent only disclose the addition of "Z" elements in a range between 2 to 5 atomic percent and do not teach the critic-ality of the 0.1 to 15 atomic percent specified for "Z" additions set out in claim 1 of the '513 patent. (Ex. P-443).

155. The '513 patent does not disclose any specific ternary MYZ alloys. (Grant TR 2900-01, 2914-2923; Turnbull TR 2272-2273; Ex. P-443; Ex.-1210A, Chen Dep. TR 22-23).

Infringement of the '513 Patent

Nippon Steel Corporation (NSC)

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160. Nippon Steel Corporation has infringed claims 1, 2 and 4 of the Allied '513 patent, if that patent is valid.

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162. Neither Chen nor Polk did any magnetic work with respect to the development of their alloy compositions which form the *basis* for the '513 patent. Drs. Chen and Polk made no magnetic measurements such as magnetization, magnetostriction, coercivity, core loss, or magnetic anisotropy on the alloys they developed or for use as input in alloy composition development. (Ex. P-1010A, Chen Dep. TR 64; Ex. P-1224, Polk Dep. TR 11).

163. Prior to the '573 patent application, neither Chen nor Polk did any work on an alloy system which had boron as the major non-metal component. Polk distinguished the '513 patent...from a boron metalloid system in the file history of his later '201 patent. (Ex. P-123; Ex. P-216; Ex. P-218).

164. In this later '201 patent, Polk stated: "In accordance with the present invention, the resistance to embrittlement upon heat treatment of these alloys in the temperature range of about 200° to 350° C for several minutes is improved by replacing phosphorous with boron or boron plus at least one of the metalloid elements of carbon, silicon and aluminum." (Ex. P-11 col. 3 line 67 through col. 4 line 4).

165. Allied initially offered as an amorphous magnetic alloy an "MY" alloy system which was not covered by the '513 patent and which included phosphorous as the major non-metal component. (Ex. P-168, p. 4660, col. 1).

166. In the late 1970's, others pointed out that phosphorous was detrimental to amorphous metal alloys used for magnetic applications. Allied in the late 1970's turned to non-phosphorous containing alloy systems. (Ex. P-45; Ex. P-169).

167. In the late 1970's and early 1980's Allied filed patent applications in the Patent Office claiming Fe-B-Si and Fe-B-Si-C alloy compositions for magnetic applications in the names of inventors other than Chen and Polk. U.S. Patent No. 4,219,355 (Ex. p-27) issued in the name of DeCristofaro et al. and is directed to Fe-B-Si-C alloys.

VACUUMSCHMELZE

168. Vacuumschmelze (VAC) has imported into the United States amorphous metal alloy ribbon or strip of varying widths having the following chemical compositions:

(1)	6025
(2)	6025F
(3)	6025X
(4)	6025Z
(5)	6030
(6)	6030Z
(7)	4040
(8)	4040F
(9)	40402
(10)	0080
(11)	6010
(12)	E6010

(VAC's Interrogatory Responses 4, 5, 7, 20, 39-41, 56; 57, 59, 60, 79, 91, 98, 99 and 104 of Phys. Ex. 515; Stipulations 51-62 of Phys. Ex. 656; Allied Phys. Ex. CC(13)—(17).

169. Each 0080, 6010 and E6010 amorphous alloy strip or ribbon imported into this country by VAC infringes claims 1 and 4 of the '513 patent in suit. (Turnbull TR 2254-2258).

170. Each such amorphous metal alloy strip or ribbon imported into this country by VAC has the formula M_aYbZ_c wherein "M" *is* either nickel (Ni), or

a mixture of cobalt (Co) and iron (Fe), or a mixture of iron and nickel, or a mixture of cobalt and nickel, or wherein up to about one-fourth of.the metal "H" is replaced by elements commonly alloyed with iron or nickel, "Y" is in each instance boron (8), and "Z" is in each instance silicon (Si). (Turnbull TR 2254-2258).

170. Molybdenum (Mo) and manganese (Mn) are elements commonly alloyed with iron or nickel. (Turnbull TR 2254-2258; Phys. Ex. 18 at col. 4, 1. 10-16).

171. Dr. Hilzinger received his undergraduate degree in physics' in 1972 from the University of Stuttgart, and received his doctoral degree in 1975 from the Max Planck Institut of Metal Research in Stuttgart in the area of magnetism and magnetic materials. (Hilzinger TR 3535-3536). Dr. Hilzinger *is* currently employed by VAC as the head of the laboratory for special metallurgy within the research and development department of VAC. CRilzinger TR 3536).

172. When Dr. Hilzinger was first employed by VAC in 1976, he was assigned two tasks: the development of semiconductors, and development and research work in the area of amorphous metals. (Hilzinger, TR 3536).

173. In the area of amorphous metals, Dr. Hilzinger was first asked at VAC to complete the construction of small test equipment to produce samples of amorphous materials, to look at the properties of the samples, and to look at different **compositions_** (Hilzinger TR 3537).

174. The composition for VAC's amorphous alloy 0080 shown in Allied Phys. Ex. CC(16) *is* (16) is in error, and the true composition is 1 (Hilzinger TR 3563).'

175. Although VAC cannot attain exactly the stated compositions for the above alloys, there always being some small deviation, VAC has carefully examined the composition of the cast alloys and has found that the deviations are at most some tenths of a percent. (Hilzinger TR 3564).

176. VAC's amorphous metal customers are interested in the physical properties of such material, mainly soft magnetic properties and zero magnetostriction. Soft magnetic properties in which VAC's customers are interested are magnetic separation induction, Curie temperature, magnetic permeability, corrosive field, magnetic losses, and electrical resistivity. Mechanical properties such as ductility are also important to VAC customers. (Hilzinger TR 3591).

177. The property of magnetic permeability depends upon several factors in order to achieve high permeability. The magnetostriction must be as close to zero as possible, the Curie temperature should not be too large, because in order to obtain a high permeability VAC must anneal the amorphous material, and such annealing treatments are favorably done if the temperature range between the Curie temperature and, for amorphous material, below the crystallization temperature. (Hilzinger .TR 3592-3593).

178. Magnetic permeability *is* the ratio between the induction of the magnetic material and the magnetic field apptied to obtain *this* induction. (Hilzinger TR 3591).

179. A high initial permeability means that the highest induction is obtained with the lowest applied magnetic field possible. (Hilzinger TR 3592).

180. The Curie temperature of a material is the temperature at which the material no longer *is* ferromagnetic, and defines the transition from ferromagnetic status to paramagnetic status. (Hilzinger TR 3593).

181. The crystallization temperature of a material is the temperature above which the atoms *of* the material rearrange and, if the material is amorphous, the material becomes crystalline. (Hilzinger TR 3593-3594).

182. For annealing amorphous materials, the Curie temperature, above which the amorphous material should be annealed, must be below the crystallization temperature in order to avoid crystallizing the material during annealing. (Hilzinger TR 3594).

183. The Curie Temperature is affected by all of the five elements in VITROVAC 6025. (Hilzinger TR 3594).

184. Silicon, with the exception of iron, is the least expensive raw material utilized in VAC's amorphous alloys, while boron is the most expensive, silicon costing between $2 and $4 per kilogram and boron costing more than $100 per kilogram. (Hilzinger TR 3605).

185. Both boron and silicon decrease the Curie temperature in VITROVAC 6010. Silicon does so to a greater degree. The same amount of silicon and boron affects the ductility or brittleness of the material so that by using less silicon more favorable ductility is achieved. (Rilzinger TR 3616).

186. All VAC's VITROVAC amorphous alloys contain the elements boion and silicon because the best properties are obtained with those elements. Phosphorous, which *also* results in easy glass formation, has undesirable effects on ductility and on the thermal stability of the magnetic properties. (Hilzinger TR 36323633).

187. VAC began investigating the use and manufacture of amorphous metal alloys in the middle 1970's because it had at that time become known that such materials had soft magnetic properties. (Warlimont TR 3378).

188. In the middle 1970's, VAC first obtained amorphous materials *from* outside sources for the purpose of studying their properties and to investigate heat treating such material to optimize existing properties. (Warlimont TR 3379).

189. VAC only entered into the technology of making ribbons in detail for technological development after Dr. Warlimont's arrival at VAC in 1977. (Warliment TR 3379).

190. Although VAC has decided to export only VITROVAC 6025 to the United States, VAC has sent samples of other amorphous compositions to potential customers in the United States because (1) in many instances those customers said that they could not obtain the specific alloys they wanted from any other source in the United States and (2) VAC was earlier hopeful that a license agreement with Allied could be reached which would permit VAC to supply such material in the United States. (Warlimont TR 3381).

191. VITROVAC 6010 is no longer being produced or sold by VAC. (Warlimont TR 3454).

192. In claim 1 of the '513 patent, the range for the Z component is "about 0.1 to 15 atomic percent." (Ex. P-245).

193. There are no statements in the specification of the '513 patent which provide a teaching as to how much, if at all, the stated percentage ranges in claim 1 of the patent may be varied while still practicing the invention as set forth in the specification. (Phys. Ex. P-245).

194. The only component range limitations for an MYZ composition found in the '513 patent are the literal ranges set forth in the claims of that patent. (Phys. Ex. P-245, Claim 1).

195. VAC's VITROVAC 6025 amorphous alloy *is* not. literally within the scope *of* any asserted claims of the '513 patent. (Ex. P-245, Allied Phys. Ex. CC(13)).

196. VAC's amorphous metal alloy VITROVAC 6030 *is* not literally within the scope of coverage of any asserted claims of the '513 patent. (Ex. P-245, Allied Phys. Ex. CC(14)).

197. VAC's amorphous metal alloy VITROVAC 4040 is not literally within the scope of any asserted claim of the '513 patent. (Tx. P-245, Allied Phys. Ex. CC(15)).

HITACHI

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are elements commonly alloyed with iron or nickel. (Turnbull TR 2240-2254, 2315 and.5646-5648; Allied Ex. 18 at col. 4, 1.

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203. No iron-based amorphous metal alloy has been exported to the United States for the purpose of sale by Hitachi Metals (Reaps' Ex. P-1215A; 11-35). HHL delivered only two small evaluation samples of amorphous metal material to General Electric Company more than two and one-half years ago, the first in Japan in November, 1979 (1.5 kg), and the second in the *United* States in July, 1981 (0.5 kg). (Allied Ex. 514, Answers of HMI. to First Set of Interrogatories No. 6).

204... Hitachi Metals does not have any iron-based amorphous metal alloy for use in distribution transformers. (Ex. Pr121613, p. V-15).

205. CH-139, a cobalt-based amorphous metal alloy, exists in the form of a flat sheet of ribbon. (TR 3832-3833).

206. ACO and ACO-S, cobalt-based amorphous metal alloys, exist in the form of wound cores. (TR 3632-3833).

207. A core of ACO and ACOI-S comprises a wound tape having a shape similar to a doughnut with a hole¯in the center. (TR 3834).

208. ACO-type materials are used as cores for switch mode power supplies for electronic equipment which requires stabilized and constant voltage. (TR 3834).

209. 1CH-139, ACO and ACO-S all have the same chemical composition and the chemical composition in atomic percent is C°71.48 ^{Fe}0.50^{4} 5.95$^{141/}$0.31 138.75Si13.6. (TR 3832, C.P.Ex. CC-9 and CC-10).

210. ACO-SSS has a different chemical composition from CM-139, ACO and ACO-S, and the chemical composition in atomic percent is Co69.19Fe0.50 lin6.2584.308.75Sii5.0• (TR 3832, C.P. Ex. CG-11).

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212. The only disclosure in the '513 patent specification concerning claim 3 is at column 4, beginning at line 5, wherein it is stated:

> **The alloys discussed above in each case are made from the high purity elements, however, in the utilization of these alloys, it is anticipated that the alloys would be made from the less expensive commercially available materials which would have <u>small amounts</u> of other elements in solution. Thus, the alloys contemplated by the invention** mat **<u>contain fractional amounts</u> of other elements which are commonly found in commercially available Fe or Ni alloys, for example, either as a result of the source of the primary metal or through a later addition.**

(Emphasis added). (Ex. P-443, Col. 4, lines 5-15). The disclosure *is* to small amounts of impurities being present. (Ex. P-1224, at 126-127).

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214. Dr. Chen and Dr. Polk made no magnetic measurements such as magnetization, magnetostriction, coercivity, core loss, or magnetic anisotropy on the alloys they developed or for use as input in alloy composition development. (Ex. P-12248, at 11, 53-54).

215. In the late 1970's, Dr. Luborsky at General Electric pointed out that phosphorous was detrimental to amorphous metal alloys used for magnetic applications. (Ex. P-45, p. 1, lines 38-40).

216. Professor T. Masumoto *is* a professor at the Research Institute of Iron, Steel and Other Metals (ICINICEN) at Tohoku University, Sendai, Japan, and an advisor to the Research Institute of Electrical and Magnetic Alloys (DENJIKEN). (TR 1913, 1935, 1950-1951).

217. In 1969, Professor Masumoto modified equipment referred to as a "Pond—Maddin" apparatus used in producing metal alloys in the crystalline state. Among the modifications made to this equipment so it could be used to produce metal alloys in the amorphous state were the use of a gas other than oxygen to avoid oxidation of the samples and an increase in the speed of rotation of the chill surface from a low speed of rotation to a high speed of rotation of approximately 5,000 RMS. (TR 1923-1924).

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241. The Curie temperature *is* a temperature above which a magnetic material loses its magnetic properties. (la 3835).

242. Curie temperature is a temperature specific to the composition of an amorphous metal alloy. (Ex. P-1215; TR 40-41).

243. The temperature of crystallization *is* the temperature at which an amorphous material changes into crystalline material. (T1 3836).

244. Amorphous metal alloys have different mechanical, electrical and magnetic properties depending upon their composition. (Tr 2319-2324, 3844, 3845; Ex. P-1015, at 624, 629-630).

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TDK

287. TDK Corporation has imported into the United States amorphous metal alloy ribbon having the chemical composition: $Fe_{76.7}B_{7.67}Si_{15.6}$. The atomic percentages for boron and silicon (the Y and Z elements) are outside the ranges claimed in the '513 patent. (TDK Supplemental Interrogatory Response 82, Allied Ex. 518). This composition does not infringe the '513 patent, if that patent is valid.

288. Based on sanctions imposed on respondent TDK Electronics Corporation, it is found that this respondent has the capacity to make and to import into the United States sufficient amorphous metal alloy covered by the '513 patent to have the tendency to injure Allied's domestic industry, and that it has imported amorphous metal alloys into the United States that are not within the license granted by Allied to TDK, and that infringe the claims of the '513 patent, if that patent is valid. (Allied Ex. 657, Order No. 32).

Validity of the '257 Patent

289. On October 22, 1967, Allied filed' in the Patent Office a patent application entitled "Continuous Casting Method for Metallic Strips," naming Mandayam C. Harasimhan *as* the inventor (Ex. P-294). The application (assigned Serial No. 734,776) included claims to an "apparatus for making continuous metal strip" (Claims 1 to 11), a "method of forming amorphous metal strip" (Claims 12 to 19), and a "strip of amorphous metal" (Claims 20 to 23). The Examiner required Allied to elect to prosecute only ode of the three groups of claims for immediate prosecution, and Allied chose to pursue the apparatus claims. In July of 1977, the Examiner rejected all of the apparatus claims as obvious in view of prior art patents. In October of 1977, Allied abandoned application Serial No. 734,776.

290. Prior to abandoning the original application, Allied filed a continuation—in—part (CIP) application on August 2, 1977 (Serial No. 821,110). This application added new material to the patent specification, including five examples of operation of the process. This CIP application contained the same three groups of claims as the original application. Again the Examiner required Allied to elect only one of the three groups of claims for immediate prosecution, and Allied chose to•prosecute the apparatus claims.

291. In April, 1978, the Examiner rejected all of the apparatus claims as obvious in view of prior art patents. In trying to overcome these rejections, Allied argued in July, 1978:

> The critical dimensions of the slotted nozzle, its slotted nozzle, its spaced relationship with respect to the chill body, in combination with the critical parameters of chill surface veldcities within the above stated range are what makes possible production of the above described metal strip, which heretofore could not be produced by known apparatus. (Emphasis added).

292. These critical dimensions were described as follows:

> The slot is defined by a pair of generally parallel lips, a first lip and a second lip, numbered in direc tion of movement of the chill surface. Slot widths, measured in direction of movement of the chill -surface, and the width of the lips, and the gap between the lips and the chill surface are all critical dimensions, and are all critically interrelated. (Emphasis added).

(Ex. P-448).

293. On March 6, 1979, the '571 apparatus patent (Ex. P-447) issued with 11 claims to an apparatus for casting amorphous metal strip. Each claim included dimensions for the width of the lips.

294. On October 10, 1978, Allied filed Application Serial No. 949,839 as a division of Application Serial No. 821,110. (Ex. P-450). A preliminary amendment cancelled the apparatus claims from this divisional application. Prosecution began with claims 12 through 21 directed to a casting method and

claims 22 through 25 directed to a strip of amorphous metal. In April of 1979, all of the claims in the application were rejected by the Examiner. The method claims were rejected as obvious in view of prior art patents, and certain of the method claims were rejected as vague and indefinite.

295. On August 17, 1979, Allied submitted an amendment cancelling all of the method claims in the application and submitting a new set of method claims. Allied argued that the new method claims were patentable over the prior art because (1) prior art did not teach use of a slotted nozzle, and (2) prior art did not teach the "close spacing between a nozzle and a chill surface." (Ex. P-450).

296. Allied argued that the strip claims were distinct from the prior art because they were directed to "amorphous metal strip having a width of at least about 7 mm and having isotropic tensile properties, that is to say, having identical tensile strength and elongation measured in the traverse (sic - transverse), as well as in the longitudinal direction, or in any direction therebetween." (Ex. P-450, Amendment of August 17, 1979 at 6-7).

297. Following an interview with the Examiner, Allied submitted a further supplemental amendment on October 15, 1979., GEx. P-450). The Examiner had indicated that certain limitations needed to be incorporated into Allied's independent method claim 26 to describe the applicant's invention. Allied then stated that:

> The amendment incorporating the limitations of claim 29 into claim 26 was made at the suggestion of the Examiner to further distinguish over the art of record. During the interview, the Examiner indicated that the limitations of claim 29 (incorporated into claim 26 from which it depends] would serve to adequately define applicant's invention and to eliminate any indefiniteness which might perhaps reside in the phrase "located in close proximity."

298. In this amendment, Allied alleged that the claimed method "for the first time, provides a method for casting wide amorphous strip of any desired width having excellent physical properties, including isotropic tensile properties." (Ex. P-450). Allied's new Argument was that the difference between the method claimed in the '257 patent and the method of the prior art was that the method employed in the prior art patent cited against the application made fine grain crystalline metal strip rather than amorphous strip. (Ex. P-450).

