In the Matter of

CERTAIN PORTABLE ELECTRONIC CALCULATORS

Investigation No. 337-TA-198

USITC PUBLICATION 1732

JULY 1985

United States International Trade Commission / Washington, DC 20436

UNITED STATES INTERNATIONAL TRADE COMMISSION

Address all communications to
Kenneth R. Mason, Secretary to the Commission
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Washington, DC 20436

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U.S. INTL. TRADE COMMISSION

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

In the Matter of

CERTAIN PORTABLE ELECTRONIC CALCULATORS

Investigation No. 337-TA-198

NOTICE OF COMMISSION DECISION NOT TO REVIEW INITIAL DETERMINATION OF NO VIOLATION OF SECTION 337 OF THE TARIFF ACT OF 1930

AGENCY: U.S. International Trade Commission.

ACTION: Nonreview of initial determination.

SUMMARY: Notice is hereby given that the Commission has determined not to review an initial determination (ID) that there is no violation of section 337 of the Tariff Act of 1930 in the above-captioned investigation.

FOR FURTHER INFORMATION CONTACT: Wayne Herrington, Esq., Office of the General Counsel, U.S. International Trade Commission, telephone 202-523-3395.

SUPPLEMENTARY INFORMATION: The authority for the Commission's action is contained in section 337 of the Tariff Act of 1930 (19 U.S.C. § 1337) and in section 210.53-.56 of the Commission's Rules of Practice and Procedure (49 F.R. 46123, Nov. 23, 1984; to be codified at 19 C.F.R. §§ 210.53-.56).

The Commission instituted this investigation on July 5, 1984, in response to a complaint filed by Texas Instruments Inc. (TI), of Dallas, Texas to determine whether there is a violation of section 337 in the importation of certain portable electronic calculators into the United States, or in their sale, by reason of alleged infringement of claims of U.S. Letters Patent 3,819,921. Complainant TI alleged that the effect or tendency of the unfair acts was to destroy or substantially injure an industry, efficiently and economically operated, in the United States. Numerous firms, both foreign and domestic, were named as respondents. A notice of investigation was published in the Federal Register of July 18, 1984 (49 F.R. 29162).

An evidentiary hearing was held before the presiding administrative law judge. Appearances were made by counsel for complainant TI, counsel for certain respondents, and by the Commission investigative attorney.

On April 18, 1985, the administrative law judge issued an ID that there is no violation of section 337 in the importation or sale of the portable electronic calculators under investigation. Specifically, the administrative law judge found that the '921 patent was valid, but that there was no infringement of the '921 patent and no industry in the United States with respect to the patented calculators. The ALJ also made findings on several other issues.

Complainant TI filed a petition for review of various portions of the administrative law judge's ID. Respondents Nam Tai, IMA, and Enterprex filed a "conditional" petition for review. No agency comments were received.

On June 10, 1985, the Commission determined not to review the ID, but limited its adoption of the ID to the following issues:

1. The '921 patent is valid.

2. The '921 patent is not infringed.

3. There is no "industry . . . in the United States" because the TI calculators are not covered by the claims of the '921 patent.

The Commission takes no position with respect to the other issues discussed in the ID. That is, the Commission neither affirms nor reverses the ID with respect to those other issues. (Vice Chairman Liebeler does not reach the question of the existence of an industry in the United States.)

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

By order of the Commission.

Kenneth R. Mason
Secretary

Issued: June 10, 1985

CERTIFICATE OF SERVICE

I, Kenneth R. Mason, hereby certify that the attached Notice was served upon Denise DiPersio, Esq. and upon the following parties via first class mail, and air mail where necessary on June 11, 1985.

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PUBLIC INSPECTION

UNITED STATES INTERNATIONAL TRADE COMMISSION
Washington, D.C.