299. On January 17, 1980, the Examiner indicated that the method claims in the application had been allowed. The Examiner also issued a restriction requirement to separate the method claims from the strip claims since "the inventions as above grouped are separate and distinct because the product as claimed can be made by another materially different process H.P.E.P. 806.05(e)." (Ex. P-450). The Examiner further stated that:

> In accordance with H.P.E.P. 812.01 a telephone call was made by Examiner G.T. Hampilos, Art Unit 324 to applicant attorney Hr. Buff on December 13, 1979, who elected without oral traverse the Group I invention. Claims 22-25 stand withdrawn from

further consideration by the Examiner as being *drawn* to a non—elected invention 37 C.F.R. 1.142B.

As authorized by applicant's attorney Hr. Buff, Claims 22-25 are hereby cancelled.

300. The '257 method patent (Ex. P-449) issued on September 9, 1980, with 13 claims directed to a method of forming continuous strip of amorphous metal from a molten alloy. The specification recited that "for purposes of the present invention, a strip is a slender body whose.transverse dimensions are much less than its length, including wire, ribbons and sheets, of regular or irregular cross—section." (Ex. P-449, col. 1, lines 17-20).

301. Although the '257 method patent was issued after Allied argued that there were distinctions between methods of casting amorphous strip and crystalline strip, Dr. Narasimhan believed that his process was equally applicable to both amorphous and crystalline strips. (Narasimhan Dep. at 374, Phys. Ex. P—D). The claims of the '257 patent refer only to casting amorphous strip.

302. the „IL work by skilled researchers at Allied Corporation, General Electric Company and Vacuumschmelze ¯rhow that there was a long felt need for a solution to the problem of how to make wide amorphous metal strip.

303. "Wide amorphous metal strip", as used in the '257 patent is construed as meaning continuous strip of more or less uniform width over 7 mm vide.

304. The long felt need for a solution to the problem of how tomake wide amorphous metal strip was noted in an article by Dr. Robert W. Cahn dated January 29, 1976. (Allied Ex. 606). At the time of writing the article, Dr. Cahn was department head of metallurgy at the University of Sussex and had done research work in the field of rapid solidification. (TR 3435-3436). •

305. The Cahn article comments on the Second International Conference on Rapidly Quenched Metals held at MIT on November 17-19, 1975 and concludes:

> Much of the ground work in establishing suitable compositions and forms of magnetic annealing has been done. There is just one remaining obstacle, but it is a major one! Up to the present, alloy glass ribbons can only be made a few millitres wide. For most applications, wide sheet *is* essential. The commercial people present were extremely tight—lipped about this crucial problem,

> which seems to be very obstinate. A very large prize, indeed, awaits the processing specialist who *is* first able to resolve this impasse, either by inventing a new form of continuous quench-casting or by some totally different approach.

(Allied Ex. 606).

306. Before the Narasimhan invention in December, 1975, there had been numerous efforts by others who attempted to make continuous amorphous metal strip 7 mm or more wide and with relatively consistent width. Some attempts to make amorphous metal strips of 7 mm or more in width had been successful. The Hilzinger and Hillman report stated that 7 mm strip had been made, but it was of "unsatisfactory quality." The technique used at that time produced strip of uneven width. Mr. Bedell at Allied had made strip more than 7 mm wide. Techniques other than fast quenching techniques also had produced splats of amorphous metal more than 7 mm wide. Double roll casting by Dr. Narasimhan and by Mr. Bedell at Allied had produced continuous amorphous metal strip over 7 mm wide using the double roll method but the strip was not uniform in width. (TR 760-764, Ex. P-636, TR 1973-1974, TR 534-539, Allied Ex. 19, cols. 2 and 3).

307. In 1972, Allied Corporation assigned John R. Bedell to find improved ways of making amorphous metal strip. (TR 533). Mr. Bedell's initial efforts were directed toward using a double roll quench technique. The product produced by this technique was uneven in width. (TR 534-539, Allied Exs. TTT, UUU and VVV).

308. Mr. Bedell then began investigating various forms of jet spinning. (TR 539-541). Jet spinning involves the passage of a free jet of molten metal from a nozzle onto the surface of a single rotating roll or chill wheel. (TR 539-541, Allied Ex. WWW). Mr. Bedell encountered two problems. One was the instability of the free liquid jet as it travelled from the nozzle to the chill wheel. The *liquid* jet had the tendency to change shape or break up into little spheres. (TR 542). The other problem was that a puddle of molten material formed on the surface of the chill wheel. (Tr 541). The puddle was unstable and was broken up by the air currents being drawn around the wheel by the rapid movement of the chill wheel. (TR 543-544, Allied Ex. WWW).

309. Mr. Bedell investigated jet spinning using other nozzle forms and devices such as a rectangular shaped orifice, a flattened nozzle, deflector blades or plates, vacuum deflector plates, and multiple jet nozzles or orifices. (TR 570, 547, -551, 552, 558, 564). None of these attempts produced entirely satisfactory results. Bedell obtained amorhpous metal strip about 7.5 mm wide by using multiple jet nozzles. Bedell was unable to produce any continuous amorphous metal strip of a relatively uniform width of over about 3-5 mm. (See Allied Exs. 504-513). Allied was able to produce amorphous metal strip over 7 mm wide. (Ex. P-564, Ex. P-724, Ex. P-744, Ex. P-401,.TR 648, 652-653, 658, 701, Allied Ex. 19, col. 2).

310. Hr. Bedell considered bringing the nozzle orifice closer to the chill wheel to stabilize the free jet of molten material. (TR 571-573). When he got as close as 3 to 4 mm, splatter problems occurred, "it was a mess," and he "had to stop right away." (Bedell TR 572-573).

311. In 1975, Mr. Bedell was doing jet spinning or casting in a vacuum chamber to avoid the problems of the air boundary layer breaking up the puddle, and causing holes and bubbles. (TR 591-592). In the vacuum chamber, even when making amorphous metal strip widths of about 5 mm, the strip rapidly became welded to the surface of the wheel, and "just built up *this mess on* the wheel." (TR 592-593). Efforts were made to divert the air boundary layer, but they were unsuccessful. (TR 593-594). Mr. Bedell and others at Allied worked unsuccessfully on the problem of making continuous wide amorphous metal strip of good quality and relatively consistent width from early 1972 until the beginning of 1976. (TR 556-557).

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313. Dr. Hans-Reiner Hilzinger began research for VAC in 1976 (TR ″36) in the area of amorphous metals. (TR 3536). His initial work involved the use of a• free jet melt spinning process. (TR 3537). In free jet melt spinning, there is a free liquid jet between the nozzle and the chill surface, and a puddle forms on the surface of the chill roll. (TR 3691).

314. In November, 1977, Dr. Rilzinger and Dr. Ullman of VAC prepared a report entitled: "Present State of Development of the Production of Wide Strip from Amorphous Metal." (Allied Ex. 420, TR 34i8-34I9). The November 1977 report deals with various types of free jet melt spinning experiments performed at VAC by Dr. Hillman and Dr. Hiulzinger. The November, 1977, report states that with a single round nozzle orifice, the upper limit for the width of the strip appeared to be approximately 2 mm. Difficulties with using multiple nozzles were described in the report and the report

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stated that fluctuation problems (hills and valleys) occurred with the use of multiple individual jets. (TR 3424-3425, Allied Ex. 420 at p. 10). The report discusses the use of "slitted nozzles" placed approximately 3 mot from the chill surface. The report states that strip width of 6-7 ma had been produced, but it had rough edges and a surface that is not as smooth as the narrower strip. (Allied Ex. 420 at p. 11). In order to improve the stability of the puddle, various techniques, such as damming the puddle and the use of additive chemicals, were tried. (Allied Ex. 420 at 11-12). These puddle stabilization efforts were unsuccessful. (Allied Ex. 567 at 2).

315. Subsequent to this work, VAC continued its efforts to make wide amorphous metal strip. (TR 3431). Dr. Hilzinger testified that during the period from 1976 to 1978, he considered other forms of casting amorphous metals, including using twin rollers, the melt drag process and the melt extraction process. (TR 3539-3540). In 1979, Dr, ililzinger concluded that processes other than free jet melt spinning were better suited for producing amorphous metals. (Ti 3540, 3711-3712, 3718, and Allied Ex. 567).

316. Dr. Narasimhan obtained his Ph.D. degree from Brown University in the field of Material Science. (TR 738). He joined Allied Corporation on July 1, 1975. (TR 739). His assignment was to develop a process for making wide strips of metallic glass, i.e., amorphous metal. (TR 739-741). After he joined Allied, he saw jet casting procedures in use at Allied, both in vacuum and in air. •(TR 742 and 746). Be saw the ejection of a molten metal under a high pressure through a circular orifice to form a free molten jet of metal falling through a space of about one—fourth of an inch between the nozzle opening and chill roll surface. When the molten jet hit the chill roll surface, a puddle was formed on the surface of the chill wheel and the solidified strip or ribbon was produced from this puddle. (TR 742-745).

317. Dr. Narasimhan initially considered and rejected the idea of using a multiple jet or multiple hole type nozzle. (TR 753). He investigated the use of a multiple hole nozzle interconnetted by a slot. (TB 754-755). He decided to work in a vacuum in order to minimize the effects of the air currents (air boundary layer) which are caused by the rotating chill wheel. (TR 755). These efforts were unsuccessful. (TR 756-757).

318. Dr. Narasimhan concluded that jet¯nesting procedures could not give him a wide ribbon because of the poor stability of the jet itself and the resulting puddle. The puddle behaved like jello, and became unstable. He thought that the puddle would break up if he tried to make amorphous metal 7 ma wide. (TR 758-760).

319. Dr. Narasimhan investigated double roll casting, but the product was not dimensionally uniform and was deformed. (TR 760-764). •

320. On December 5, 1975, Dr. Narasimhan tried using a substantially larger slot opening on the bottom of his crucible and some form of melt support or melt constraint generated by the chill wheel and the bottom of the crucible. .(TR 766-772). On about December 21, 19.75, he succeeded in making a wide amorphous ribbon by his new process. (TR 776)..

321. Dr. Narasimhan gave the wide ribbon to his supervisor, Dr. L. Davis, on January 4, 1976. (TR 779). Dr. Narasimhan testified that the ribbon he gave to Dr. Davis was amorphous. (TR 780). Re made several additional runs using his new process during the month of JanuaryI976 and he demonstrated his process to Dr. L. Davis and Dr. Gilman (Dr. Davis' supervisor). (TR 780-781). About a month later; he demonstrated his new

to the Vice President of Allied, Dr. Denkewalter. (TR 781). During the month of January 1976, Dr. Narasimhan used his process to obtain amorphous metal ribbons varying in widths from half an inch to one inch. (TR 784).

322. Pages 50 and 51 of Dr. Narasimhan's laboratory notebook are contemporaneous entries concerning some of his January 1976 runs using his new process. (TR 801-809, Allied Ex. 329).

323. Dr. Narasimhan described his process at the hearing as a supported melt pool created by positioning the slotted nozzle close to the chill surface. (TR 969). He defined the slotted nozzle as including a back lip, a slot, and a front lip. The lips were required to support or constrain the melt. *(TR* 925). He stated:

> The melt is supported between the front lip and the solidification front and the back lip and the very tiny, small, nascent growth of the ribbon which is also moving. (TR 905).

(See also TR 818, 916-917, 944 and 969).

324. Dr. Narasimhan testified that when the gap between the nozzle and the wheel surface was increased over about one millimeter, the ability to support the melt was lost:

> I *find* if you go like 1.5 to t ib millimeters, it is hopeless, but as you come down around one millimeter for a particulsealloy, this is great support, and for some alloys you might like to go a little closer, so I decide to put the distance of one millimeter, and about one millimeter as what I perceive it to be based upon my experience with a large number of amorphous alloys. (TR 812).

325. Dr. Narasimhan determined that the lover gap limit was .03 mm. (TR 810).

326. Allied contemporaneous documents support Dr. Narasimhan's oral testimony concerning his December 1975 discovery and his subsequent work with his process. (Allied Exs. 500, and 332-337).

327. Dr. Narasimhan originally called his process the "Supported Melt Drag Process," but later it was described at Allied as the "Planar Flow Casting Process." (TR 838-839, 908; 595).

328. Dr. Narasimhan was assigned by Allied to work on a method for making wide strip in July of 1975. (TR 739). Dr. Narasimhan did not have technical discussions with others at Allied who had previously worked in this area (T1 879), nor did he conduct any thorough review of prior art patents or publications on amorphous and crystalline casting. (TR 746-747).

329. After briefly experimenting with nozzles with multiple *orifices* (TR 902-905), Narasimhan's *first* experiment "was to have some kind *of slot."* (TR 752).

330. In December of 1975, Narasimhan moved his nozzle close to the chill wheel to cast amorphous metal- strip. He made *wide* amorphous strip by the end of December, 1975, less than six months after he began work on the project. This was only a few weeks after he attended the second conference on rapidly quenching materials at MIT where many of those working in the amorphous area were present. (Narasimhan Dep. 96-97, Phys. Ex. P—D).

331. On April 23, 1976, Narasimhan filed a memorandum of invention' concerning his work. The memorandum recites a March, 1976, date of conception and also a March, 1976, date of *first* disclosure to a colleague (L.A. Davis). Both of these dates are now said by Dr. Narasimhan to be a mistake. (TR 842).

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335. The application for the U.S. Letters Patent 4;221,257 was filed on October 10, 1978, and issued September 9, 1980. (Allied Ex. 20).

336. The specification of the '257 patent describes the width of the lips as a "critical parameter." (Allied Ex. 18, col ..3). The minimum width of the first and second lip are given in the specification. (See Allied Ex. 20, col. 3, col. 6, and Fig. 1, 4, 6 and 7).

337. The word "nozzle" as used in the '257 patent is ambiguous, and can be construed in connection' with the descriptions of the nozzle and nozzle lips in the specification.

338. Dr. Hilzinger was the principal author of a Vacuumschmelze internal report dated November 15, 1981. (Allied Ex. 567, TR 3711). The report relates to work that Dr. Hilzinger did at Vacuumschmelze. (Ti 3711). The November 15, 1981 Vacuumschmelze report describes the operation of the Vacuumschmelze melt-drag process. (TR 3718 and 3720). In the introduction to the November 15, 1981 Vacuumschmelze report, Dr Hilzinger stated:

> In earlier reports (1,2] the production of. amorphous ribbons by the melt spin process was described. In the process, the melt was extruded through a small nozzle orifice, whereby the pouring jet produced impacted the chill roll after passing through a distance of several mm only. The size of the melt droplet forming in the impact point determines, together with the circumferential velocity of the roll, principally the width and thicknesk of the ribbon formed. Because of the existence of the free jet, the process will be designated in the following as "free jet" method. Even small instabilities of this. very low viscosity melt droplet lead to nonuniform ribbon quality, for example because of the turbulent impact on the air boundary layer entrained.by the tall. This melt drag method has the further disadvantage that the expansion of the width of the ribbon usii& a slit nozzle is practically impossible, as the free pouring jet and the melt droplet would be deformed by the strong surface tension. Measures described in an earlier report El] to stabilize the melt droplet had no lasting results.
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> The stability of the production process is, however, increased by a reduction in the distance between the nozzle and the roll to a few tenths of a (sic] sm. Such a process has been proposed- initially by Narasimhan Corp.) for the production of wide strips from slit nozzle."

339. In an external publication authored by Dr. Hilzinger and Dr. S. Hock (also a Vacuumschmelze employee), and published in the summer of 1980 *in* connection with an International Conference held in Hungary (TH 3721-3724), Dr. Narasimhan *is* described as the one who made a remarkable improvement in avoiding the instability that limited the width of ribbon cast by the free jet melt spinning process. (Allied Ex. 341). At Page 75 and 76, this publication states:

> It may thus be stated that free jet melt spinning is subject to melt surface instabilities which limit the width of the ribbons produced *this way* to about 5mm. Additional perturbations may occur when, a row of closely spaced round orifices or a slitshaped nozzle is used for the casting *of* wider tapes (12-23]. A <u>remarkable improvement</u> in *this* respect is achieved when the nozzle is arranged in very close distance from the substrate surface, thus providing a mechanical constraint for the liquid alloy throughout -Its way from the crucible to the point of solidification, <u>an *idea* which was first set forth publicly by Narasimhan</u> (24]. Such a configuration minimizes the perturbations originating at the free melt surface and greatly improves the geometry of the product. ¯(Fig. 2).
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> A further advantageous feature of the process is that even a rectangular melt reservoir *is* easily stabilized by the nozzle lips, and so a slit—shaped nozzle may favourably be used without any inherent limitation to the width of the tape. In this configuration the metal reservoir between the nozzle lips is refilled from above essentially at the same rate as material *is* removed. from it by the rotating wheel surface. (Emphasis added).

340. The relevant prior art (and contemporaneous art) relied upon by respondents under Section 103 includes known crystalline casting processes as well as known amorphous metal casting processes. Specifically, it includes. the work of Dr. Masumoto, Mr. Wellslager, Mr. Bedell, Dr. Lieberman, the Strange and Pim patent, the BaseIett patent, the Battelle process and the King patents.

341. The '257 patent contains six examples of the operation of Narasimhan's alleged invention. In four of the six examples, the process is used to cast polycrystalline sheets of pure copper, or copper and aluminum alloyed with small amounts of other metals. (Ex. P-449, table at column 12). The '257 patent recites that "the present invention provides an apparatus for makinicontinuous metal strip from the melt," (Ex. P-449, col. 3, lines 18-19), without making a distinction between polycrystalline and amorphous strip.

342. Allied's application was originally entitled "Continuous Casting Method for Metallic Strips" (Ex. P-450) and the title was changed during prosecution to "Continuous Casting Method for Metallic Amorphous Strips" (Ex. P-450) after the Patent Office cited relevant prior art involving casting of crystalline materials. The attempt to restrict the field of the '257 process solely to amorphous metals was inconsistent with the teaching of the continuation—in—part Narasimhan patent application.

343. 301. The '257 patent itself recites that "Metals which can be formed into polycrystalline strlp directly from the melt by my process include

aluminum, tin, copper, iron, steel, stainless steel and the like." (Ex. P-449, col. 9, lines 41-43›.

344. In the development *of* proceises for casting amorphous metal alloys, *use was made* of prior methods for casting crystalline metal ribbons. For example, the Pond-Maddin apparatus for casting crystalline metal strips was modified by Xasumoto to form the Masumoto-Haddin apparatus for casting amorphous metal alloy. This modification was accomplished simply by changing the material of the crucible to accommodate a hotter material and increasing the speed of rotation of the casting drum. (TR 1923-1924 and *Exs.* P-606 and P-607).

345. Professor Maddin testified that given the knowledge of the art is 1975 concerning the conditions necessary to cast amorphous metal strips, there would have been no difficulty in adapting the Razelett process to cast amorphous metal strips. (TR 4757-4759).

346. The '257 patent itself cites the Razelett process as prior art. The Razelett patent (Ex. P-1000) recites that its process may *be* used for casting aluminum and copper (Ex. P-1000, p. 2, lines 32-34) into a sheet which is homogeneous and has uniform textures throughout. (Ex. P-I000, at 2, lines 54-56).

347. In the 1920's the Razelett Company was casting crystalline metal sheets as thin as 0.06 inches (Allied Ex. 618). When Allied was seeking

to explore different processes for casting amorphous metal strip in the 1975-1976 period, Allied asked Hazelett Company about possible processes. (Ex. P-712).

348. The prior art jet casting process had been used for casting both crystalline and amorphous materials. Allied researchers commonly used a crystalline material, solder, as a test material to' evaluate whether processes such as jet casting were suitable for use in casting amorphous metal strips. (Ti 684-685, T1 4321).

349. Prior art techniques for casting crystralline metal strips were pertinent art to the casting of amorphous strips.

350. Both the•language of the '257 patent specification and the work of others in casting the amorphous metal make it clear that before 1975 others working in this field had moved a nozzle'close to the chill wheel and rotated the chill wheel rapidly to cast amorphous metal strip.

351. The '257 patent specification discusses certain prior art processes for casting metal strip. The specification notes that amorphous metal strips "require rapid quenching of certain molten alloys at a cooling rate of at least 1040 C per second, more. usually 10^{6}° C per second." (Ex. P-449, col. 1, lines 57-60). The '257 patent recognizes that it was known in the art that high quench rates were required to farm most amorphous metal strips. Professor lUddin testified that in 1975 it was known that quench rates of

10^{4} °C per second were usually necessary to make amorphous ribbons, as disclosed in the literature by Professor Duwez and others. (TR 4807-4808).

352. The '257 patent states that in order to achieve rapid quenching rates the prior art jet casting process employed a "rapidly moving chill substrate (velocity typically between 1,300 and about 2,000 meters per minute)." (P-449, col. 2, lines 1-2). This velocity range is entirely within the range of 200 to 2,000 meters per minute recited in claim 2 of the '257 patent.

353. The adaptations necessary to cast amorphous metal strips were made by others working in the art either prior to or at about the same time as Narasimhan's work.

354. In 1969 the Pond-Maddin apparatus was used to make crystalline metal ribbon by flowing molten metal through a nozzle onto the inner surface of a rotating chill cylinder. (P-72; TR 1921-1923). Working at the University of Pennsylvania, Dr. Masumoto modified this equipment to cast amorphous ribbons. Re did this by changing the material of the crucible where samples were inserted, purifying gas used to pressurize the melt to avoid sample oxidation, and increasing the rotation of the motor 'from a low speed to approximately 5,000 rpm's. (P-F?; P-647, abstract No. 83). (See Ex. P-633, Mainichi newspaper article).

355. Dr. Masumoto noted that the diameter of the drum used in the Masumoto—Maddin apparatus was 10 cm. (TR 1928). If the drum were rotated at 5,000 rpm, the inner surface of the drum would be traveling at over 1,500 meters per minute, within the range recited in claim 2 of the '257 patent.

356. Normally the gap between the nozzle and the chill surface on the Masumoto—Maddin apparatus was set about 1 mm to .5 mm. (TR 1923-1928).

357. Allied employees tried a number of methods for casting of amorphous metal strips prior to the work done by Narasimhan

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366. Allied, in the course of its work with jet casting onto a chill wheel, used a nozzle at a spacing close to the chill wheel to cast 1 inch solder strip in September of 1973.

367. A diagram by Hr. Bedell showing a nozzle with <u>knife-edged</u> • lip placed close to the chill surface is included in a .memo dated December 1974 (Ex. P-398), prior to Harasimhan's employment at Allied. Mr. Bedell's efforts to bring the nozzle close to the chill surface. were unsuccessful due to "spattering." (TR 572-573).

368. Dr. Davis, who was Dr. Harasimhan's immediate supirvisor at Allied (TR 1676), testified that jet casting using a rectangular nozzle orifice was in practice at Allied prior to the work of Dr. Narasimhan. (TR 1716-1717; Ex. P-428). Amorphous metal ribbons about one-quarter inch wide (roughly 6 or 7 110 were made at Allied using jet casting with a rectangular nozzle orifice •prior to the work of Dr. Narasimhan. (TR 1715-1716; Ex. P-428; at 1-2).

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370. In operating his device Lieberman noted that "the space between the orifice and the surface of the copper disk was held fixed at 1 ma." (Ex. P-3I6 at Sates 264924).

371. The Lieberman apparatus employs all of the elements of claim 1 in the '257 patent for use in casting amorphous metal strip, except that the Lieberman article does not specifically disclose use of a slotted nozzle. A notebook kept by Lieberman recording his experiments recites the use of a slotted nozzle in *his apparatus. (Ex.* P_308).

372. A preprint of the Lieberman article (Ex. P-316) was sent to Allied early in 1976, prior to the October, 1976, date on which Allied first filed an application on Narasimhan's alleged invention. Lieberman Dep. 87-89; Xavesh Dep. 121-122).

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374. United States Patent 905,758 issued to E.R. Strange and C.A. Pim is entitled "Process of Manufacturing Thrzi Sheets, Foil, Strips, or Ribbons of Zinc, Lead, or Other Metal or Alloy." *(Ex.* P-317). The Strange and Pim patent states:.

> The object of our invention *is* to provide an improved process, by means of which zinc, lead, or other metal, or alloy, of a character adapted for use in the form of thin sheets, or foil or strips, or ribbons, and of a melting point sufficiently low to allow of being treated as hereinafter described, can be continuously and very expeditiously and economically formed into very thin and even sheets, or foil, or strips, or ribbons, of even width and thickness and as free from flaws, or other imperfections, as possible and in a condition eminently adapted for being acted upon chemically.

(Ex. P-317, p. 1, lines 12-25).

375. The Strange and Pim patent discloses that the metal to be made into thin sheets or foil *is* maintained in a molten condition in any suitable receptable and "passes, or is passed out of the said receptacle through an outlet, or outlets, having a cross-sectional area proportional to the cross-sectional area of the required thin sheets, or foil, or strips, or ribbons." (Ex. P-317, p. 1, lines 26-34). In describing the outlet, the Strange and Pim patent recites that "the molten metal passes out by the outlet 3 which may be tubular, or slitted, or with an orifice of any other suitable shape in cross-section." (Ex. P-317, p. 1, lines 83-85).

376. To solidify the molten metal passing out of the outlet, the Strange and Pim patent recites that:

> In close proximity to, but not in Contact with, the said outlet, or outlets, we provide a cool and traveling surface, so that the molten metal, or alloy *is* continuously'received upon, and rapidly wiped up by, the *said* traveling cool surface as it passes the outlet, or outlets, the *said* metal, or alloy being solidified by contact with the said cooled surface and continuously carried away at a rapid rate from the outlet, or outlets ... (Ex. P-317, p. 1, lines 38-48).

377. With respect to the "cool and traveling surface" the Strange and Pim patent recites that:

> The *said* surface *is* preferably a disk, wheel, or roller <u>set in close proximity to, but not in contact with, the outlet,</u> or outlets from the molten metal, or alloy, receptacle, so that the molten metal, or alloy, is received on•the cooled side face, or cooled periphery of the wheel, or roller, (or wheels or rollers) which *is* (or are) rapidly rotated and the metal or alloy sets by contact with and is given off continuously from the cooled face or periphery, *as* a very thin and even shet, foil, strip or ribbon... (Emphasis added).

(Ex. P-317, lines 58-75).

378. Strange and Pim discloses a process for the manufacture of thin sheets, foil, strips or ribbon of a metal or alloy by the following steps:

a. Passing the molten metal or alloy through an outlet, which may be "slitted," onto a cool and traveling surface located in close proximity to, but not in contact with, the outlet;

b. the cool surface being "rapidly rotated;" and

c. the metal sets by contact with the surface and is "given off continuously from the cooled face or periphery, as a very thin and even sheet, foil, strip or ribbon."

379. The Strange and Pim patent was cited as "of interest" by the Patent Office during the prosecution of the Narasimhan applications, but it was not considered by the Examiner to make Narasimhan's alleged invention obvious. The Strange and Pim patent and a related British patent were brought to the attention of the Examiner by a description in the specification. (Allied Ex. 20). The Examiner stated in the first Official Action that all the prior art cited in the specification had been considered. (Allied Ex. 5587).

380. The Strange and Pim patent describes the use of low-melting crystalline material (i.e. zinc and lead) that is unsuitable for formation into a continuous strip of amorphous metal. No reference is made in the patent to amorphous metals.

381. The Strange and Pim patent does not specifically recite a slotted nozzle which has a gap between the slot and the wheel surface of about 0.03 to about 1 mm. It does recite that the traveling surface shall be in close proximity to, but not in contact with, the slitted outlet.

382. In Strange and Pim, the chill roll speed is not specifically described, and the relationship between chill roll speed, the gap and the pressurization of the melt in order to obtain a continuous strip•of amorphous metal *is* not disclosed. (TR. 1317-1322).

383. Dr. Hilzinger and Dr. Rock, VAC employees, were aware of the Strange and Pim patent when they prepared the publication "Preparation of Metallic Glasses." In *this* publication they acknowledged that Dr. Narasishan was the first to set forth how the free jet melt spinning instabilities could be minimized, and described his contribution as a "remarkable improvement." (Allied *Ex.* 341).

384. The Hazelett Patent, United States Letters Patent No. 1,600,688 issued to Clarence W. Hazelett, is entitled "Process and Apparatus for Casting Sheet Metal" (Ex. P-1000). The Hazelett process, as disclosed in *this patent, has* a container for molten metal and a *way* of keeping the metal molten. The bottom of the container contains a "casting slot 41" (Ex. P-1000, at 1, lines 84-85). The molten metal comes out of the casting slot and onto a rotating chill drum 20. The casting slot 41 is positioned generally perpendicular to the chill drum 20 (Ex. P-1000, Fig. 1; TR 4804-4805). The slot is kept at a distance from the drum equal to the thickness of the metal the user would like to produce (TR 4754-4756); P-1000, at 1, lines 74-79). The Hazelett patent recites that the machine disclosed may be used "for casting aluminum, brass and copper ..." (Ex. P-1000, at 2, lines 33-34). Operation *of* the Hazelett process "results in producing a sheet, which is homogenous and has uniform texture throughout."' (Ex. P-1000, at 2, lines 54-56).

385. Hazelett teaches a process for casting sheet metal by the follow ing steps:

a. Passing molten metal through a casting slot positioned perpendicular to the direction of movement of a chill casting drum and located a distance from the casting drum approximately the width.of the strip to be cast;

b. advancing the chill drum at a predetermined speed; and

c. cooling the molten metal in' contact with the casting drum to form a sheet which is homogeneous and has uniform texture.

386. Hazelett teaches that the lower face of the metal pot may be in contact with the molten metal on the upper surface of the sheet being cast while the lower surface of the sheet is congealing (solidifying) on the casting drum (Ex. P-1000, at 2, lines 41-49). Fig. 1 of the '257 patent (Ex. P-449), *shows* the nozzle lips in contact with the molten metal flowing from the slot while the lower surface *of* the amorphous sheet solidifies on the chill wheel.

387. The Hazelett patent was not considered by the PTO during the prosecution of the Narasimhan patent applications.

388. The Hazelett patent teaches the use of some features that would prevent the formation of a continuous strip of amorphous metal. CIR 1322- • 1332). The preparation of amorphous metals by fast quenching depends on extremely fast quenching rates of at *least* 10,000°C per second and commonly 1,000,000°C per second. (Allied Ex. 398 at Col. 1, lines 10-16; and Allied Ex. 20). In contrast to these high quenching rates, the Hazelett patent requires a *heated* metal pot containing the molten *metal* to be positioned over the casting drum so that the bottom of the heated melted pot contacts the upper surface of the cast metal, enabling the cast metal to "cool slowly." (Ex. P-1000 at at 2, lines 44-49). The patent teaches away from fast quenching methods.

389. The Hazelett patent does not disclose the high rate *of* speed of the chill roll necessary to obtain a continuous strip of amorphous metal. It describes the use of a mat or gasket 42 of a material such as copper which is positioned between the metal pot and the casting drum. The frictional force of *this* sandwiched mat or gasket 42 would slow down the rotational speed of the wheel *and,* if higher speeds were obtained, the friction might destroy the surface of the casting drum. (Ex. P—I000 at 1, lines 74-99).

390. The Hazelett patent fails to disclose a gap within the specific range of from about 0.03 to about 1 mm (TR 1329), but it discloses that the gap between the nozzle outlet and the moving surface can be the same size as the thickness of the strip being *cast.*

391. The '257 patent teaches in the paragraph bridging Columns 4 and 5, that the solidification front *misses* the front lip. Ii other words -during operation of the '247 process, only liquid metal touches the front lip. If the solidification front contacts the front lip, poor strip quality will result and rapid failure of the nozzle can occur. (Allied Ex. 20 at column 6, lines 16-19). The Hazelett patent specifically requires that the solidifying metal contact the bottom of the metal pot, and the solidifying *metal is* to be kept in the "semi—plastic condition" (Ex. P-1000 at 3, lines 91-98), so that the metal can be smoothed by the bottom of the pot. *(Ex.* P-1000 at 2, lines 49-56).

392. Dr. Warlimont is head of the research and development division of VAC. Dr. Warlimont became interested in the rapid solidification field in 1968. He first studied rapid solidification of crystalline alloys but later investigated rapid solidifiction of amorphous alloys. (TR 3373-3376).

393. When Dr. Warlimont worked for Aluswiss in 1974, he visited the laboratory of Dr. Kurz of Battelle, Geneva, on several occasions. Dr. Warlimont saw the apparatus of Dr. Kurz for practicing the melt drag and the melt extraction processes for rapid solidification. (TR 3384).

394. Dr. Warlimont described the melt drag process as basically having a reservoir for holding the melt positioned above a chilled rotating wheel, and a spout for discharging the melt onto the wheel, and a gas inlet or outlet. (TR 3385). Pressure on the melt at the spout of the reservoir came from the weight of the head of metal above the spout, and from externally supplied gas. (TR 3385-3386).

395. The externally applied pressure could be adjusted as needed. The desired goal was to achieve sufficient pressure to permit the meniscus of the melt to come into contact with the rotating cooling *surface* and to be drawn out of the spout in the direction of rotation of the cooling surface. (TR 3388-3390, Phys. Ex. P-NN).

396. When the melt drag process was used to cast ribbon, a slotted orifice was used as the spout for the reservoir; (TR 3391).

397. In 1975-1976, Professor Guntherodt in *Basel,* Switzerland, used the melt drag process to cast amorphous ribbon with a slotted orifice. (TR 3392). Professor Cuntherodes goal was the manufacture of amorphous alloys, and his melt drag apparatus was designed specifically for that purpose. (TR 3393).

398. The apparatus and method described in Exhibit P-1141 accurately reflects what Dr. Warlimoat understood in 1974 to be one embodiment of a melt drag process. (TR 3395-3396).

399. The method and apparatus in United States Letters Patent 32605,863 to Xing *(Ex.* P-62) reflects what Dr. Warlimont knew in 1974 to be one embodiment of the melt drag process. (TR 3396-3397).

400. Exhibit P-1140; entitled "Melt Drag: A Process for Continuously Cast Precursor Wire and Sheet," reflects the melt drag casting process as known by Dr. Warlimont in 1974. (TR 3397).

401. Exhibit P-1142, entitled "Some Aspects of Continuous Wire and Fiber Production by Rapid Solidification of Metal Melts," describes the melt drag casting process *as* known to Dr. Warlimont in 1974. (TR 3397-3398).

402. Exhibit P-1143, entitled "Patent Art Concerning Rapid Solidification Processes," describes the melt drag casting process as known to Dr. Warlimont in 1974. (TR 3398-3399).

403. Dr. Warlimont saw the laboratory apparatus of Professor Guntherodt *in* 1976. He did not measure the gap distance between the nozzle and the chill surface. (TR 3401).

404. The "melt drag process" for continuous casting essentially includes a crucible with a spout containing molten metal, the spout being positioned a small distance above a moving chill surface, and a means for applying pressure to the melt in the crucible to control discharge of the melt from the spout onto the chill surface. (TR 3385-3387).

405. The pressure applied to the melt, which may be the result of the pressure of the melt head or externally applied gas pressure, or both, is used to control the discharge of the melt, so that a meniscus *is* formed which touches the chill surface and the melt *as* it solidifies on the chill surface is dragged away. (TR 3388).

406. Two patents *issued* to King, United *States* Letters Patent 3,605,863 *(Ex.* P-62) and United States• Letters Patent 3,522,836 (Ex. P-1141) describe one embodiment of the melt drag process. (TR 3394-3397).

407. The use of externally applied pressure to control the meniscus in the melt drag process as described by King is taught in *his* patent as follows:

> *it is* obvious that numerous other variants exist of the apparatus. Thus, for example, instead of using a level regulator to keep the surface of the material at the pressure necessary for forming a meniscus, it *is* possible to provide the apparatus with a device allowing the pressure of a gas in contact' with the surface of the material in the reservoir to be controlled. This device serves to increase the pressure of the gas as the height of the metal level falls during operation of the apparatus, such that the pressure of the material be kept at the desired level at the orifice. This would allow a relatively high column, i.e., a larger reserve of metal in the reservoir by choosing a gas pressure below atmospheric pressure. •

(Ex. P-62, col. 6, lines 50-62).

408. The applicability of the melt drag processS as described by King to the manufacture of amorphous material *is* taught as follows:

> It may also be mentioned that to (sic] the preient invention allows the rate of solidification pf the material on the moving surface to be controlled in a precise manner especially by regulating the speed as well as the temperature of *this* surface. *This* allows the crystalline structure of the product to be determined *so* as to confer desired mechanical properties to said product.

(P-62, col. 6, lines 44-50).

409. Omitted.

410. Claim 1 of the '257 patent reads *as* follows:

> 1. A method of forming continuous strip of amorphous metal from a molten alloy capable of forming an amorphous structure comprising:
>
> a. forcing the molten alloy under pressure through a slotted nozzle positioned generally perpendicular to the direction *of* movement of a chill surface and located in close proximity to the chill surface to provide a gap of from about 0.03 to about 1 millimeter between said nozzle and the chill surface;
>
> b. advancing the chill surface, at a predetermined speed; and
>
> c. quenching the molten metal in contact with the chill surface at a rapid rate to effect solidification into a continuous amorphous •metal strip.

(CX20).

411. A number of phrases in the '257 patent claims are ambiguous.

412. When a claim *is* ambiguous, both complainant and respondents are entitled to read the claims in the light of the specification. Under certain circumstances a respondent can be found not to infringe an ambiguous claim if the specification teaches away from a broad construction of the claim.