In the Matter of CERTAIN PORTABLE ELECTRONIC CALCULATORS	)	Investigation No. 337-TA-194

INITIAL DETERMINATION

Pursuant to the Notice of Investigation in this matter (49 Fed. Reg. 29162, July 18, 1984), this is the Administrative Law Judge's initial determination under Rule 210.53 of the Rules of Practice and Procedure of this Commission, 19 C.F.R. § 210.53. The Administrative Law Judge hereby determines, after a review of the briefs of the parties and of the record developed at the hearing, that there is no violation of Section 337 of the Tariff Act of 1930, as amended (19 U.S.C. § 1337, hereinafter § 337), in the unauthorized importation into the United States, and in the sale of certain portable electronic calculators by reason of alleged infringement of claims 1, 2, 6, 7, 30, 37, 41 and 53 of U.S. Letters Patent No. 3,819,921, with the effect or tendency to destroy or substantially injure an industry efficiently and economically operated in the United States.

TABLE OF CONTENTS

ABBREVIATIONS

CPFF : Complaint's Proposed Findings of Fact

CPFFR: Complaint's Proposed Rebuttal Findings of Fact

CPH : Complaint's Post -Hearing Brief

CPHR : Complaint's Post-Hearing Reply Brief

CPX : Complaint's Physical Exhibit

CX : Complaint's Exhibit

RPFF : Respondents' Proposed Findings of Fact

RPFFR: Respondents' Proposed Rebuttal Findings of Fact

RPH : Respondents' Post-Hearing Brief

RPHR : Respondents' Post-Hearing Reply Brief

RPX : Respondents' Physical Exhibit

RX : Respondents' Exhibit

SPFF : Commission Investigative Staff Proposed Findings of Fact

SPH : Commission Investigative Staff Post-Hearing Brief

SPHR : Commission Investigative Staff Post-Hearing Reply Brief

SPX : Commission Investigative Staff Physical Exhibit

SX : Commission Investigative Staff Exhibit

FF : Administrative Law Judge Findings of Fact

ALJX : Administrative Law Judge Exhibit

Exh : Exhibit

Tr : Hearing Transcript

PROCEDURAL HISTORY

On June 8, 1984, Texas Instruments, Inc. ("TI"), 13500 North Central Expressway, Dallas, Texas 75265, filed a complaint with the U.S. International Trade Commission under § 337 of the Tariff Act of 1930, as amended (19 U.S.C. § 1337, hereafter § 337). The complaint and its supplements filed June 28 and July 2, 1984 alleged unfair methods of competition and unfair acts in the importation into the United States of certain portable electronic calculators, or in their sale, by reason of alleged infringement of claims 1 and 6 of U.S. Letters Patent No. 3,819,921 ('921 patent). It was further alleged that the effect or tendency of the unfair methods of competition and unfair acts is to destroy or substantially injure an industry, efficiently and economically operated in the United States. The complaint and its supplements requested that the Commission institute an immediate investigation, schedule and conduct a hearing on permanent relief pursuant to § 337, and issue a permanent exclusion order and permanent cease and desist orders.

Upon consideration of the complaint and its supplements, on July 5, 1984, the Commission ordered that an investigation be instituted pursuant to subsection (b) of § 337 to determine whether there is a violation of subsection (a) of § 337, as alleged by TI. The notice of such investigation was published in the Federal Register on July 18, 1984 (49 Fed. Reg. 29162).

The following twenty-one parties were named as respondents in the Notice of Investigation:

APF Electronics ("APF")
43-28 37th Ave.
Long Island City, New York 11101

Cosmo Corporation ("Cosmo")
16502 N.W. 16 Court
Miami, Florida 33169

Dah Sun Electronics Co., Ltd. ("Dah Sun")
7th Floor, Flat A on Loong Fty Bldg.
11-13 Luk Hop St.
San Po Kong
Kowloon, Hong Kong

Enterprex ("Enterprex")
P.O. Box 30508
Los Angeles, California 90030

Far East United Electronics Ltd. ("Far East")
171 Bun Hoi Road
Kwun Tong
Kowloon, Hong Kong

FLX (HK) Ltd. ("FLX)
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Tronica Electronic Engineering Co. Ltd. ("Tronica")
6/8/9/12/14/15F, Sang Hing Ind. Bld.
83 Ta Chuen Ping St.
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N.T., Hong Kong

Voesa Ltd. ("Voesa")
Room 1301 Tak Shing House
20 Des Voeux Road Central
Hong Kong

Cal-Comp Electronics (Cal-Comp), Inventa Electronics (Inventa), and Tandy Corporation (Tandy) were named, as proposed respondents, in the complaint (¶¶ 3.24-3.26) but were deleted from the Notice of Investigation at TI's request. (Letter to the Commission from Richard Donaldson dated June 29, 1984, p. 2).