413. The '257 patent claims are ambiguous with respect to the meaning of "nozzle" and "slotted nozzle." In. one paragraph which discusses Fig. 2, the specification refers to "slotted nozzle 10" (P-449, Col. 7, line 31), the "nozzle 10" (P-449, Col. 7, line 39 and again on line 41), and then *back* to "slotted nozzle" 10 (P-449, Co]. 7, line 50). The '257 patent specification sometimes uses the terms "nozzle" and "slotted nozzle" interchangeably. Sometimes the nozzle *is* the structure "employing concave lower walls terminating in a slot" as shown in Fig. 5. (Ex-. P-449, Col. 8, lines 60-62).

414. Although the terms "nozzle" and "slotted nozzle" are ambiguous *as* used *in* the '257 patent, the use of these terms in the specification is clear in each context in which such a phrase *is* used. In fact, an understanding of the invention makes it clear that "slotted nozzle" and "nozzle" have specific meaning in specific contexts or the invention obviously would not work. If the specification is used to construe what these terms must mean in each context, the ambiguity *is* resolved.

415. By construing the term "slotted nozzle" in accordance with the discus *sions in the specification,* the phrase refers to a slot with two lips located on the bottom of the crucible on the surface closest to the chill wheel. (Allied Ex. 20 at col. 3, lines 35-48, col. 4, lines 2-4, col. 4, lines 48-53, and col. 7, lines 59-60; TR 818, 925 and 969).

416. The term "slotted nozzle includes a front lip and back lip of sufficient width to support the molten metal as illustrated in the Figures of the '257 patent and as described at col. 5, lines 1-20. (Allied Ex. 20).

417. The term "generally perpendicular" is ambiguous.

418. Claim 1 recites the presence of a "slotted nozzle positioned generally perpendicular to the direction *of* movement of the chill surface." The corresponding language in claim 12 recites that *"said* nozzle *is positioned* generally perpendicular to the direction *of* rotation of the chill roll." (Ex. P-449, Col. 13, lines 26-28). This phrase *is* ambiguous.

419. Allied contends that the requirement that a slotted nozzle be placed generally perpendicular to the direction of rotation of the chill surface means that the nozzle must lie along the.Y-axis as depicted in the blow up of Exhibit 1[1]-117 (Resps' Phys. *Ex.* PVV).

420. Allied relies on the statement in the '257 specification that "there is no limitation on the length of the slot (measured perpendicular to the direction of movement of the chill surface) other than the practical consideration that the slot should not be longer than the width of the chill surface" (emphasis added). *(Ex.* P-449, Col. 3, lines 42-46).

421. The <u>written</u> description of Figure.5 of the patent *describes* a "cross-sectional view taken at a plane perpendicular to direction *of* movement of the chill surface illustrating a preferred embodiment of a nozzle employed in the practice of the present invention providing concave-shaped internal sidewalls."

422. Respondents take the position that this teaches that the "slotted nozzle" referred to in claim 1 is the structure above the slot *as* well *as the* lips forming the *slot,* an that this *is* "generally perpendicular to the direction of movement of the chill surface" if it lies along the Z-axis, as shown in respondents' *Ex.* P-717. In other words, *it* would refer to the perpendicularity of the whole structure above the nozzle slot to the direction *of* movement of•the chill surface. The *axis* of the nozzle can be perpendicular to the chill surface even if the nozzle is rotated in various directions in a circle around *its* axis. If respondents were correct, the nozzle could be perpendicular to the direction of movement of the wheel, even though the length of the slot *is* not centered in the direction of movement of the wheel. If this occurred, the ribbon being cast would run off the side of the wheel.

423. Allied argues that Figure 5 is a draftsman's error. Figure 5 must be a draftsman(s error, because the Narasimhad invention, *as* clearly described elsewhere in the specification, would not work if claim 1 were construed to reflect "perpendicularity" as shown in Figure 5.

424. The specification states that the nozzle may be tilted or that the nozzle may be mounted off-center. (Allied Ex. 20, col. 6, line 69 to col. 7, line 3).

425. If the slotted nozzle *is* twisted so that one side of the slot is higher than the other, an uneven gap will occur which results *in* a strip of uneven thickness when a chill roll is used, or the melt starts "walking" when a chill belt *is* used. (TR 818-819 and 1009). A small amount of twisting of the slotted nozzle, plus or minus 5 degrees, may be tolerated. (TR 1011-1012).

426. If the slotted nozzle *is* twisted so that the slot *is* turned *sideways to the* direction of movement of the wheel, the ribbon will run off the side of the wheel.

427. The patent specification contemplates that the slotted nozzle may be rocked back and forth, so that the gap betweed the front lip and the wheel surface may be equal to or different from the gap•between the back lip and the wheel surfice. An unequal gap is contemplated by the patent specification under certain circumstances, such as when an annular chill roll *is* used, to prevent the ribbon from *staying* on the wheel too long, and hitting the nozzle. The gaps would be equal when a flat surface, such as a belt, *is* used. (Allied Ex. 20, col. 6).

428. The words "generally perpendiculAr" therefore must be construed to permit the rocking back and forth of the nozzle, while the length of the slot remains perpendicular to the direction of the wheel. This will be the construction given to "perpendicular" here. The length of the slot must be perpendicular to the direction of movement for the Harasimhan process to work. It will be perpendicular even if the nozzle is rocked back and forth, raising or lowering the front lip relative to the back lip. The slotted nozzle, however, cannot be twisted sideways, allowing the ribbon to run off the side of the wheel, and it cannot be twisted so that one side of the slot *is* farther from the wheel surface than the other side, causing a strip of uneven thickness to be formed.

429. The perpendicular angle therefore refers to the length of the slot being perpendicular to the direction of movement of the chill surface. (Allied Ex. 20 at col. 3, lines 35-48 and lines 42-44; TR 1008-1012).

430. The phrase "forcing the molten alloy under pressure" is ambiguous, but because of file wrapper estoppel it must be construed as Allied used the term in the file wrapper rather than as Allied used the term in the patent specification.

431. Because of file wrapper estoppel, the *phrase.* "forcing the molten alloy under pressure" means more than the pressure of the weight of the melt must be applied to push the molten alloy through the nozzle onto the chill surface. This pressure may include the pressure of the static head of molten alloy *as* well as external *gas* pressure. (Allied Ex. 20 at Col. 7, lines 13-14, Col. 7,liaes 36-42, Col. 9, lines 16-39; TR 796-797). Allied is estopped from claiming that pressure from the weight of the melt alone constitutes "forcing" because of the position Allied stated with the Examiner in order to get the claim allowed over the prior art King melt drag process patent.

432. The phrase "predetermined speed" is ambiguous. The specification shows that this phrase does not mean that the predetermined speed must be constant. (Allied Ex. 20, Col. 3, line 64 to Col. 4, line 2). The predetermined speed need only be sufficient to form a continuous strip of amorphous metal. Thus, if a predetermined speed is used for only a few seconds, and strip *is* formed, the process is covered by claim 1. Representative speeds that may be *used are* set forth at Col. 5, lines 20-54.

433. The manner in which the gap between the nozzle and the chill surface is to be measured is ambiguous.

434. The '257 patent specification states that:

> When the chill surface is a flat surface, such as a belt the gaps between the surface of the chill surface and the first and second lips represented by dimensions d and e in TIC. 4 may be equal. If, however, the movable chill body furnishing the chill surface is an annular chill roll then these gaps may not be equal, or else the strip formed will not separate from the chill roll, but it will be carried around the perimeter of the roll and will hit and destroy the nozzle. I have surprisingly found that this can be avoided by making gap d smaller than gap e, that is to say, by providing a smaller gap between the first lip and the chill surface than between the second lip and the chill surface.

(Ex. P-449, Col. 6, lines 50-62).

435. There *is* no language in the '257 patent identifying the exact place whee the gap should be measured. Dr. Narasimhan testified he would measure the gap between the front lip and the chill surface. (Ex. P-D at 213). Dr.Mehrabian initially testified that for a curved chill surface he would measure the gap between the rear lip and the chill surface. He changed his testimony three times as to where he would measure the gap. (TR 1616-1629). Column 6 of the *specification,* however, indicated that at least sometimes gap d must be smaller than gap e. Under certain conditions, there must be a smaller gap between the first lip and the chill surface than between the second lip and the chill surface.

436. Ac the hearing, Dr. Narasimhan testified that a larger chill roll was in effect a flat surface such as a belt, and when a large chill roll was used, the two gaps could be equal, notwithstanding what was *said in* the '257 patent specification. (TR 960-961). In each of the six examples recited in the '257 patent where *a* chill roll *is* used, however, the gaps between the two *lips* always differ, whether the chill roll *is* 7 1/2 inches in diameter (example 6) or 16 inches in diameter (examples 1-5). (Ex. P-449, Col. 11, line 35-col. 12 table).

437. The claims of the '257 patent do not require that the gaps between the first lip and the chill surface and the second lip of the chill surface be unequal. The specification gives the reader an understanding that under certain circumstances it is better to have them equal and under other circumstances it is better to have *them* unequal. Allied set forth the "best mode" known to the inventor when it described circumstances under which the gaps should *be* unequal.

438. To practice the invention, it is not necessary to know exactly where the gap should be measured. If the gap is measured anywhere between the nozzle surface and the wheel surface, and it falls within the range of measurements for the gap in claim 1, it falls within claim 1.

439. The specification of the '257 patent recites certain dimensions concerning the lips of the slotted nozzle as critical to the operation of the Narasimhan invention. The '257 patent specification states that:

> The width of the lips measured in the direction of movement of the chill surface, *is* a critical parameter. The first lip has a width at least equal to the width of the slot. The second lip has a width of from about 1.5 to about 3 times the width of the slot.

(Ex. P-449, Col. 3, lines 49-53).

440. None of the claims of the '257 patent refers in any way to the width of the lips of the slotted nozzle used in the process. The claims refer to the slotted nozzle, however, and the structure of the nozzle is not clear without a reading of the specification.

441. There is no recitation in any of the '257 claims of a step such as "supporting a puddle of molten metal with the lips of a slotted nozzle." This is found only in the specification.

442. Dr. Narasimhan has acknowledged that if the slotted nozzle had *knife* edge lips it would not function to support the puddle and would not work in his process. (TR 940).

443. Narasimhan did not review the claims of the patent application to see if they contained the critical elements he believed to be his invention. (TR 945-947).

444. Because the '739 strip patent *is* a *division* of the '257 process patent, which is in turn a division of the 4,142,571 apparatus patent, the specification of all three patents *is* generally the same. The claims differ. (Phys. Ex. 19, 20 and 22).

445. Athough Allied Corporation's counsel Mr. Buff acquiesced in the issuance of a separate patent directed to the strip claims, he continued to maintain that "Methods for casting amorphous metal strips known prior• to applicant's invention were incapable of producing such strip." (Allied Ex. 558 at page 2 of Amendment dated September 25, 1981). If either patent is invalid, this issue is not reached.

Infringement of the '257 Patent

K

446. The following sanctions were issued in Order No. 32 against TDK Electronics CO., Ltd. (TDK Electronics Corporation) because of its failure to comply with an order compelling discovery: •

(1) An inference is drawn that any documents, testimony, and written answers sought by Allied from TDK, and ordered produced by TDK, and that TDK has failed to produce, would have been adverse to TDK if they had been produced:

(2) An inference is drawn that TDK has facilities in Japan for making amorphous metal alloy by the process defined by the claims of Allied's Patent No. 4,221, 257;

(3) That TDK has the capacity to make and to import into the United States sufficient amorphous metal alloy covered either by Allied's Patent No. 3,856,513 or No. 4,331,739 to have the tendency to injure Allied's domestic industry; and

(4) That TDK has imported amorphous metal alloy into the United States that is not within the license granted by Allied to TDK, and that infringes the claims of Allied's Patent Nos. 3,856,513 and 4,331,739, and that was made by the process of the claims of Allied's Patent No. 4,221,257.

447. TDK Electronics was advised that if it promptly produced the information ordered produced, it could file a motion *showing good cause* why all or some of the above sanctions should be lifted.

448. TDK Electronics declined to produce the information.

449. It is therefore found as to TDK Electronics Corporation only that TDK has facilities in Japan for making amorphous metal alloy by the process defined by the claims of the '257 patent and that TDK has imported amorphous metal alloy into the *United States* that was not within the license granted by Allied Corporation to TDK and was made by the process of the claims of the '257patent.

450. TDK has produced amorphous metal alloy strips by forcing the molten alloy under pressure through a slotted nozzle positioned generally perpendicular to the direction of movement of *a* chill surface and located in close proximity to the chill surface to provide a gap of from about 0.03 to about 1 millimeter between the nozzle and the chill surface; and advancing the chill surface at a predetermined speed; and quenching the molten metal in contact with the chill surface at a rapid rate to effect solidification into a continuous amorphous metal strip. (Response to Interrogatory No. 47, Allied Ex. 518).

451. The amorphous ribbon furnished by TDK to Lawrence Livermore National Laboratory pursuant to Purchase Order 9409201 was produced in Japan in accordance with the method set forth in claim 1 of U.S. Patent No. 4,221,257. (Response to Interrogoratories. 72 and 83, Allied E . 518).

2. Vacuumschmelze and Siemens

452. Vacuumschmelze (VAC) has *used* casting machines C and E to produce amorphous metal alloy strips identified by the trademark Vitrovac. (TR 3560; Dep. TR Vol. II, pp. 73-79, Allied Phys. Ex. WW1); Allied Ex. 390).

453. Amorphous metal alloy strips produced by VAC on casting machine C have been exported to Siemens in the United States in strip fors. (Stipulation No. 50, Allied *Ex* 656; Responses to Interrogatories 57-60, Allied Exs. 515; 418 and 419).

454.1

(Responses to Interrogatories 57-60, Allied Exs. 515, 418, and 419; and Dep. TR., Vol II, pp. *17-18,* Allied Phys. Ex. XX(1)).

455. Casting Machine C recently operated as follows:

a. Casting machine C includes a chill roll mounted on a hori-.xontal shaft which is supported by two bearings.

b. The shaft is driven through a variable belt transmission by a direct current motor with a feedback control.

458. Casting Machine E has the same general design as Casting Machine C and recently operated in the same manner. (TR. 3541-3542; Allied Ex. 415, Rilzinger Dep. TR. Vol. II, at 47,48, 104, and 105, Allied Phys. Ex. XX(1)).

460. Specific process conditions for the individual VAC runs (e.g., Vitrovac designation number, gas pressure, chill roll velocity, nozzle dimensions and gap) used in the production of amorphous metal alloy strip exported to the United States are *set* forth in Allied. Phys. Ex. 418A and 419A. (TR. 3727-3743). Although Dr. Hilzinger indicated that the gas pressure ranges from millibars. (TR. 3676), the actual process *conditions used* by VAC (Allied Ex. 418A and 419A) show that almost all of the runs were made using gas pressures above millibars.

461. VAC's process for making *its* Vitrovac amorphous metal alloys' recently included the following steps:

(1) the nozzle is located in close proximity to the chill surface;

(2) the gap between the nozzle and the chill surface *is* from about 0.03 to about 1 millimeter;

(3) the chill surface is advanced at a piedetermined speed; and

(4) the molten metal is quenched in contact with the chill surface at a rapid rate to effect solidification in a contin— uous amorphous metal strip. (Allied Ex. 515).

462. VAC's casting machines C and E recently used a process for casting a continuous strip of amorphous metal that included all the steps of claim 1 of the '257 patent. VAC's casting machines C and E recently *used a process*

for casting a continuous strip of amorphous metal according to claim 2 of the '257 patent wherein the chill surface *is advanced relative to the slotted nozzle at a* velocity of from about 200 to about 2,000 meters per minute. (Hilzinger Dep. TR., Vol. II, p. 45, Allied Phys. Ex. WW(1); *Allied Exs.* 418A and 419A).

463. VAC's Casting Machines C and E recently used a method for casting a continuous strip of amorphous metal according to claim 3 of the '257 patent wherein the molten alloy *is* quenched at a rate of at least 10^4 C per second.

464. VAC's Casting Machines C and E recently performed a method of forming a continuous strip of amorphous metal according to claim 5 of the '257 patent wherein the chill surface *is* a chill roll and wherein the molten alloy *is* deposited on the peripheral surface of the rotating chill roll. (Allied Ex. 415; T7. 3543; Dep. TR., Vol. at 33 and Vol. II, at 106, Allied Phys. Ex. XX(1).

465. Dr. Hilzinger described the nozzle used in the VAC process as having nozzle lips that did not support the melt. He testified that photographs showed that the melt in the VAC process was not supported by the lips of the nozzle. Cm 3534-3554). He made a drawing of the lips not supporting the melt. (Phys. Ex. P-00).

466.

467. Although Dr. Mils/tiger testified that there were photographs of the current VAC process in action (TR 354.6-3547), no photographs were offered into evidence.

468. It *is* found that a Vacuumschmelze report dated November 15, 1981, co-authored by Dr. Hilzinger, describes how the Vacuumschmelze process operated at least in the recent past. (Allied *Ex.* 567; TR 3718).

469. The abstract of the November 15, 1981 report noted that a substantial improvement in the geometrical quality of amorphous ribbons *is* obtained by *using a* process wherein the casting nozzle *is* placed at a very narrow distance from the chill roll.

470.

471. The article by Hilzinger and Hock entitled "Preparation *of* Metallic *Glasses*" (Allied *Ex* 341) states at 75–76:

Constrained melt tape casting

> It may thus be stated that free jet melt spinning is subject to melt surface instabilities which limit the width of the ribbons produced *this way* to about 5 mm. Additional perturbations may occur when, a row of closely spaced round orifices or a siltshaped nozzle *is* used for the casting of wider tapes. A remarkable improvement in *this* respect is achieved when the nozzle *is* arranged in very close distance from the substrate surface, thus providing a mechanical constraint for the liquid alloy throughout its way from the crucible to the point of solidification, an idea which was first set forth publicly by Narasimhan. Such a configuration minimizes the perturbations originating at the free melt surface and greatly improves the geometry of the product.
>
> A further advantageous feature of the process is that even a rectangular melt reservoir *is* easily stabilized by the nozzle lips, and so a slit-shaped nozzle may favourably be used without any inherent limitation to the width of the tape. (Reference omitted).

472.

473. VAC does not use exactly the same process as the "melt drag process" described in U.S. Patent No. 3,522,836 to King. (See TR 3649-3655).

474. U.S. Patent No. 3,522,836 to King *(Ex.* P-1641) was assigned to the Battelle Development Corporation. The patent relates to a method of making wire from a molten *material. It* does not disclose the preparation

of amorphous metal strip and, *in* the patent examples, it uses a chill surface speed of from 4.4 to 38 meters per minute. The patent describes the method at column. 1, lines 61-68 as follows:

> "Thus it may be seen that the method according to the invention consists essentially in maintaining the molten material, at a constant temperature and at an appropriate static pressure, at the outlet of a nozzle such that the *said material forms, at said* outlet, between the pressure and the surface tension thereof, and in carrying away from said meniscus the material serving to form the desired product. (Emphasis added).

475. As set forth in column 4, lines 41-71, the process of the King patent includes the following steps:

> The metal is next introduced slowly into the reservoir I so *as* to form thereon a bath of molten metal at constant temperature, the surface *of* which rises progressively. When the level of the molten metal has attained *a* sufficient height above pipe 7 for the metal to form an appropriate convex meniscus at the outlet orifice of said nozzle 10, introduction of the metal into the reservoir I *is* stopped. The level which is chosen will obviously be situated between the limits I, II mentioned above, at a height giving a meniscus which is sufficiently curved to alloy (sic] it to be brought into contact with the drum 16. The metal temperature at the orifice *is* preferably at *least* 20^{o} C above the melting point of the particular metal.

> The drum 16 *is* then heated to a temperature of at least 40° C by means of the bath 18 and made to rotate with a peripheral velocity which corresponds to the desired feed velocity of the metal. The meniscus formed—At the orifice of the nozzle 10 is next brought into contact with the peripheral surface of the drum by adjusting the horizontal and vertical position of the support 6. (Emphasis added).

476.

3. Hitachi

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503.

504. There are no Common officers or directors between HTC and MIL except that the Chairman of the Board of HTC which has 25 members, sits as an ordinary director on the board of HML, which has 20 members. (Ex. P-1200, at 2).

505. MEL has *its* own corporate charter and by—laws, separate and distinct from HTC. *(Ex.* P-1200, at 2).

506. HML has *its* own fully adequate supply of capital separate and distinct from HTC. (Ex. P-1200, at 2).

507. HML keeps its own accounting records separate and distinct from RTC. *(Ex.* P-1200, at 2).

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511. HHL has its own American subsidiary, HH1, which handles *sales* and distribution for MIL. HTC also has its own American *subsidiary,* Hitachi America, Ltd., which handles sales and distribution for HTC. (Allied *Ex. 514).*

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4. <u>Nippon Steel</u>

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VALIDITY OF THE '739 PATENT

554. Prior to December, 1975 (the date of the Narasimhan invention) (TR 3769; Allied Ex. 606), no one had made continuous amorphous metal strip having even surfaces, uniformity of cross—section, and uniform thickness and width along *its* length, at least seven millimeters wide and having isotropic tensile properties.

555. No contemporaneous documentary evidence was offered to support the oral contentions of Dr. Masumoto or his co—workers that they had made prior to December 5, 1975, an amorphous metal strip having a relatively constant width equal to or greater than 7 mm.

556. The only contemporaneous documentary proof of Dr. Masumoto or his co—workers showi that when strip width equal to or greater than 7 mm was obtained, the strips had extreme variations in width .along their length.

Exs. 622 and 623).

557. Exhibit P-636 states at page 234 that "The present authors and co—workers were able to produce ribbon specimens with maximum dimensions of about 10 mm in width." This statement *is* consistent with the specimens shown in Mr. Kikuchi's lab notebook at p. 622 and 623. The Kikuchi strips do have maximum dimensions that exceed 7'mm, but the width variation along the length *is* extreme.

558. The strip photographed at page 235 of Ex. P-636 does not have a width equal to or greater thiii 7 mm. The strip width of the photographed

samples *was* approximately 6 mm (TR 2083-2084). The *same* photograph appears at translation page 8 of Ex. P-635, and a scale is provided in the photograph. (TR 2080-2081).

559. If Dr. Masumoto or his co-workers had made a dimensionally uniform strip having a width equal to or greater than 7 mm at the time of publication of Exs. P-635 and 636, they would have been expected to show such a strip in the photographs in the publications.

560 Dr. Masumoto was not precise about the width dimensions reported in his U.S. Patent No. 3,986,867. (Ex. P-714). Dr. Masumoto testified that 5 mm was about the maximum width amorphous metal material that he made *using* the centrifugal device. (TR 2027). In his U.S. Patent No. 3,986,876 at Col. 4, lines I-5, however, he reports making an amorphous material 10 mm wide. (Ex. P-714 at Col. 4, lines 1-5). Such a width dimension is contriry to Dr. Masumoto's oral testimony,. and *is* not supported by any example in the patent. The examples specify making strip widths *of .5* mm and 1 mm. (Ex. P-714).

561. In Ex. P-657 Dr. Masumoto and his co-workers state that they obtained a specimen with a fairly broad range of dimensions, i.e., 0.2-8 mm vide. This suggests that Dr. Masumoto and his co-workers were only able to make strips widely fluctuating in width along their length.

562. Dr. Grant was responsible for presenting an award to Dr. Duwez at the Second International Conference on Rapidly Quenched Metals (held November 17-19, 1975). As the award, Dr. Grant and his wife prepared a plaque

containing samples from around the world of rapidly solidified or quenched materials, both amorphous and crystalline. *(TR* 3763-3765; *Ex.* P-643; Allied *Ex.* PPPP). Dr. Masumoto sent samples of amorphous metal strip to Dr. Grant for use in the award. (Ex. P-643; TR 2084-2092). The HASUMOCO samples were used by Dr. Grant in the plaque. (TR 2092; 3767; Allied Phys. Ex. QQQQ and RRRR). The Masumoto samples *in* the plaque have a width of about 3 mm. (TR 3768, Allied Phys. Ex. SSSS). The only amorphous metal "strip" having a width grater than 7 mm is the dimensionally non-uniform, *fish-like* "strip" shown at the top of the plaque. (TR 3769). The plaque presented to Dr. Duwez and made by Dr. Grant illustrates the state of the art in November of 1975 as to the quality and type of amorphous metal strip that was being produced around the world.

563. In 1975, there was an existing need in the art, prior to the invention claimed in the '739 patent, for continuous amorphous strip of consistently over 7 mm in width. (See Allied Ex. 606).

564. On March 7, 1980, Allied filed a patent application (Serial No. 128,005; P-452) as a division of Application Serial No. 949,839. This patent contained four claims directed to an amorphous metal strip. In May of 1981, the Patent and Trademark Office rejected these claims as anticipated by United States Patents issued to Eavesh (U.S. patent 3,856,074) and to Masumoto et al. (U.S. Patent 3,986,867). On September 30, 1981, Allied filed an amendment in response to the Examiner's rejection. In the amendment, Allied.contended that prior -art processes could not make amorphous ribbon wider than about 6 mm. (Ex. P-452, Amendment of September 30, 1981, at 2).

565. Allied did not advise the PTO that an Allied employee, John Bedell, had made strip 15.9 mm wide by a prior art process (jet casting) which had been sent to an Allied customer "for evaluation. Allied stated in the '739 specification that Bedell's prior art amorphous strip of 1.27 cm width had "anisotropic tensile properties." (Ex. P-451).

566. Allied also did not *advise* the PTO that Allied had advertised the availability of strip 0.5 inches (12.7 mm) wide in a Chemical and Engineering News article *in* 1973. *(Ex.* P-564).

567. The Examiner issued a Notice of Allowance on December 23, 1981. On May 25, 1982, more than three years after the initial '571 apparatus patent issued and more than 18 months after the '257 method patent *issued,* the '739 strip patent issued with four claims directed to an amorphous metal strip having a greater than 7 um width and "isotropic tensile properties." (Ex. P-451).

568. Allied relied heavily on the argument that Narasimhan was the first to produce strip with isotropic tensile properties in securing the claims of the '739 patent (Ex. P-452, Amendment of September 30, 1981, at pp. 2, 6).

569. Claim 1 of the '739 patent recites "a strip of amorphous metal having a width of at least 7 millimeters, and having isotropic tensile properties." This includes every strip of amorphous metal greater than 7

millimeters in width, made by any process, if such strip has "isotropic tensile properties." Claim 2 adds a minimum thickness limitation to claim 1, and claims 3 and 4 change the width requirement of claim 1.

570. The term "isotropic tensile properties" as used in claim 1 *is* unclear in meaning since there are a number of different tensile properties in a metal alloy strip, such as *yield* strength, ultimate tensile strength, and modulus, none of which except tensile strength are discussed or defined in the specification. (TR 3407). The term "isotropic tensile properties" as used in the '739 patent is vague and ambiguous.

571. In the specification of the '739 patent the only definition of tensile strength is in the following discussion of isotropic tensile properties in reference to the prior art:

> In any event it has not been possible to obtain wide metal strips, say wider than about 6 millimeters, by single or multiple jet casting procedures having isotropic strengths, that is to say having <u>identical</u> tensile strengths and elongation measured in the transverse as well as in the longitudinal direction, or in any direction therebetween, even though metal strips *with* amorphous structures should be isotropic at least with respect to their tensile properties, and those with cast polycrystalline structures should be approximately isotropic. (Emphasis added).

(Ex. P-451, col. 2, lines 36-46).

572. In describing tests allegedly run upon the strip produced in example 1, the '739 patent states that:

> Tensile specimens cut from the strip in longitudinal and transverse direction exhibit equal tensile strength and elongation. The strip has isotropic tensile properties. (Emphasis added).

(Ex. P-451, col. 12, lines 3-8).

573. The '739 patent specifically states that a strip must have identical tensile strength and elongation in the transverse and longitudinal directions *in* order to have isotropic properties. The '739 patent indicates that tests showed that strips made according to the Narasimhan process had isotropic tensile properties.

574. There is no evidence that Allied actually performed tensile tests which demonstrated equal or identical tensile strengths in the transverse and longitudinal direction for strips made in accordance with the Narasimhan process. No evidence appears in the record as to the results of any tests *done* by Allied on strips made by the Narasimhan process on the longitudinal and transverse directions prior to the commencement of this hearing.

575. Dr. Narasimhan has stated that he did not do such tensile strength *tests,* but believes that he might have asked Lance Davis to do such tests. (TR 856).

576. Dr. Davis, described by Alllied as the man most knowledgeable concerning tensile testing at Allied, could not recall any tensile *tests* done prior to the hearing on Narasimhan'i strip in both transverse and longitudinal directions. (TR 1701). Dr. Davis *testified* that Dr. Takayama tested some material for isotropic tensile properties in approximately June of 1975, but *this material* was not produced by the Narasimhan process. Aside from this one test, Dr. Davis has stated that he is not personally aware of any other tests *at* Allied made to determine if an amorphous metal strip had isotropic tensile properties. (TR1730-1731).

577. John Bedell, another Allied employee active *in* the area of producing amorphous metal strip, *said* he did not recall doing any such trans;ftrse and longitudinal tensile strength *tests* on amorphous strip. (TR 655).

578. Shen respondent *NSC* sent out a deposition notice asking to take the deposition of the person most knowledgeable as to the actual tensile test work that supported the claims made in the '739 patent, Allied's response was that such person was "unknown." (Ex. P-688).

579. The evidence of record indicates that Allied did not have any actual test results showing that the Narasimhan strip had equal tensile strength in the longitudinal and transverse directions. Allied did not have any test results showing that the tensile properties of Narasimhan's wide amorphous metal strips were different from the tensile properties *of* wide amorphous metal strips made by the methods of the prior art.

580. Allied does not currently test its commercial strips for quality control by measuring their tensile strength in the transverse and longitudinal directions. (Response to Interrogatory NO. 129 ofjISC).

581. The term isotropic tensile properties, which did not appear in Narasimhan's Memorandum of Invention (Ex. P-270), is stated in the '739 patent to mean equal or identical tensile strengths in the transverse and longitudinal direction, yet no tests have ever shown that any amorphous strip made by the Narasimhan process has such properties.

582. The '739 strip patent discloses that isotropic tensile properties of an amorphous metal strip may be determined by using standard tensile testing methods. (Ex. P-451, col- 10, lines 56-62). The '739 strip patent does not disclose any tensile testing method or procedure for use *in* testing amorphous metal strips other than stating that standard tensile testing methods may be used. (Ex. P-451, col. 10, lines 56-62)..

583. The only known standard tensile testing method is the ASTM standard for tensile testing of thin foil metal material. (Sinclair Dep. Ex. No. 8).

584. Allied's expert in tensile testing, Dr. Glen Sinclair, had testified that in order to comply with the ASTM standaid for tensile testing of thin foil metal material, the test specimen requires a central portion 2

inches (50.8 mm) long. (Sinclair Dep., p. 62, line 9 to p. 63, line 6). It *is* impossible to comply with the ASTH standard for tensile testing of thin foCr-metal material for a strip that is only 1 inch (25.4 mm) wide. (Sinclair Dep.,p., 62, line 9 to p. 63, line 61).

585. It is impossible to comply with the ASTH standard for tensile testing of thin foil material for a strip which is only 30 mm wide (claim 4 of the '739 patent). It is impossible to comply with the ASTH testing standard for amorphous strips having a width of 1 cm (10 mm) or 7 mm (claims 1 and 2 of the '739 patent).

586. The '739 strip patent does not disclose any procedure for testing for isotropic tensile properties of an amorphous metal strip covered by any claim of the '739 pitent. The '739 patent does not disclose to one skilled in the art how to determine whether an amorphous metal strip having a width within the range of any claim of the '739 patent has isotropic tensile properties.

587. Statistical analysis of tensile strengths of an amorphous metal strip in the longitudinal and transverse directions to determine whether the strip had isotropic tensile properties were first developed by Allied during the course of this investigation. Dr. Laska, retained by Allied as an expert in statistics for purposes of this investigation, has tetified that he developed tensile testing procedures for determining isotropic tensile properties after meetings and telephone discussions with Dr. Davis, Dr•. Mehrabian, Dr. Narasimhan, Dr. Colin Adams and attorneys (TR 1768-1771).

588. Dr. Davis has testified that for purposes of *this* investigation, tensile tests on Allied commercial amorphous *metal strips at least* 7 mm *wide* were carried out under his direction and control. (TR 1692).

589. The first time Dr. Davis ever conducted or directed tests specifically to determine whether or not an amorphous metal alloy strip had isotropic tensile properties was a few weeks prior to.the hearing in this investigation. (TR 1729).

600. Dr. Davis selected strip for testing which did not have defects that would have produced unfavorable results (TR 1733-1734), and then conducted tensile strength measurements on a number of these carefully selected samples.

681. These results were then analyzed by Dr. Laska, a statistician, who has no background in metallurgy. Dr. Laska concluded that two of the six Allied samples did not have statistically equal tensile strengths in the transverse and longitudinal directions and four did. *(TR* 1794).

602. Dr. Davis testified that even after discarding strip samples which be could visually tell did not have a uniform cross—section and therefore "he knew would not exhibit isotropic tensile properties," two out of six of the samples tested did not exhibit isotropic 'tensile properties as computed by statistical analysis. (TR 1740-1741).

603. No tests could be made showing whether the six samples of Allied commercial amorphous strip which were tested for purposes of this investigation had identical or equal tensile strengths in the longitudinal *and* transverse directions. When a strip was tested *in* one direction, the test destroyed the strip.

604. Allied failed to prove that strip made by the Narasimhan process is fully amorphous and therefore inherently isotropic. Dr. Naddin pointed out that very complex tests must be performed to determine whether a material *is* fully amorphous. Transmission electron microscope *tests* are not referred to in the '739 patent as a means for telling whether strip had isotropictensile properties. (TR 4840). It *may* be that a fully amorphous state cannot be realized in practice. (TR 3459-3461).

605. Dr. Williams testified that transmission electron microscopy (TM) is not a standard tensile testing method. (Williams Dep., p. 38, lines 5-8). Dr. Williams *also* stated that it *is* very difficult to obtain quantitative information from electron diffraction patterns. The most you can say is that there *is* more or less crystallinity rather than amorphousness, but you cannot put numbers on *it.* (Williams Dep., p. 35, lines 9-18). Transmission electron microscopy testing does not prove whether an amorphous strip has isotropic tensile properties.

606. The *results of* a TEM *test* are not representative *of* the condition of a strip as a whole because TEM testing necessarily examines'only a minute portion *of* the whole strip. (TR 4840).

607. Allied contended that isotropic tensile properties *depend* on the existence of a uniform cross section and smooth surfaces and that strips with such uniform cross sections and smooth surfaces that were amorphous would have isotropic tensile properties.

608. Tensile strength is defined as strength per unit area, and does not depend on cross section. (TR 4760). The '739 patent itself defines a "strip" as having "regular or irregular cross section." (Ex. P-451, col. 1, lines 20-23).

609. A diagram drawn by Narasimhan shows his strip to have an irreg-+ ular cross section. (Ex. P-291). .

610. The '739 patent failed to advise the. reader how Allied failed to prove that either Allied's strip or respondents' strip has isotropic tensile properties. Allied was unable to distinguish the Narasimhan strip from a prior art strip wider than 7 millimeters, nor to prove infringement of the Narasimhan '739 patent by any particular amorphous strip.

611. Allied did prove that sometimes a statistical conclusion could be made that small pieces taken from Allied's strip had isotropic tensile properties, and that small pieces taken from respondents' strip had isotropic tensile properties.

612. Allied takes the position that amorphous strip less than 7 millimeters wide with isotropic tensile properties *was* known prior to the Narasimhan process (Response to Interrogatory 127 *of* Respondent NSC).

613. Prior to conception and reduction to practice in the Narasimhan process, amorphous strip had been made wider than 7 millimeters. The existence of such strip made by the double—roll method *is* disclosed *in* the Bedell '658 patent. (Ex. P-40I; TR 648, 652-653).

614. This product was described as deformed by the double—roll process. This may have affected its tensile properties.

615. An article in Chemical and Engineering News, reporting on work at Allied, referred to the production of smooth amorphous strip as much as 12 millimeters wide *in* 1973. (Ex. P-564; TR 658).

616. Allied supplied .samples of the amorphous strip wider than 7 millimeters to Schick for testing in a project to make razor blades in 1974. (Ex. P-724; TR 701).

618. By June of 1974, Allied reported that it had produced "smooth 3/8 *wide* ribbons" of amorphous alloy. (Ex. P-744; Ex. P-427).

618. Dr. Masumoto had made a strip wider than 7 millimeters using the double roll method, and published the results of *this* work in June, 1975. (Ex.: 4-636 at p. 234; TR 1973-1974). The double-roll method is *used* commercially today by Sony to make amorphous metal strip. (TR 2143).

619. There *is* no evidence that the.Narasimhan strip had identical tensile strength in the transverse and longitudinal directions.

620. The tests made by Allied show that tensile strength measured *in* the transverse direction of one piece from a certain strip made by Allied *is* always different from the tensile strength measured in the longitudinal direction of a second piece from the same strip. Since the test destroys the piece tested, the same piece cannot be tested for tensile strength in more than one direction.

621. Even with the statistical tests made by Allied, different pieces of strip sometimes do and sometimes do not have "statistically equal" strengths in the transverse and longitudinal directions.

622. The record contained no evidence of a means to compare the tensile strength characteristics of strip made by the Narasimhan process with prior art strips made by the Masumoto and Bedell doilble-roll process, or the Bedell prior art jet-tasting process. No tests comparing the strip *made* by the Narasimhan process and prior art amorphous strips are in the record.