Denise T. DiPersio, Unfair Import Investigations Division, U.S. International Trade Commission, was named as Commission investigative attorney, a party to the investigation.

By Order No. 1, issued July 19, 1984, the Chief Administrative Law Judge Donald K. Duvall designated Paul J. Luckern as Administrative Law Judge in the investigation.

Responses to the complaint and Notice of Investigation were filed with the Commission by the following respondents: Cosmo, Dah Sun, Enterprex, IMA, Nam Tai and Tronica. Respondents Fordstech and Success have submitted letter responses to the complaint and Notice of Investigation (SX-3,4). Service of the complaint and Notice of Investigation was perfected on respondents Cosmo, Dah Sun, Enterprex, Fordstech, General Electronics, Hua Chang, Integrated, IMA, Luks, MBO, Mino, Nam Tai, Promoters, Success and Tronica. (SX-2).

No acknowledgment of receipt of the complaint and Notice of Investigation was received by the Office of the Secretary from respondents APF or Far East. (SX-2). This fact was confirmed with the Office of the Secretary on March 11, 1985.

On August 10, 1984, complainant TI, respondent Sears, and the Commission investigative attorney filed a joint motion to terminate this investigation, as to Sears, on the basis of a settlement agreement. (Motion Docket No. 198-11). The Administrative Law Judge issued an initial determination granting this motion (Order No. 11, issued August 24, 1984). The Commission declined to review the initial determination. (Notice of Commission Decision Not to Review Initial Determination Terminating Respondent on the Basis of a Settlement Agreement, issued September 20, 1984).

In a letter dated August 3, 1984, respondent Luks contended that it had been invalidly served with the complaint and Notice of Investigation because Luks' name and address were incorrectly stated. By Order No. 15, issued September 13, 1984, the Administrative Law Judge issued an initial determination amending the complaint and Notice of Investigation to reflect the following address for respondent Luks:

5th Floor, Cheong Wah Industrial Bldg.
39-41, Sheung Heung Road
Tokwawan, Kowloon, Hong Kong

The Commission did not review the initial determination. (Notice of Commission Decision Not to Review Initial Determination Amending Complaint and Notice of Investigation, issued October 15, 1984).

On August 23, 1984 respondent Voesa submitted a telegram requesting an extension of time in which to respond to the complaint (Motion Docket No. 198-19). Since Voesa had been in receipt of the complaint and Notice of Investigation and copies of all related documents received by the Commission since on or about August 10, no good cause was found for a further extension of time and Voesa was ordered to repond to the complaint no later than September 21, 1985 (Order No. 16, issued September 13, 1985).

On September 17, 1984, complainant TI filed a motion to disqualify the law firm of Burns, Doane, Swecker & Mathis from representing respondents Nam Tai, Enterprex, and IMA in this investigation (Motion Docket No. 198-27). The Administrative Law Judge denied complainant's motion. (Order No. 21, issued September 28, 1984). Complainant, on October 2, 1984, filed a request for leave to file an application for interlocutory review of Order No. 21. (Motion No. 198-33). The Administrative Law Judge granted TI's request in Order No. 28, issued October 23, 1984. The Commission denied complainant's application for review. (Notice of Commission Decision Denying Application for Interlocutory Review, issued December 20, 1984).

Complainant TI, on October 15, 1984, filed a motion to amend the complaint and notice of investigation to allege infringement of claims 1, 2, 6, 7, 30, 37, 41 and 53 of the '921 patent. (Motion Docket No. 198-36). The Administrative Law Judge issued an initial determination granting complainant's motion. (Order No. 31, issued November 16, 1984). The Commission declined to review the initial determination. (Notice of Commission Decision Not to Review an Initial Determination Amending Complaint and Notice of Investigation, issued December 19, 1984).

On December 12, 1984, respondent Tronica was ordered to show cause, no later than December 17, 1984, why it should not be found in default (Order No. 34). In a "Statement of Counsel For Tronica Relative To Complainant's Motion For Sanctions", counsel for Tronica stated, in response to Order No. 34, that he "has not been authorized by Tronica to take a position in its defense with respect to the Motion for Sanctions."

Although all non-settling respondents, except APF, were served with discovery requests by complainant TI only respondents Dah Sun, Nam Tai, IMA, and Enterprex have given any responses.

On December 19, 1984, complainant TI and respondent FLX filed a joint motion to terminate this investigation, as to FLX, on the basis of a settlement agreement. (Motion Docket No. 198-57). The Administrative Law Judge issued an initial determination granting this joint motion. (Order No. 57, issued December 31, 1984). The Commission declined to review this initial determination. (Notice of Commission Decision Not to Review Initial Determination Terminating Respondent on the Basis of a Settlement Agreement, issued January 31, 1985).

On December 18, 1984, complainant TI and respondent RJP filed a joint motion to terminate this investigation as to RJP on the basis of a settlement agreement. (Motion Docket No. 198-55). The Administrative Law Judge issued an initial determination granting this motion. (Order No. 58, issued December 31, 1984). The Commission declined to review this initial determination. (Notice of Commission Decision Not to Review Initial Determination Terminating Respondent on the Basis of a Settlement Agreement, issued January 31, 1985).

On February 8, 1985 respondents Far East, Fordstech, Hua Chang, Integrated, MBO, Mino, Promoters, Success, Luks, Voesa, General Electronics and Cosmo were ordered to show cause, no later than February 18, 1985, why they should not be found in default (Order No. 72). No responses to the Order to Show Cause were received.

A prehearing conference was held on January 28, 1985, and the final hearing commenced on that same day before the Administrative Law Judge to determine whether there is a violation of § 337. Appearances were made by counsel for complainant TI, the Commission investigative attorney, and respondents Nam Tai, IMA, and Enterprex. The hearing concluded on February 8, 1985. Closing oral arguments were made on March 8, 1985.

The issues have been briefed and proposed findings of fact submitted by the participating parties. The Commission investigative attorney has also submitted proposed conclusions of law. The staff took no position with respect to either the alleged infringement of the '921 patent or its validity or enforceability. The matter is now ready for decision.

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

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

JURISDICTION

The Commission has *in rem* and subject matter jurisdiction in this investigation, under § 337, since the alleged unfair methods of competition and unfair arts involve the importation into, and sale in, the United States of portable electronic calculators, the alleged effect or tendency of which is to destory or substantially injure an industry, eficiently and economically operated, in the United States.

Service of the complaint and Notice of Investigation was perfected on nineteen of the named respondents Cosmo, Dah Sun, Enterprex, FLX, Fordstech, General Electronics, Hua Chang, Integrated, IMA, Luks, MBO, Mino, Nam Tai, Promoters, RJP, Sears, Success, Tronica and Voesa. No acknowledgement of receipt of the complaint and Notice of investigation was received by the Office of the Secretary from two of the named respondents, *viz.* APF or Far East. (FF 1, 2).

OPINION

I. THE PATENT AND PRODUCTS IN ISSUE

This investigation involves allegations of infringement of claims 1, 2, 6, 7, 30, 37, 41 and 53 of the '921 patent. (FF 65). This patent entitled "Miniature Electronic Calculator" issued on June 25, 1974 to inventors Jack S. Kilby, Jerry D. Merryman and James H. Van Tassel. The patent is assigned to complainant TI. (FF 63).

The '921 patent is based on application Ser. No. 317,493 filed Dec. 21, 1972 which in turn is a continuation of abandoned application Ser. No. 143,192 filed May 13, 1971. Ser. No. 143,192 was a continuation of abandoned application Ser. No. 671,777 filed September 29, 1967. (FF 64).

Independent claim 1 recites a miniature, portable, battery operated electronic calculator. The entire calculator is said to be contained within a "pocket sized" housing. (FF 65). Each of independent claims 6, 30 and 53 is to a minature electronic calaulator. (FF 65). The claims in issue require that the claimed calculator comprise an input means, including a keyboard for entering digits of numbers and arithmetic commands with said keyboard including a single set of decimal keys for entering numbers in sequence as well as command keys. Those claims also include an electronic means comprising an integrated semiconductor circuit array located in substantially one plane with the area occupied by the integrated semiconductor array being no greater than that of the keyboard. Said integrated semiconductor circuit array comprises a memory means, arithmetic means for performing the arithmetic function, and a system for selectively transferring numbers from the memory to the arithmetic means and back to the memory for storage. The claimed calculator in issue further contains a means for providing a visual display coupled to the integrated semiconductor circuit array and responsive to control signals for indicating an answer. (FF 65).