623. The evidence indicates that strip wider than 7 millimeters had been produced by Masumoto by the double-roll proce's prior to the Narasimhan process as disclosed in a prior art publication, and had been produced by Bedell by the double roll process at Allied and furnished to an Allied customer, thus constituting a prior public use of such strip. The width of these, strips anticipates claims 1 and 3 of the '739 patent.

624. Claim 4, which refers to a 3 centimeter or 30 millimeter strip, has not been shown by Allied to have any patentable distinction over prior art wide amorphous metal strips.

625. There is no reason to believe that Narasimhan thought that he had discovered a new type of amorphous metal strip with "isotropic tensile properties." His invention memorandum contains no reference to any such and there are no test results to substantiate such a discovery. Dr. Narasimhan did nothing more than develop a process to cast wide amorphous metal strips that cannot be distinguished from the amorphous strip known in the prior art based on isotropic tensile properties.

626. The language used in the claims of a patent must define the patentee's alleged advance over the prior art and limit the scope of the claim so that it will not extend to something already known in the prior art. If a term, such as "isotropic tensile properties" in the present case, is used in an attempt to distinguish the patent claims from the prior art, the specification must establish a standard usable by one of ordinary skill in the art for determining when the claim is infringed. Kaiser Industries Corp. v. McLouth Steel Corp., 400 F.2d 36 (6th Cir. 1968).

<u>Infringement of the '739 Patent</u>

627. The '739 strip patent contains four claims. These claims read as follows:

> 1. A strip of amorphous metal having a width of at least 7 millimeters, and having isotropic tensile properties.
>
> 2. A strip according to claim 1 having thicknesses of at least about 0.02 millimeters.
>
> 3. A strip according to claim 2 having width of at least about 1 centimeter.
>
> 4. A strip according to claim 2 having width of at least about 3 centimeters.

628. All four claims of the '739 patent require an amorphous metal strip having a specified minimum width and isotropic tensile properties.

629. The '739 patent defines isotropic tensile properties as <u>identical</u> tensile strength and elongation in the transverse as well as the longitudinal direction. ('739 patent, Col. 2, lines 38-41, Allied Ex. 20). Example 1 of the '739 patent, the only example of the '739 patent which addresses isotropic tensile properties, discloses that tensile specimens cut in the longitudinal and transverse directions exhibit <u>equal</u> tensile strength and elongation. ('739 patent, Col. 12, lines 5-8, Allied Ex. 20).

630. The '739 strip patent distinguishes betweeh isotropic tensile properties and approximately isotropic tensile properties. ('739 patent, Col. 2, lines 38-46, Allied Ex. 20).

631. The '739 strip patent makes no disclosure that isotropic tensile properties as that word is used in the claims of the '739 strip patent means statistically, equal tensile properties in the longitudinal and transverse directions. There is no disclosure in the '739 strip patent that statistical analysis is to be used to determine whether an amorphous metal strip has isotropic tensile properties.

632. For an amorphous metal strip to have isotropic tensile properties as defined it the '739 patent, it must have identical tensile strengths in the longitudinal and transverse directions. ('739 patent, Col. 2, lines 38-41, Allied Ex. 20).

633. An amorphous metal strip having approximately equal tensile strengths in the longitudinal and transverse directions does not have isotropic tensile properties as defined in the '739 strip patent.

634. The term "tensile properties" is not defined in the text of the '739 patent.

635. The term "tensile properties" as commonly utilized in the metallurgical science comprises several properties which are: elastic modulus, yield stress, fracture stress or tensile strength, and elongation to fracture.

636. The term "tensile properties" is broader than the term "tensile strength" (TR 3407), but as this term *is used in* the '739 patent, it means "tensile strength." "Identical" as utilized in the patent means exactly the same.

637. Allied made tests of the tensile strength of pieces cut from amorphous metal strip made by the Narasimhan process and strip made by the respondents and furnished to Allied for the purpose of testing *in* connection with this investigation. Allied's statistical expert, Dr. Laska, interpreted the results of these tests. Dr. Laska was qualified as an expert witness in the area of mathematical *statistics.* (TR 1768).

638. In conducting the tensile tests of Allied amorphous material for the purpose of this investigation, Allied personnel rejected Allied material having visual defects and did not test such material. (TR 1732-1733).

639. The rejected material was made by the Narasimhan process, as was the tested material. (TR 1734).

640. There is no language *in claim 1* of the '739 patent which *limits* the amorphous metal article claimed therein to an article of saleable quality. (TR 1734-1735).

641. Dr. Laska interpreted the term "isotropic tensile properties" *in* the physical sense to mean that the properties are equal in all directions. (TR 1785).

642. Dr. Laska interpreted the term "isotropic tensile properties" as used in USLP 4,331,739 (Ex. P-258) in the statistical sense to mean satisfying a statistical *test* of a null hypothesis of equality of strengths in two or more directions. (TR 1785).

643. The only definition of the term "isotropic strengths" as used in the '739 patent (Ex. P-258) found in the '739 patent is at column 2, lines 38-42 which states that "isotropic strengths" means "having identical tensile strengths and elongation measured in the transverse as well as the longitudinal direction, or any direction therebetween." Ckllied Ex. 19).

644. Dr. Laska applied a statistical technique known as the T—test which asks whether there is a statistically significant difference between the means of measurements taken in the transverse and longitudinal directions. (Ti 1791).

645. Dr. Laska was advised that the strength of amorphous material tested in the transverse direction could not be greater than the strength in the longitudinal direction. (TR 1792)

646. On *the basis* of information given to him that the amorphous material tested could not exhibit strengths in the transverse direction greater than strengths in the longitudinal direction, Dr. Laska applied a one-sided T-test. A one-sided T-test rejects the hypothesis *of* equality whenever the mean of the strengths in the longitudinal direction *is* sufficiently greater than the means of the strengths in the transverse direction. (TR 1792-1793).

647. The only tensile properties measured by Allied for the purpose of this investigation in connection with the '739 patent was fracture strength. (TR 1742).

648. In determining whether the samples from which the T-value was calculated *failed* or did not fail to *satisfy* the hypothesis of equal means (the T-test) the T-values were analyzed based on the application of a probability factor of 0.5. (TR 1828).

649. After calculating a T-value from the data, one looks up that value in a table to determine whether that number exceeds the tabulated number, the table being selected in accordance with a dedired probability factor. (TR 1829).

650. Dr. Laska personally had to make a determination as to what probability value he would apply in analyzing the data set forth on Exhibits 615 and 616. (TR 1829-1830).

651. If the calculated T-values had been closely bunched, selection of the probability value could have made a difference *in* Dr. Laska's conclu-sion- as to whether data for a certain sample does or does not *satisfy* the hypothesis of equal means. (TR 1830-1831).

652. There *is* an element of arbitrariness in the selection of the probability value for evaluating the results of the T-test. (TR 1831).

653. The only language in the '739 patent on which Dr. Laska relied as a basis for selecting .05 as the probability value for use in evaluating the data on Exhibits 615 and 616 *is* the language found in column 10, line 58 which states "employing standard tensile testing methods and apparatus." (TR 1831-1832).

654. Dr. Laska did not examine any tensile properties of amorphous material in connection with *this* investigation other than *tensile* strengths. (TR 1836).

655. Dr. Laska did not know whether Young's modulus of an amorphous ribbon is statistically independent of the tensile strength *of* that ribbon. (TR 1837).

656. Dr. Laska did not know whether the manner in vtich the samples for which data is shown on Exhibits 615 and 616 are cut *is* statistically inde-pendent of the tensile strengths of the material. (TR 1837).

657. Dr. Laska did not know whether the shape of the sample for which data 'is shown on Exhibits 615 and 616 is statistically independent of the tenette strength of that sample. (TR 1837-1838).

658. Dr. Laska did not know whether the edge treatment for the sample which *data* is shown on the test results *is* statistically independent of the tensile strength of those samples. (TR 1838).

659. Dr. Laska did not know whether the fact that the samples for which *data* is shown on the test results may or may not be polished is statistically independent of the tensile strength of the sample. (TR 1838).

660. Dr. *Laska* did not know the composition of any of the samples for which data *is* shown on Exhibits 615 and 616. (TR 1838-1839).

661. Dr. Laska did not know whether the tensile strength of amorphous ribbon is statistically independent of the composition of the ribbon. (TR 1839).

662. Dr. Laska did not know the pressure which was utilized to force the molten alloy through a slotted nozzle in the process by which the ribbon *was made* for which data appears on Allied Exhibit 616. (TR 1839).

663. Dr. Laska did not know if *the* amount of pressure which is utilized in forcing the molten alloy through a slotted nozzle to make the samples for which data *is* shown in the test results *is* statistically independent of the tensile strength of those samples. (TR 1840).

664. Dr. Laska did not know what the distance between the slotted nozzle and the chill surface was for the processes that were used to make the ribbon for which data is *shown in the test results.* (TR 1840).

665. Dr. Laska did not know whether the process which was utilized to make the ribbon for which data is shown in'the test results was a process in which the chill surface was advanced at a predetermined speed. (TR 1841).

666. Dr. Laska did not know if the speed of the chill surface which was utilized to manufacture the ribbon for which data *is* shown in Allied Exhibit 616 is statistically independent of the tensile strength for such ribbon. (TR 1842).

667. Dr. Laska did not know the rate of solidification of the melt which was utilized to make the ribbon for which data is shown in Allied Exhibit 616. (TR 1842)

668. Dr. Liska did not know whether the rate of solidification which was used to make the ribbon for which data is shown in Allied Exhibit 616 *is* statistically independent of the tensile strength of that material. *(TR* 1842).

669. Dr. Laska did not know what, if any, the effect of the atmosphere *is* on the product which is produced by the Allied casting process which Dr. Laska witnessed. (TR 1842-1843).

670. Dr. Laska did not know what, if any, the effect of humidity *is* on the product produced by the casting process at Allied which Dr. Laski' witnessed. (TR 1843).

671. Dr. Laska did not know what, if any, the effect of wear on the bearings *is* on the product manufactured by the casting process at Allied which Dr. Laska *witnessed.* (TR 1843).

672. Dr. Laska did not know what, if any, the effect of wear on the nozzle is on the product produced by the casting process at Allied which Dr. tasks witnessed. (TR 1843).

673. Dr. Laska testified that four possibilities which could introduce statistical error in *the* casting process at Allied *which* he *witnessed* were the effects of atmosphere, humidity, wear on the bearings, and wear on the nozzle. (TR 1842).

I. <u>TDK</u>

674. Sanctions relating to infringement of the '739 patent have been issued. It *is* found that TDK Electronics Co., Ltd. has infringed the '739 patent, if it is valid.

. <u>Hitachi</u>

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688. In conducting tensile test of Hitachi Metals' amorphous metal material Allied hired Dr. Sinclair and Dr. Williams. (Allied Phys. Ex. A-DDDD; A-EEEE).

689. It is not possible to quantify the amount of material in the amorphous phase as opposed to the amount of material in the crystalline phase from viewing an electron diffraction pattern of a metal alloy. (Williams deposition, February 14, 1984, p. 35).

690. Neither X-ray diffraction nor TEM are standard tensile testing methods. (Allied Phys. Ex. A-EEE, pp. 37-38).

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694. There is no evidence that the Hitachi respondents have infringed the '739 patent, if valid.

3. Vacuumschmelze (VAC)

695. Dr. Warlimont *is* head of the research and development division of VAC. XTR 3373-3374). VAC is a specialty metal manufacturer which offers *a* large variety of different metals manufactured in comparatively small quantities. (TR 3379).

696. Dr. Laska did not know whether the VAC data shown on Allied Exhibit 616 was randomly selected from a population *of* all VAC processes. (TR 1848).

697. Dr. Laska could not point to any language in the patent stating that saleable quality of amorphous strip has anything to do with isotropic tensile strength. (TR 1854).

698. The samples tested for which data *is* shown in Allied Exhibit 616 were cut to be rectangular in shape. (TR 1744).

699. At the time *of* testing of the Allied amorphous metal samples for which data is shown in Allied Exhibit 616, no testing of any amorphous metal samples of any of the respondents had been undertaken by Allied. (TR 1745).

700. Of the six samples for which data is shown on Allied Exhibit 616, the data for two out of the six samples is not representative of isotropic tensile properties. (TR 1740).

701. Of the 11 sets of data set forth on Exhibits 615 and 616, Dr. Laska found that three of those sets of data failed to *satisfy* the hypothesis of the equality *of* the means. (TR 1793).

702. The remaining samples for which data *is* shown on Allied Exhibits 615 'and 616 failed to reject the hypothesis of equal means. (TR 1793).

703. The final circulated T-value calculated by Dr. Laska based on the data shown in Allied Exhibit 616 does not appear on that exhibit. (TR 1827).

704. Even after discarding strip,samples which.Allied personnel could vis wally perceive did not have a uniform cross section and therefore would not exhibit isotropic tensile properties under Allied's definition, two out of the six samples which were tested did not exhibit isotropic tensile properties, as reflected on Allied Exhibit 616. (TR 1740).

705. The decision made by VAC not to sell amorphous metal strip having a width' greater than 7 mm in the United States was made before VAC undertook its tests for tensile strength in connection *with this case.* (TR 3480).

706. VAC currently offers for sale in the United States only amorphous metal that does not exceed 7 mm in width. (TR 3383).

707. VAC made *tests* for tensile strength on VAC's VITROVAC alloys and Allied Metglas alloys for the purpose of this investigation. (TR 3408).

708. VAC in the normal course of its business undertakes measurement of tensile properties. (Warlimont TR 3403).

709. The testing undertaken by VAC was done according to standard testing procedures of the type utilized by VAC in the normal course *of its* business. (TR 3408-3409).

710. The specimens for which tensile testing *was* undertaken were made with a restricted cross section in the middle, as *is* standard, in order to avoid erroneous information caused by breaking in the grips of the testing machine, as would occur *if* the specimens were rectangular (or unindented) in shape. (TR 3408).

711. Exhibit' P—/153 represents the VAC test data for tensile testing undertaken *for* the purpose of this investigation. (TR 3409).

712. The last'page of Exhibit P-1153 shows the shape of the samples for which tensile•testing was undertaken by VAC. (TR 3409-3410).

713. The sections of the amorphous ribbon from which the samples were cut for the purpose of generating the *data* shown in Respondents' Exhibit P-1153 were cut from regular intervals along the length of the strip. (TR 3411).

714. No pre—selection for the VAC alloys for which data is shown in Exhibit P-1153 was made in order to avoid taking samples from any particular location along the ribbon. (TR 3411).

715. Exhibit P-1153 has pairs of columns thereon designated according to the different alloys tested, with tensile strength plotted on the vertical axis. The *bars* in those columns identify the mean of all of the measurements that were made on one particular *series of* samples. The left column in each case shows measurements in the longitudinal direction and the right column shows measurements made in the transverse direction, the hatched area indicating the region in which the scatter is characterized by three times the standard deviation. (TR 3411-3412).

716. The purpose of undertaking the test for which data *is* shown in Exhibit P-1153 *was to* establish whether VAC ribbons and the Allied ribbons exhibited isotropic or anisotropic tensile strengths. (TR 3412).

717. None of the data shown on Exhibit P—I153 shows the ribbons tested to have isotropic tensile strengths as that *term is* utilized in the '739 patent, but rather shows in all cases anisotropic tensile strengths. (TR 3412).

718. Amorphous ribbon would not necessarily be stronger in the machine (longitudinal) direction as opposed to the transverse direction. (TR 3461).

4. <u>Nippon Steel</u>

719. Tensile testing of amorphous metal strips of Nippon Steel Corporation occurred on February 10 and 11, 1984, under the supervision of Allied tensile testing expert Dr. Glenn Sinclair. (Allied Phys. Ex. DDDDD). The results of the tensile testing of amorphous metal strips on February 10 and 11, 1984, appear in Allied Exhibit 677 and Sinclair Dep. Ex. 4. (Allied Phys. Ex. DDDDD).

720. Prior to February 10 and 11, 1984, Allied Corporation had conducted no tensile testing on amorphous metal strips of the respondents. (Davis TR 1745).

721. The tensile *tests* of the amorphous metal strips by Dr. Sinclair on February 10 and 11, 1984, were selectively conducted. The strips were inspected prior to testing in an attempt to avoid the effect of defects in the strips on the tensile test results. (Sinclair Dep. TR 23, line 15 to page 24, line 2).

722. Dr. Sinclair selected samples for testing on the basis that there would be little point in testing samples he knew were going to break at a lower tensile stress. (Sinclair Dep. TR page 31, lines 8-13).

723. Three Nippon Steel Corporation amorphous metal strips were tested on February 10 and 11, 1984. These three strips are identified as Nippon NartVU, Nippon Deposition and Nippon Wide. (Allied Phys. Ex. DDDDD, Sinclair Dep. Ex. 4, and Sinclair Dep. *TR* 65, lines 16-19). The Nippon Narrow, Nippon Deposition and Nippon Wide strips tensile testing results are tabulated in Sinclair Dep. Ex. 4 (Allied Ex. DDDDD).

724. Sinclair Dep. Ex. 11 *is* similar to Sinclair Dep. Ex. 4, i.e., the master sheets. Sinclair Dep. Ex. 11 has on it only the data recorded by Dr. Sinclair. (Sinclair Dep. TR 80, line 12 to page 81, line 8).

725. For the Nippon Narrow strip, the tensile strengths in the longitudinal and transverse directions are not identical or equal. (Sinclair Dep. 4 and Sinclair Dep. Ex. 11, table entitled Nippon. Narrow);-•

726. •For the Nippon Deposition strip, the tensile strengths in the longitudinal and transverse directions are not identical or equal. (Sinclair Dep. 4 and Sinclair Dep. Ex. 11, table entitled Nippon Deposition).

727. For the Nippon Wide strip, the tensile strengths in the longitudinal and transverse directions are not identical or equal. (Sinclair Dep. Ex. 4 and Sinclair Dep. Ex. 11. table entitled Nippon Wide).

728. The Nippon Deposition strip is statistically anisotropic or not isotropic. (Laska TR 5824, line 20 to 5825, line 1.)

729. The Nippon Deposition strip is not statistically isotropic, i.e., the mean in the longitudinal direction does not equal the mean in the transverse direction because the T-test rejected the hypothesis *of* equal means. (Laska TR 5825-5826).

730. The Nippon Narrow strip is not statistically isotropic. The Nippon Narrow strip rejected the null hypothesis and the means would have to be treated *as* different. (Laska TR 5826, lines 18-20).

731. The statistical analysis for the Nippon Wide strip was based on six readings in the longitudinal direction. *(Laska* TR 5825 and Sinclair Dep. Ex. 4 and 11 and Allied Ex. 677).

732. The statistical analysis for the Nippon Wide strip in the transverse direction was based on four readings. (Laska TR 5835 and Sinclair Dep. Ex. 4 and 11 and Allied Ex. 677).

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735. Twenty four tensile test readings were taken for the Nippon Wide strip. (Sinclair Dep. Ex. 3, 4 and 11).