The products in issue are certain non-printing portable electronic calculators which allegedly fall under the asserted claims. Desktop calculators are excluded from those products. (FF 61). The portable electronic calculators in issue can be divided into two main classes: "four-function" (alternatively termed "consumer handheld," "basic-handheld," or "general purpose") calculators and "professional" calculators. Professional calculators include both "scientific" and "business" (alternatively termed "financial") calculators. (FF 62).

II. VALIDITY OF THE '921 PATENT AS TO THE PRIOR ART

Pursuant to 35 U.S.C. 282, a patent is presumed to be valid and the person alleging invalidity has the burden of proving, by clear and convincing evidence, facts which establish that the claims are invalid. Jones v. Hardy, 727 F.2d 1524, 1528, 220 U.S.P.Q. 1021, 1024 (Fed. Cir. 1984). Respondents not only have the procedural burden of establishing a prima facie case, but the burden of persuasion remains on the respondents and the "clear and convincing" standard does not change. TP Laboratories, Inc. v. Professional Positioners, Inc., 724 F. 2d, 965,971. 220 U.S.P.Q. 577,582 (Fed. Cir. 1984). Moreover a challenger's "burden of proving invalidity is made heavier" when the United States Patent and Trademark Office considered the prior art relied upon in advance of the hearing. Fromson v. Advance Offset Plate, Inc., Nos. 84-1542, 84-1553 (Fed. Cir., Feb. 21, 1985).

The test under 35 U.S.C. § 103 for patentability is whether the claimed invention, considered as a whole, would have been obvious or nonobvious at the time it was made in view of the prior art as a whole. Environmental Designs Ltd. v. Union Oil Co. of California, 713 F. 2d 6593, 698, 218 U.S.P.Q. 865, 870 (Fed. Cir. 1983), cert. denied, 104 S. Ct. 709 224 U.S.P.Q. 520 (1984); Jones v. Hardy, 727 F.2d at 1529, 220 U.S.P.Q. at 1025; Carl Schenck A.G. v. Norton Corp., 713 F.2d 782,785, 218 U.S.P.Q. 698, 700 (Fed Cir. 1983). It is not proper to limit the focus of inquiry to the structural differences between the claims and the prior art and to attempt to show that the differences alone would have been obvious. Carl Schenck, A.G. v. Norton Corp., supra, 713 F.2d at 785 218 U.S.P.Q. at 700. It is also improper to select and rely on isolated portions of references while disregarding the teachings of those references when read in their entirety. W.L. Gore, & Associates Inc. v. Garlock, Inc. 721 F.2d 1540, 1547, 1550, 220 U.S.P.Q. 303, 311.

Respondents Nam Tai, IMA and Enterprex (hearing respondents) urge that except for the downsizing features, the entirety of the claimed subject matter is found in such prior art desk calculators as the Frieden calculators, a Wang et al U.S. Patent No. 3,402,285 (the '285 patent) calculator, and a "Green Machine". The "missing" downsizing aspects of the asserted claims are said to be taught by a Moore publication which is "illustrated with a picture of a handheld personal computer". (RPH p. 20).

Patent claims are the measure of a patent grant. Construction of claims to ascertain the intended boundaries of a patent grant must be made by reference to the patent's specification. Coleco Industries, Inc. v. U.S. Intl. Trade Comm. 573 F. 2d 1247 197 U.S.P.Q. 472,476 (1978).

In the FIG. 14 preferred embodiment of the '921 patent the claimed integrated semiconductor circuit array comprises four integrated semiconductor circuits, three integrated semiconductor shift registers and two resistors all interconnected and arranged on an insulating substrate. (FF 82, 85, 87). FIGS. 15-18 illustrate the logic circuitry of the integrated semiconductor circuit array of the FIG. 14 preferred embodiment. FIG. 15 has 151 functional unit NAND gates interconnected on a substrate or quadrant. FIGS. 16, 17, and 18 have respectively 132, 135 and 116 functional unit NAND gates interconnected on substrates. (FF 85). In the preferred embodiment the input means comprises a keyboard encoder which accomplishes in substantially one plane the generation of unique electrical signals at its output terminals corresponding to the selected information inscribed on the tops of keys of the keyboard. (FF 67-70). The display means in the preferred embodiment is a thermal printer. (FF 116-122).

According to inventor Kilby, it was TI's president in 1964 who felt that the integrated circuit could provide an interesting new electronic small calculator, perhaps using a slide rule as a size reference. (FF 152). The "Cal-Tech" project started in 1965 at TI had as its goal the production of a miniature, portable electronic calculator. A first working prototype of a calculator, based on the preferred FIG. 14 embodiment of the '921 patent, was completed in March 1967. The prototype operated four hours between battery charging. (FF 153-178).

Parts of two other Cal-Tech prototypes, built according to the FIG. 14 preferred embodiment of the '921 patent were completed and assembled in March 1967. One of the prototypes was delivered to TI's then president. That unit is now in the possession of the Smithsonian Institution. The second prototype is now in inventor Kilby's possession. The third prototype has been retained by the TI Patent Department. (FF 178). One of the Cal-Tech prototypes was in the hearing room. (FF 179). It was approxiamtely six inches in length and four inches in width. Its average height was approximately one one-half inches. It has eighteen keys, could be hand held and weighed approximately two pounds thirteen and one half ounces. (FF 189).

The prior art Frieden desk calculator, relied on by the hearing respondents, was believed by inventor Kilby to come on the market in 1965.

(FF 292). When the Cal-Tech project began at least one electronic calculator was on the market. This calculator was the "Anita" made in Great Britain. Inventor Kilby purchased one for examination and found that it was designed using a unique type of logic with neon tube elements arranged as decade counters. No integrated circuits were used. The display was a set of "Nixie" tubes. Physically the "Anita" was quite large, probably about 20 inches wide, 12 inches high and about 16 inches deep, its weight was probably of the order of 25 pounds. (FF 214(a)).

The Frieden desk calculator had an input means, including a keyboard for entering digits of numbers and arithmetic commands into the calculator and for generating signals. (FF 292). It also had an electronic means responsive to the commands for performing arithmetic calculations on the entered numbers and for generating control signals. (FF 294). The electronic means in the Frieden calculator comprised memory means, arithmetic means and means for selectively transferring numbers. (FF 293). It used discrete transistors for its logic circuitry. The entire Frieden desk calculator, including the keyboard, the electronic means, and the digital display means, was contained within a very large housing. (FF 296). The electronic means in the Frieden desk calculator did not comprise an integrated semiconductor circuit array as the term is defined in the '921 patent specification. (FF 215, 297). The display of the Frieden calculator was a cathode ray tube, making the unit physically somewhat larger and heavier than the "Anita". Several thousand discrete transistors provided the logic. No integrated circuits were used. Both the Frieden and the "Anita" calculators sold for $2,000 or more in the United States and both were considered desk machines. Both of the calculators took more space on a desk than would have been desirable even for the desk mode of operation. (FF 215).

Inventor Kilby testified that later "perhaps in 1966", Frieden "announced" a second generation machine which was "the first in its line to use integrated circuits." (FF 297). It was not established by the hearing respondents when this second generation machine was specifically announced, constructed and out on the market. The second generation machine however used several hundred integrated circuits for its logic. (FF 297). Like the first generation Frieden desk calculator, the second generation Frieden calculator was a "line operated" desk calculator. The second generation Frieden calculator was believed by Kilby to be smaller than the first generation calculator, probably about 8 inches by twelve inches by 6 inches. (FF 298).