736. Only six longitudinal tensile test readings for the Nippon Wide strip were transferred from the data sheets of Sinclair Ex. 3 to the Nippon Wide table in the master sheets of Sinclair Ex. 4 and 11.

737. Only four transverse tensile test readings for the Nippon Wide strip were transferred from the data sheets of Sinclair Ex. 3 to the Nippon *Wide table in* the master sheets of Sinclair Ex. 4 and 11.

738. The limited data used by Dr. Laska for statistical analysis of the Nippon Wide strip are the data appearing in the Nippon Wide table of Sinclair Ex. 4 and 11. (Allied Ex. 677; Sinclair Dep. Ex. 4 and 11; and Laska TR 5835).

739. All the amorphous metal strips inspected by Dr. Sinclair on February 10 and 11, 1984; had surface defects in a preferred orientation. (Sinclair Dep. TR 24, lines 10-11).

740. Dr. Sinclair testified that it *is* the fabrication process that usually produces these defects with a preferred orientation. (Sinclair Dep. TR 30, line 1 to 30.)

EQUITABLE DEFENSES

A. Inequitable Conduct at the Patent Office *in* connection with the '513 Patent Application

741. At the time the application for the '513 patent was filed, there was a desire at Allied to extend its patent protection to cover the periodic table. (Ex. P-1226, Dep.TR 18).

742. The scope of the claims of the '513 patent extends far beyond the alloy systems worked on by the inventors, both with respect to the constituent elements and the ranges of the atomic percentages of the constituent elements in the alloy compositions.

743. During the prosecution of the application resulting in the '513 patent, Dr. Chen and Dr. Polk published a paper describing their research on iron, nickel alloys falling within the scope of claim 1. This paper was approved for publication by the Allied Corporation Patent Department. The Chen and Polk paper discloses that two compositions within the scope of claim 1 of the '513 patent, Fen!'$_{18}$Al$_4$ and $Ni_{78}P_{18}Al_4$, were fully crystalline upon quenching from the melt. (TR 2957-2963; Ex. P-253, p. 172).

744. Allied did not disclose this information to the Patent and Trademark Office, although it was known to the inventors and their attorneys while the application for the '513 patent was pending. (Ex. P-444).

745. During the prosecution and pendency of the '513 patent•, Allied was: aware that an alloy system within the scope of the "M_aYbZ_c" claimed categories was understood by the inventors to be fully crystalline when quenched from the melt. (Ex. P-222; Ex. P-253).

746. This fact was known, or should have been known, to the patent attorneys handling the filing and prosecution of the '513 patent. (Ex. P-1224A, Dep. TR II 65-65).

747. If such information had been disclosed to the Patent Office, the Examiner would not necessarily have rejected the application, since the same alloys might have been made amorphous by using means other than quenching from the melt.

74e. If this information had been disclosed by Allied to the Examiner, the claims may have been narrowed or rejected, or-Allied might have been required to establish that the material could be made amorphous. By failing to disclose *this* information, the Examiner did not have the opportunity to determine *its* impact on the patentability of the claims. The failure to disclose was a material omission.

749. Allied, in attempting to overcome a rejection of the Examiner on Che overbreadth of *its* claims, asserted that the applicants had conducted "rigorous experimentation" necessary to set forth the elements of the formula "H", "Y" and "Z" and the proportions recited in the claims. (Ex. P-444).

750. There is no documentary evidence that either Dr. Chen or Dr. Polk or anyone at Allied had conducted the program of "rigorous experimentation" before the patent application had been filed.

751. The evidence suggests that such a program of "rigorous experimentation" could not have been conducted by the inventors without their discovering that many alloys within the claims of the patent could not be readily quenched from the melt into amorphous metals. In fact, Allied during the years 1979-1983, in connection with the prosecution of corresponding applications in Japan and Germany, conducted further experimentation and discovered that many alloys could not be made amorphous by liquid quenching from the melt.

752. During the short period of time the inventors were at Allied there was insufficient time for them to have done the experimentation to support the assertion of an extensive program of "rigorous experimentation."

753. The assertions of Dr. Chen that he prepared many of the alloys within claini 1 of the '513 patent, but failed to write them down is not supported by other•evidence in the record. The record shows from Allied's own 1979-1983 test program that alloy systems such as iron-carbon-aluminum and iron-carbon-silicon cannot be prepared by melt quenching, even though Dr. Chen asserted that he had prepared such compositions using melt quenching methods. (Ex. P-1210, Chen Dep. TR 18-22, 60-62).

754. There is no documentary evidence that any of the examples *in* the '513 patent were carried out before the prosecution of the patent application.

755. There is no alloy set forth in any of the inventors' notebooks corresponding to any of the examples in the patent. (Ex. P-688, Response to Interrogatory No. 115 of NSC).

756. Both Dr. Chen and Dr. Polk acknowledged that Allied Corporation did not own equipment for making amorphous alloys using the Pond-Maddin method, as is described in Example 3. (Ex. P-1210, Chen Dep. TR 139-140; *Ex.* P-1224, Polk Dep. TR 134). Both inventors admit that Example 3 of the '513 patent was not carried out by them.

757. Neither Dr. Chen nor Dr. Polk performed the flash .evaporation samples set forth in Examples 18-24. (Ex. P-1210, Chen Dep. TR 79, 134; Ex. P-1224, Polk Dep. *TR* 129-130, 134-136; Ex. P-1224A, Polk Dep. TR II 229-230; Ex. P-1226, Cline Dep. TR 50-51). There is no documentary evidence that these examples ever were performed by anyone at Allied.

758. The withdrawal of the Examiner's rejection of the claims of the '513 patent under 35 U.S.C. §112 suggests that applicant's argument as to the "rigorous experimentation" was a persuasive argument in overcoming the rejection and permitting the patent to issue. (Ex. P-444).

B. Inequitable Conduct at the Patent Office in connection with the '257 and '739 Patent Applications

3V. Misrepresentations to the Patent Office

759. During the prosecution of the Narasimhan process patent, Allied asserted to the Patent Office that *this* process was patentably distinct from prior art processes for casting amorphous metal because the Narasimhan process was capable of producing strips that had "isotropic tensile properties" and that were superior to. the strips produced by prior art casting processes. (Ex. P-450, Amendment of August 24, 1979 at p. 5).

760. The '257 patent and the '739 patent represented that strip made in accordance with the Narasimhan process has isotropic tensile properties because i it has identical tensile strength in both the transverse and longitudinal directions. (Ex. P-449, Col. 10, lines 55-61). In fact; Allied had no support for *this* assertion. Isotropic tensile propertiei are not referred to in the inventor's disclosure (Ex. P-449), and Allied has failed to show that any such tensile strength tests were in fact conducted.

761. In the prosecution of the '739 patent, Allied argued that the existence of "isotropic tensile properties" was a reason for finding that the Narasimhan strips were patentable over prior art amorphous metal strips. (Ex. P-452, Amendment of September 30, 1981, at p. 2). Allied had no support for such a distinction. Allied gave the Patent Office the impression in the file wrapper and in the specifications that tests had been run showing identical tensile strengths in the transverse and longitudinal direction. (Ex. P-452, Application at p. 20-22, '739 patent, Allied Ex. 20, Col. 12).

762. In the specifications of the '257 patent and the '739 patent, Allied' attempted to distinguish the prior art *wide* amorphous strip described in L. Patent 3,862,658 to Bedell (Ex. P-401) by stating that such strip had anisotropic properties, but Allied had no test results to support *such an* assertion. (TR 655).

2. Double Patenting

763. When the Examiner advised Allied that claims to the Narasimhan strip had to be placed in a separate patent application because such strips could be made by processes materially different from the Narasimhan piocess, Allied acquiesced without traverse in this position by the Examiner. (Ex. P-450, Examiner's amendment of January 17, 1980, at p. 1). The Allied attorneys involved in the prosecution of the patent, including the one with whom the Examiner spoke, believed that there were no other processes which could produce the Narasimhan strip (Fuchs Dep. 121; Buff Dep. 42), but did not object to the position taken by the Examiner. By failing to object to the Examiner's position, Allied obtained a separate strip patent which issued more than 18 months after the method patent. By obtaining a separate patent on the strip made only by the '257 process, Allied would have extended the patent monopoly on the '257 process patent for one and one-half years, if both patents were found to be valid.

C. **Patent Misuse and Antitrust Violations**

[Findings numbered 764 through 866, pages 204 through 227, classified as business confidential.]

D. The Due Process Defense of Nippon Steel

867. On April 13, 1983, the Commission published a notice in the Federal Register initiating an investigation in *this* matter.

868. Pursuant to 19 U.S.C. 51337(b)(1), a final determination must be made in an ITC proceeding within 12 months of its commencement, except when the case is designated "more complicated." Then up to 18 months are allowed. On September 16, 1983, the proceeding was designated "more complicated" in view of, inter alia, the complicated nature of the technology involved. The Commission established a deadline of October 13, 1984, for the final determination. (Notice of Commission Review of Initial Determination, and More Complicated Designation).

869. On September 14, 1983, five months after the investigation was instituted, NSC *was* added as a respondent. (Order 18; Notice of Commission Decision Not to Review Initial Determination Adding Two Respondents). The complainant, Allied Corporation, in moving to add NSC, alleged it had only recently learned that Nippon Steel had made some shipments of samples of amorphous metal to GE. (Motion for Leave to Amend the Complaint). In fact, Allied *knew* of NSC's agreement to ship samples to GE before the investigation was instituted. NSC could have been named in the original complaint. (Exs. E-192; E-193).

870. At the same time the ITC designated the hearing more complicated, it entered an order shortening the period in 'Which the presiding officer must file an initial determination, setting a deadline of May 13, 1984,..13 months after the proceeding started. (Notice of Commission Review of Initial Determination, and More Complicated Designation; Notice of Denial of Petition for Reconsideration).

871. On November 3, 1983, the hearing in the proceeding was scheduled for January 16, 1984. (Notice to All Parties).

872. The timetable set in the proceeding provided a period of nine months for discovery and trial preparation for the respondents other than NSC. MSC, because. of its late addition to the proceedings, had only four months to take discovery and prepare for the hearing.

873. By the time that Nippon Steel was added to the proceeding, the other parties had already served and received responses to interrogatories, four hundred thousand (400,000) documents had been produced, depositions had been taken, and 27 orders had been entered in the proceeding. (See Motion of Respondents Nippon Steel Corporation and Nippon Steel U.S.A., Inc. For An Order Compelling Complainant to Provide Discovery).

874. NSC attempted to take advantage of the discovery taken by the other respondents. For example, 400,000 documents were produced by the complainant Allied to the other-respondents. The other respondents' counsel

selected 100,000 of these for copying. NSC requested Allied to produce the 400,000 documents for NSC's review, but Alrred refused to do so saying it would be "burdensome."

875. NSC's counsel did not receive any Allied documents until September 26, 1983, and the last of the set of 100,000 was not received until November 25, 1983.

876. Following a motion to compel by NSC ()lotion of Respondents Nippon Steel Corporation and Nippon Steel U.S.A., Inc. For an Order Compelling Complainant to Provide Discovery), Allied provided access to a portion of the remainder of the set of 400,000 documents to NSC's counsel during the *first* week of December, 1983. NSC failed to move to compel further information or to move for sanctions. .

DOMESTIC INDUSTRY

877. Metglas Products, an unincorporated but separate operating unit of Allied Corporation, conducts Allied's *business* in amorphous metal alloys. (TR 2445, 2484-5). TDK is licensed by Allied to sell certain amorphous metal products made by TDK. (TR 3109; Allied Ex. 26, Ex.-T-2). Together, the activities of Metglas Products and the activities of TDK relating to manufacture and sale of products under the license, constitute the domestic industry. Allied uses_Permag Corporation as an independent distributor *of* some amorphous metal products for Allied. (TR 90). Allied has no ownership interest in Permag. (TR 90). Permag *is* not part of the domestic industry.

878.

879. Allied *is* using the "Planar Flow Casting Process" today. The process as practiced at Allied today is covered by at least Claim 1 of the '257 process patent, if claim 1 *is* read literally. (TR 1682-1686).

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881.

at Metglas Products are typical of workers found in other factories of Allied. (TR 420-421, Allied Ex. 281).

882. Reed Belden's title is Vice President and General Manager of the Metg'las Products unit of Allied Corporation. He has been in charge of Metglas Products since 1978. (TR 71-72). Dr. Colby, one of the senior vice presidents of Allied Corporation, is in charge of technology, including research, development and engineering. Re has responsibility for the commercial development of Metglas Products. (Allied Ex. 225, TR 2415-1416).

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891. Amorphous metal alloy ribbon is sold by Allied in standard widths of 1 inch, 2 inches, 3 inches and 4 inches. On some special orders, different widths are sold. Cm 76). The material.is shipped to customers on spools. (See Allied Phys. *Exs.* HR and II, TR 74).

892. Allied *is* practicing the '513 and '257 patents.

893-
902. Omitted.

903. The domestic industry is efficiently and economically operated.

INJURY

904. Most of the respondents either have exported amorphous metal products to the United States or imported such products.

1. TDK AND MHEN

905. TDK Corporation manufactures in Japan and exports to the United States magnetic tapeheads employing amorphous metal alloys under license from Allied Corporation. (Allied Exs. 26 and 656; TR 3109, Ex. T-2).

906. Under the license dated June 29, 1979, Allied agreed not to assert anywhere in the world patents owned or controlled by Allied against products made by the licensee and/or its customers under the license granted. (Ex. T-2; Allied Ex. 26).

907. Lawrence Livermore National Laboratory (LLL) is a United States Government owned, contractor operated facility. (Allied Ex. 656).

908. LLL is operated by the University of California under contract with the Department of Energy, an agency of the United States of America. (Ex. T-1; Allied Ex. 5).

909. Lawrence Berkeley National Laboratory (LBL) is a United States Government owned, contractor operated *facility.* (Allied Ex. 656).

910. LBL *is* operated by the University of California under contract with the Department of Energy, an agency of the United States of America. (Ex. T-9; Allied Ex. 46).

911. For several years the U.S. Government, through LLL, has been conducting research in the art *of* particle beam accelerators. (Exs. T-24, T-25, T-7 and Allied Ex. 48, 50, and 42).

912. At least as early as 1979, amorphous metal material *was* being evaluated for use -by LLL. *(Exs.* T-24, T-25; and Allied *Exs.* 48 and 50).

913. TDK responds to the procurement needs of ILL through MEW and C.B. King Associates (C.B. King). (Allied Ex. 656; TR 4341, 4358, 4359).

. 914. Emil Roxeny *is* the Regional *Sales* Manager for Respondent MH&W and has responsibilities for sales in the western United States and Canada. (TR 4340).

915. MFi4W is an importer -that buys directly from TDK in Tokyo and is the sole sales agent in the U.S. and Canada for TDK's Industrial Ferrite Division and microwave devices. (TR 4341, 4359).

916. C.B. King Associates is the sales representative for 24i6W in northern California. C.B. King Associates h'andles the northwestern United States and British Columbia for MH&W products. (TR 4358).

917. During a *visit* to Lawrence Berkeley Laboratory (LBL) *in* 1979, Mr. Hozeny of MH&W was asked by LBL representatives if TDK was involved with amorphous metal material. LBL wanted to know if TDK could supply such material. (TR 4341).

918. In July of 1979, TDK through MILSW and C.B. King Associates delivered nine (9) amorphous toroidal cores to Lawrence Berkeley Laboratories. *(Ex.* T-23; TR 4342).

919. There was no charge for the samples that were given to Lawrence Berkeley Laboratories. (TR 4345).

920. Dr. Daniel L. Birx *is* employed by LLL as a Physicist. Dr. Birx is Chief Researcher and Head of the Accelerator Development Group for the particle beam program at LLL. (Ex. T-25; Allied Ex. 50).

921. Mr. Louis L. Reginato *is* employed at LLL *as an* Electronics Engineer. (Ex. T-24, T-26; Allied Ex. 48).

922. In July, 1981, Mr. Takehiko Isomura of TDK and Mr. Hozeny of MHIN visited LLL. (Tr 3112).

923. All of the activities of TDK that involve amorphous metal *alloys* are under the direct supervision of Mr. Isomura. (TR 3139).

924. Mr. Isomura was told at the meeting in July, 1981, that LLL required an amorphous metal strip of approximately 15 microns thick. Dry Birx and Mr. Reginato told Mr. Isomura that they had asked General Electric and Allied to obtain this 15 micron thick strip material and were told that it was not available. (TR 3113).

925. Mr. Isomura was asked whether TDM could make such thin material. At that time, Mr. Isomura did not know and replied to them that he would ask representatives of TDK on his return to Japan. (TR 3112-3113; *Exs.* T-24, 1-25, T-26; Allied *Exs.* 48 and 50).

926. LLL personnel, including Dr. Birx and Mr. Reginato wanted to *obtain* a sample of such material if TDK could supply it. (Exs. T-24, 1-25; Allied Exs. 48 and 50).

927. LLL beam program personnel, including Dr. Birx and Mr. Reginato, had attempted to obtain a thinner improved form of amorphous metal strip *material* from Allied. (Exs. 1-24, T-25; Allied *Exs.* 48 and 50; TR 456).

928. Allied said that they could not supply such a material. (Exs. 1-24, 1-25; Allied *Exs.* 48 and 50; TR 457, 459 and 460; 2773).

929. LLL was unable to obtain *this* material from any other source. (Exs. T-24, T-21, T-25; Allied Exs. 50, 43).

930. TDK produced a 15 micron thick amorphous metal strip *in* April, 1982, and a sample of the material was sent by TDK to MH&W. (TR 3114).

931. In May, 1982, the TDK sample was delivered to LLL. (TR 4346; EX. T-29). At that time, the Narasimhan strip patent (U.S. Patent No. 4,331,739) was still a pending application. (Allied Ex. 19).

932. The TDK sample *was* too small for any meaningful electrical tests and so LLL asked for a bigger sample of at least 10 kilograms. (TR 4346 ; 3115-3116; Ex. T-26; Allied Phys. Ex. SS, p. 19).

933. TDK replied that *this* was a large quantity for them, and that it would take months to accumulate such thin strip material in a quantity of 10 kilograms. (TR 4347).

934. On October 1, 1982, Mr. Reginato sought to obtain approval from the United States Government for LLL to obtain sample material from TDK Corporation of Japan. (Ex. T-21; Allied Ex. 43).

935. The material requested of TDK was of foreign manufacture that required the Department of Energy (DOE) to grant LLL an exception to the Buy American Act. (Er. T-21; Allied Ex. 43).

936. LLL *said* that they had considered domestic. sources, in particular, Allied and General Electric. LLL stated that there were no known domestically produced equals. (Ex. T-21; Allied Ex. 43).

937. As part of the required justification, LLL stated that the unique feature of the requested material which prevents using items of domestic manufacture *is* that the material *is* the only magnetic amorphous material available that is 15 micrometers thick. (Ex. T-21; Allied Ex. 43).