The Wang '285 patent entitled "Calculating Apparatus" relied on by the hearing respondents issued September 17, 1968 on an application filed September 22, 1964. (FF 299). The Wang calculator includes an input register and a log register, each having an adder circuitry. Included in the calculator is a means for generating logarithmic signals. (FF 300). All the elements of sub-paragraph "a" of claim 1 of the '921 patent are included in the calculator of the Wang patent. (FF 303). Also TI admits that the Wang calculator has an electronic means for performing the arithmetic calculations marked on Wang's command keys. (FF 304). FIG. 1 in the Wang patent is a diagrammatic view of the control panel of a "desk top calculator". FIG. 2 is a logic block diagram of apparatus employed in that calculator. The Wang patent does not disclose what the physical embodimenmt of the disclosed calculator is. There is no drawing of the overall package. There is no suggestion of construction details. (FF 301, 302). There is no indication in the Wang patent of the particular type of memory employed, i.e. whether it is a core memory or discrete components. (FF 301). Nowhere in the Wang patent is there any mention of the use of integrated circuits. (FF 308).
While TI's technical expert Jerald Leach confirmed the electronic means of Wang included means for selectively transferring numbers from the memory means through the arithmetic means and back to the memory means in a manner

dependent upon the commands to effect the desired arithmetic operation before it took place, his testimony was predicated on the omission in the Wang calculator of an "integrated senmiconductor circuit array". (FF 306). Similarly while TI's Kilby and Leach confirmed that the Wang patent discloses a means for providing a visual display coupled to the electronic means and responsive to the control signal for indicating the answer, their testimony was conditioned upon the use of the term "electronic means" and not the more specific "integrated semiconductor circuit array" required in the language of the claims of the '921 patent in issue and disclosed in the '921 patent. (FF 305). The calculator of the '285 patent was commercialized under the name Loci. However in the first commercial version of the Loci, the control panel with electronics was in a large cabinet which occupied about half a desk. A later model of the Loci had a separate box for the electronics which was put on the floor. (FF 307).

The Wang '285 patent was included in a list of prior art references cited to the Patent and Trademark Office during the prosecution of the application which became the '921 patent. (FF 245, 309). The Examiner did not even consider the Wang '285 patent to be sufficiently pertinent to reject any claims of the '921 patent application on the '285 patent. (FF 245-258).

Thomas E. Osborne, technical expert for the hearing respondents (FF 260-265), as an independent consultant in 1964, built the "Green Machine" relied upon as prior art by the hearing respondents. (FF 260).[1/] The Green

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1/ TI asserts that the Green Machine has not been shown to be prior art. (CPH p. 9). Inventor Kilby's testified that the Green Machine cannot be considered prior art because no description of the machine has ever been published to the best of his knowledge and there has been no attempt to patent the machine during the period in interest. (Kilby, CX-1A, pp. 1,11). Prior invention in the United States by another (35 U.S.C. 102(g)) who has not
(Footnote continued to page 17)

Machine, which was present in the hearing room (FF 267), is contained in a green cabinet and a tan cabinet. Both cabinets are required for the machine to operate and in addition a third piece, a power supply, fits inside the tan cabinet. The green cabinet contained the input and the display unit. The display is provided by a small cathode ray tube. The tan cabinet contained the primary electronics which performed the arithmetic operations in response to key strokes and produced modulating signals to generate a display. Logic gates are in the circuitry of the Green Machine. (FF 268).

The dimensions of the green cabinet of the Green Machine are approximately sixteen inches deep by eight inches by eight one-half inches across. (FF 269). The weight of the green cabinet is approximately four pounds. (FF 270). The tan cabinet contained all the primary electronics and was approximately fourteen inches long by ten inches wide and eight inches high. Most of the space in the tan box was taken up by a direct current power supply. The power supply was capable of producing far more than the fifteen to twenty watts required to operate the Green Machine. (FF 271). The circuit boards containing the semiconductor logic circuitry were physically connected together. (FF 272). There were many circuit boards. (FF 273). At the time the Green Machine was built there were integrated circuit chips that would have allowed Osborne to make the Green Machine "much, much, much smaller" but at "much, much, much, much more power". (FF 274).

(Footnote continued from page 16)
abandoned, suppressed or concealed the invention is prior art for the purposes of applying the obviousness standard of 35 U.S.C. 103. Sutter Products Co. v. Pettibone Mulliken 428 F.2d 639, 166 U.S.P.Q. 100 (7th Cir. 1970); In re Bass 474 F. 2d 1276, 177 U.S.P.Q. 178 (C.C.P.A.); See also Chisum Patents Vol. 2 Section 5.03[3](1984). Osborne did not abandon, suppress or conceal the Green Machine. It is on exhibition at the Smithsonian Institute (FF 267) and invention rights to the Green Machine were sold by Osborne to Hewlett Packard. (FF 285).