938. The work to be done by LLL required a one inch by 0.6 mil thick (15 micrometers) amorphous metal tape to wind magnetic toroid cores in an effort to eliminate air gaps and achieve a near solid cast with flexibility. *(Ex.* T-21; Allied *Ex.* 43).

939. To the best of LLL's knowledge, as of October, 1982, there were no domestic equivalents that would meet LLL's work requirements. (Ex. T-21; Allied *Ex.* 43).

940. On October 27, 1982, the United States Government, through the Department of Energy, determined that the purchase by LLL of the 10 kilogram sample from TDK was an exception to the Buy American Act. (Ex. T-21).

941. In October of 1982, the 10 kilograms of amorphous metallic ribbon were delivered by TDK.

942. Because of the urgent need for the material, the 10 kilogram sample was supplied before a formal purchase order could be issued. This *was* done at the specific request of LLL. (TR 4349).

943. On November 29, 1982, Purchase. Order No. 9409201 issued to cover the 10 kilograms of amorphous metallic ribbon previously delivered in October, 1982. (Ex. T-1; Allied Ex. 5).

944. Purchase Order No. 9409201, issued by Lawrence Livermore National Laboratory, contains an authorization and consent clause. Under this clause, the Government gives its authorization and consent for all use and manufacture, in the performance of the purchase order or any part thereof or any amendment thereto or any subcontract thereunder of any invention described in and covered by a patent of the United States embodied in the structure or composition of any article the delivery of which *is* accepted by the Government under the purchase order. (Ex. T-1; Allied Ex. 5).

945. Purchase Order No. 9409201, *issued* by LLL, did not contain a patent indemnity clause.

946. The material requested in Purchase Order No. 9409201 was determined to be outside of the requirements of the Buy American Act. (Ex. T-1, T-21; Allied Ex. 5).

947. On January 3, 1983, MR6W on behalf of TDK quoted to LLL 170 kg of amorphous ribbon, 25.4 millimeters wide by 15 microns thick at $100 per kilogram. (Ex. T-12).

948. On January 3, 1983, LLL issued a Request for Quotation (Request No. 1044605) based on the verbal quote from M0i6W.

949. When MILSW vent back to TDK to get *a* confirmation, they were told'to hold up on the sale and on the quotation. (TR 4352).

950. In December of 1982, TDK was notified by NAMCO that the material supplied to LLL infringed Allied's patents. (TR 3116-3117; Ex. T-6; Allied Ex. 7).

'51. TDK immediately notified MEW who in turn notified LLL that TDK would not continue any further activity on *this* project until the matter was cleared up. (TR 3117, 4353; Ex. T-13; Allied Ex. 44).

952. On March 24, 1983, NSW notified LLL that TDK would "no bid" RFQ No. 1044605 because of legal pressure exerted upon TDK by Allied Corporation. (Ex. T-15; Allied Ex. 44).

953. As of March 28, 1983, LLL still wanted to proceed with the procure-sent of TDK's thin material. (Ex. T-16; Allied Ex. 44).

954. LLL offered to *indemnify* TDK *so* that they could obtain enough material to do further testing. (Ex. T-26). TDK would not produce thin amorphous metal material under any proposed order of LLL under any conditions. (Ex. T-26, TR 2811; Allied *Phys. Ex. SS).*

955. LLL indicated to Allied a desire to purchase material thinner than *the* typical ribbon thickness available from Allied in early 1980. (TR 456).

956. Allied refused to supply samples until such time as LLL could indicate that they needed a larger quantity. (TR 457).

957. At the time that LLL first requested an amorphous metal sample from Allied, there was no indication of any consequential business. Allied did not supply the sample. .(TR 459-460).

958. Mr. Belden of Allied told Dr. Birx thit Allied would be willing to make products for LLL once Allied could determine that there was a potential for commercial business. (TR 71, 72 and 468).

959. In December of 1982, a sample of the TDK amorphous metal material was given to Mr. Mark Rand of Allied by LLL after the material was delivered to LLL in October, 1982. (Exs. T-24, T-25, T-26; Allied Exs. 48, 50, TR 2754 and 2755).

960. After giving the TDK sample to Mr. Rand, LLL kept pressing for some samples from Allied. (TR 2735, 2754 and 2755).

961. From 1980 until early 1983, LLL tried unsuccessfully to obtain thin amorphous metal strip material from Allied. (Ex. T-26, p. 37; Allied Phys.Ex. SS; TR 456 and 457; TR 2812).

962. In the early .part of 1983, Allied, for the first time, tried to supply LLL with samples of thin amorphous•metal *ribbon.* (TR 2812; Ex. T-8; Allied Ex. 45).

963. Allied did not try to supply thin amorphous metal strip to LLL until after TDK supplied *its* thin amorphous metal strip to LLL. (TR 2812).

964. LLL indicated that the samples supplied by Allied were not as thin as they wanted them to be. (TR 2812).

965. The first time acceptable thin samples were delivered to LLL by Allied was in April of 1983. (TR 2814; *Ex.* T-8; Allied Ex. 45).

966. As late as March 28, 1983, Allied could not supply thin strip (thickness less than about 0.6 mil) on a commercial basis. (Ex. T-8; Allied Ex. 45).

967. As *late as* March 28, 1983, Allied had not fully investigated the properties of thin amorphous metal strip it proposed to supply to LLL. (Ex. T-B; Allied Ex. 45).

968. On March 28, 1983, Allied was prepared to supply ample quantities of thin amorphous alloy strip to LLL. (Ex. T-8;•Allied Ex. 45).

969. On April 5, 1983, LLL, through Mr. Reginato and Dr. Birx, agreed to the terms established by Allied. (Ex. T-8; Allied Ex. 45).

970. On May 3, 1983, Lawrence Livermore National Laboratory issued a request for quotation to Allied Corporation for 100 kilograms of 0.6 mil thick material. (Ex. T-9; Allied Ex. 46).

971. Subsequently, Allied sought delays in actual delivery of undetermined length in order to develop the capability to provide this material. (Ex. T-24; Ex. T-25; Allied Exs. 48 and 50).

972. Dr. Birx was made aware by Mr. Rand several times that Allied would be having some problems in making the shipments. (Ex. T-27; Allied Phys. Ex. TT). The problems concerned the automatic pick-up on the machine that winds the ribbon. (Ex. T-27).

973. Allied deligiered the full order about July t, 1983, about two weeks late. (Ex. T-26.; Allied Phys. Ex. SS).

974. If Allied had not received the sample of the thin TDK material from LLL, Allied eventually may have supplied the material to LLL, but it Would have taken much longer than it did. (TR 2818).

975. In a letter dated March 28, 1980, Roy H. Massengill of Allied wrote to Hr. Y. Otoshi, Executive Vice President of TDK Electronics Co., Ltd., indicating the surprise of Allied that TDK had offered amorphous products in the United States which infringed Allied's Chen and Polk patent (U.S. Patent No. 3,856,513). (Allied Ex. 3). In a letter dated April 7, 1980, Mr. M. Matsushima, patent manager of TDK Electronics Co., Ltd., wrote to Roy H. Massengill indicating that TDK would be more cautious in the future not to repeat *this* kind *of* matter. (Allied Ex. 4).

976. In *a* letter dated January 11, 1983, Mr. Matsushima again wrote to *Roy* H. Massengill concerning an infringement problem. The letter was in response to an inquiry made by Mr. Knutson of NAMCO to the *effect that* the amorphous metal strip TDK had been supplying to LLL was infringing Allied's patents. Mr. Matsushima acknowledged infringement of Allied's patent No. 4,331,739 and apologized for the trouble it may have caused Allied. Again, it was indicated that steps•would be taken by TDK to prevent it from ever happening again. (Allied Ex. 7).

977. TDK refused to supply amorphous metal alloy material to LLL because of the.present ITC investigation. (TR 3135).

978. The capacity of TDK is adequate to import sufficient amorphous metal alloy to have the tendency to injure Allied's domestic injury. (Allied Ex. 657).

979. Allied did not consider pulse power to be a potential market for thin amorphous metal strip until 1983. (TR 459 and 460, 2812).

980. As late as October, 1983, Allied did not possess a process for producing less than 0.6 mil denier thickness. amorphous metal ribbons under routine conditions. (Allied Ex. 287).

981. As late as October, 1983, Allied *was* working on a process for the production of about 0.5 mil denier thickness amorphous metal ribbons. (Allied Ex. 287).

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984. the increase in Allied's 1983 sales of amorphous metal took place in the pulse power area of specialty magnetics as a result *of* the development *in* 1983 of a thin strip amorphous material by Allied. (Allied Ex. 269).

985. Allied expects revenues from sales of amorphous metal *in* 1984 to improve because of large increases in the pulse power area. (Allied Ex. 269).

986. Allied *is* presently conducting research and development to take advantage of the opportunity in the pulse power market. (Allied Ex. 269).

987. Mr. Belden was unaware of any advertising by TDK here *in* the United States regarding amorphous metal material. (Belden, TR 453).

988. Besides tapeheads and the transactions with LBL and LLL, TDK has never imported amorphous metal material into the United States or solicited or attempted to sell'or promote amorphous metal alloys and materials in the United States. (TR 3117).

989. Apart from the license with Allied Corporation, neither TDK Corporation nor TDK Electronics Corporation is now importing into or exporting to the United States amorphoUs metal alloy or material. (TR 3117-3118).

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1039. At the Intermag conference in Philadelphia in April, 1983, VAC displayed tape wound cores made of amorphous materials. (TR 2740-2741).

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1042. The brochure entitled "VAC DEVELOPS AMORPHOUS METALS — VITROVAC" (Allied Ex. 14) has been distributed in the United States by VAC. The brochure was first distributed in mid-1981. Approximately 3300 copies of the brochure have been distributed throughout the United States. (VAC Interrog. Resp. 44 and 45 of Allied Ex. 515).

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1046. Mark *Rand,* Metglas Products' electromagnetic marketing representative, visited the Intermag Conference in Philadelphia in 1983 where VAC had a booth displaying tape—wound cores made from amorphous metal materials. Mr. Rand spoke with Dr. Marik of VAC about these cores. Dr. Marik indicated that VAC was offering these cores for sale in the United States. These cores were made *of* VAC's alloy 6025 and 4040. (Tr 2740-2741).

1047. VAC's brochure (CX 390) describes its amorphous metal alloy material that is suitable for *use in* transformers for 100 k hertz switch mode power supplies. Hetglas Products sells an alloy which would be suitable for use in *this same* application. (TR 2741-2742).

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4. Hitachi

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1052. Hitachi Metals, Ltd. ran an ad for amorphous metals in the March 21, 1983, issue of Fortune magazine, p. 16. (Allied Ex. 13).

1053. Allied Exhibit 8 *is* a photograph of the Hitichi booth at the 4th Inter national conference on Rapidly Quenched Metals, Sindai, Japan, 8/24-8/28/81.

1082. Hitachi Metals International, Ltd. had an exhibit at the POWERCON 10 Conference in San Diego, California, on March 21-25, 1983. (Stipulation S of Allied *Ex.* 656).

1083. At the POWERCON 10 show in California, 1983, Hitachi had a display booth exhibiting tape wound cores made of amorphous metal material. (TR 2748). Mr. Betts of Hitachi Metals International, Ltd. *was* attending the booth. *(TR* 2750).

1084. At the POWERCON 10 show in California, 1983, Hitachi offered to sell to Magnetics Incorporated amorphous metal alloy *strip.* (TR 2752).

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B. The practices *of* the respondents tend to injure the Domestic Industry

1094. The respondents have begun a sampling process with potential buyers in the transformer market. They have begun advertising. The sampling process *is* critical in *this* type of industry. The *first* step *is* for the customer to recognize a need for a product to solve a particular problem. The second step *is* the evaluation, in which the customer attempts to obtain samples of the material so that it can see whether it meets the customer's needs. The role of sampling in the buying process is critical. Sampling enables the potential buyer to begin to qualify the supplier. Once the product *is* qualified, then the buying process can begin. (TR 4430-4431). The qualification process may take a year or two years.

1095. If the potential supplier has exported samples to the United States before the patent expires, and these samples have been qualified, then Allied has lost the lead time that otherwise would have been required for the competitor to become qualified. (TR 4431-4432).

1096. Two kinds *of* delay damages may result from infringement by a potential competitor. Damage may occur in the first year because the potential buyer, seeing a potential second source, begins to compare and evaluate the product of the infringing competitor and may begin to qualify the infringing competitor, instead of buying from Allied immediately. Allied may lose early sales of the product while the buyer sees whether the product can be obtained from a second source at a lower cost. Later, if the infringing competitor becomes qualified before the expiration of the patent, then as soon as the patent expires, the infringer may begin selling to the customer, without taking additional time to'qualify his product. (TR 4434-4435)

1097. In regard to the distribution transformer market, the *demand* for Allied's amorphous metal alloy ribbon *is* derived from the needs of the utility companies, rather than the distribution transformer manufacturers, who are Allied's customers. (TR 4437).

1098. A buyer's preference for a second source frequently *is* motivated by interest in reducing the price of the product, which may well occur when two suppliers compete for sales to a customer. (TR 4442).

1099. **Lf infringing products are imported prior'to the expiration of a valid patent, Metglas Products' potential gain may be less, and the risk of failure may be greater, causing the company to decide not to invest further. (TR 4452-4453).**

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"Exhibit B"

The claims of the '513 patent read as follows:

1. A metal alloy of the formula M_aYbZ_c which *is* <u>at least 50 percent</u> amorphous and wherein M *is* a metal selected from the group consisting essentially of iron, nickel, chromium, cobalt, or vanadium or a mixture thereof. Y is a metalloid selected from the group consisting of phosphorous, carbon and boron or a mixture thereof, and Z is an element selected from the group consisting of aluminum, silicon, tin, antimony, germanium, indium, and beryllium and mixtures thereof, "a", "b" and "c" are atomic percentages ranging from about 60 to 90, 10 to 30 and 0.1 to 15, respectively, with the proviso that a *plus* b plus c equals 100.

2. The amorphous metal alloy of claim 1 wherein "a", "b" and "c" range from 69 to 84.5, 15 to 25, and 0.5 to 6, respectively.

3. The amorphous metal alloy of claim 1 wherein up to about one-fourth of the metal M is replaced by elements commonly alloyed with iron or nickel.

4. As Sn article of manufacture, sheets, ribbons and powders of the amorphous metals hairing the compositions of claim 1.

5. As an article'of manufacture, sheets, ribbons and powders of the amorphous metals having the compositions of claim 3.

6. As an article of manufacture, a <u>metal wire</u> comprising as alloy -which is at least 50 percent amorphous and having a composition of the - formula $T.X_j$ wherein T is a transition metal or mixture of said transition metals and X is an element selected from the group consisting of aluminum, antimony, beryllium, boron, germanium, carbon, indium, phosphorous, silicon, tin, and mixtures thereof and wherein i and j are in atomic percentages and 'range 'from about 70 to about 87 and from about 13 to about 30 tespectively:

7. 'The article of claim 6 wherein i ranges from about 74 to about 84 and j ranges from about 16 to about 26.

S. Amorphous metal wire of claim 6 wherein iron comprises at least 60 atomic percent of T.

The claims of the '257 patent read as follows:

1. A method of forming continuous strip of amorphous metal from a molten alloy capable of forming an amorphous structure comprising:

a. forcing the molten alloy under pressure through a slotted nozzle positioned generally perpendicular to the direction of movement of a chill surface and located in close proximity to the chill surface to provide a gap of from about 0.03 to about 1 millimeter between *said* nozzle and the chill surface;

b. advancing, the chill surface, at a predetermined speed; and

c. quenching the molten metal in contact with the chill surface at a rapid rate to effect solidification into a continuous amorphous metal strip.

2. The method of claim I wherein the chill surface is advanced relative to said nozzle at a velocity of from about 200 to about 2000 meters per minute.

3. The method of claim 1 wherein the molten alloy *is* quenched at a rate of at least 10^{4}° C per second.

4. The method of claim 1 wherein the slotted nozzle is located in close proximity to the chill surface to provide a gap. of from about 0.03 to about 0.25 millimeter between said nozzle and the chill surface.

5. The method of claim 1 wherein the slotted nozzle has a width of from about 0.03 to about 1 millimeter, measured in direction of movement of the chill surface.

6. The method of claim 5 wherein the step of forcing the molten alloy through the slotted nozzle *is* conducted under vacuum of from about 100 to about 3000 microns.

7. The method of claim 5 wherein the step of forcing the molten alloy through the slotted nozzle is conducted in an inert atmosphere.

8. The method claim 1 wherein the chill surface is provided by a rotating chill roll, and the molten alloy is deposited onto its peripheral surface.

9. The method of claim 8. further comprising the step of directing a stream of inert gas against the surface of the chill roll ahead of the point of contact between the molten alloy and the chill surface.

10. The method of claim 1 wherein the chill surface is provided by moving belt.

11. The method of claim 1 wherein the chill surface is provided by a moving endless belt.

12. The method of forming continuous strip of amorphous metal from a molten alloy capable of forming an amorphous structure, comprising:

(a) forcing the molten metal under pressure through a slotted nozzle onto the peripheral surface of a chill roll, wherein said nozzle is located in close proximity-to said peripheral surface such that the gap between the nozzle and said peripheral surface is from about 0.03 to about 1 millimeter, wherein the nozzle has a width of from about0.3 to about 1 millimeter, measured in the direction of rotation of the chill roll, and wherein. the nozzle is positioned generally perpendicular to the direction of rotation of the chill roll;.

(b) rotating the chill roll at a predetermined speed to provide a peripheral velocity of from about 200 to about 2000 meters per minute; and

(c) quenching the molten metal in contact with the peripheral chill roll surface at a rate of at least about $10^{4 \circ}$ C per second to effect solidification into a continuous amorphous strip.

13. The method of forming continuous strip of amorphous metal from a molten alloy capable of forming an amorphous structure, comprising:

(a) forcing the molten metal under pressure through a slotted nozzle onto the surface of an endless chill belt, wherein said nozzle is located in close proximity to said surface such that the gap between the nozzle and said surface is from about 0.03 to about 1 millimeter, wherein the nozzle has a width of from about 0.3 to I millimeter, measured in longitudinal direction of the belt, and wherein the nozzle is positioned generally perpendicular to the longitudinal direction of the belt;

(b) advancing the belt at a predetermined speed of from about 200 to about 2000 meters per minute; and

(c) quenching the molten metal in contact with the surface of the belt at a rate of at least about 1040 C per second to effect solidification into a continuous amorphous strip.

The claims of the '739 patent read as follows:

1. A strip of amorphous metal having a width of at least 7 millimeters, and having isotropic tensile properties.

2. A strip according to claim 1 having thickness of at least about 0.02 millimeters.

3. A strip according to claim 2 having width of at least about 1 centimeter.

4. A strip according to claim 2 having width of at least about 3 centimeters.