Visual inspection and photographs of the Green Machine and the Cal-Tech prototype taken in the hearing room showed the Cal-Tech prototype to be smaller than either the tan cabinet or the green cabinet of the Green Machine. (FF 276). A Ferrite core memory in the Green Machine was approximately five inches by three and one-fourth inches by two inches which approximates the total dimensions of the Cal-Tech calculator. (FF 278). The memory of the Cal-Tech prototype in contrast is contained in three shift registers, each smaller than a fingernail. (FF 278). The Green Machine was constructed totally from discrete components. There are some solid state parts which are the transistors. All of the transistors are of the bipolar semiconductor type. (FF 279).

From the foregoing analysis of the Green Machine, Wang patent calculator and Frieden calculators it is clear to the Administrative Law Judge that the hearing respondents are incorrect in their assertion that except for the "missing" downsizing aspects of the claims in issue, these prior art desk calculators contain the entirety of the claimed subject matter in issue. None of that prior art even suggested, as the primary electronics of the desk calculators, the "integrated semiconductor circuit array" taught in the specification of the '921 patent. The Wang and Green Machine calculators do not even suggest the use of integrated circuitry.

The hearing respondents argue that the "missing" downsizing aspects are taught in a Moore publication. (RPH p.20). This publication entitled "Cramming more components onto integrated circuits" appeared in an April 18, 1965 issue of Electronics. (FF 310). The publication does not even suggest anything comparable to equipping the Green Machine or the Wang or Frieden calculators with an integrated semiconductor circuit array as called for by the '921 patent. The Moore publication is absent any detail about integrated circuits, their design, implementation, or how they might be used in a calculator. (FF 311-317). Moore does refer to integrated circuits but the publication is merely a generalization of what could happen in the future. (FF 311-317). No specific means are provided by any of the cited references including the Moore publication for implementing a miniature hand-held electronic calculator and the references considered by themselves are not even directed to such a device. Thus the illustration relied upon by the hearing respondents in the Moore publication shows a device which has a plug attached thereto. (FF 316).

In making the analysis under §103 set forth in Graham v. John Deere, 383 U.S. 1,148 USPQ 454 a tribunal must be careful to avoid the trap of beginning with knowledge of what the invention is and then using that knowledge as a basis to select and combine references to reach a conclusion that the invention was obvious. W.L. Gore & Associates, Inc. V. Garlock, Inc., supra 721 F. 2d at

1553; Stevenson v. U.S.I.T.C., 612 F.2d 546, 553 (CCPA 1979). As the Federal Circuit said in the Gore case:

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

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

There is additinal evidence in the record that supports patentability of the claimed subject matter. Under 35 U.S.C. §103, a claim can be invalid only when the invention set forth in that claim is obvious "to one of ordinary skill in the art". (Emphasis added). As an aid in determining obviousness, that requirement precludes consideration of whether the invention would have been obvious (as a whole and just before it was made) to the rare genius in the art, or to a judge or other layman after learning all about the invention. Stratoflex Inc. v. Aeroquip Corp. 713 F.2d 1530, 218 U.S.P.Q. 871, 879 (Fed. Cir. 1983).

The Administrative Law Judge finds Osborne, the hearing respondents' technical expert, to be a person of ordinary skill, at least, in the relevant art at the time the invention of the '921 patent was made. Osborne received a BSEE degree in 1957 and a MSEE degree in 1961. (FF 262). He first became involved in the design of small electronic calculators in 1962 (FF 262) which was approximately five years before inventors Kilby et al constructed the first prototype under the '921 patent. (FF 178). Osborne constructed the Green Machine in 1964. (FF 260). The Green Machine is not a calculator that could be held in one's hand (FF 267-275) and a comparison of the Green Machine with the Cal-Tech calculator conclusively establishes that the Green Machine was not a "miniature" electronic calculator as that term is used in the claims in issue specify. (FF 267-284). Moreover Osborne testified that if he were to have implemented the Green Machine in the integrated circuit technology existing in the mid-sixties, the Green Machine would have taken a section of table space that was probably six feet wide or six feet square. (FF 275). Osborne did contribute to the making of a handheld calculator, viz Hewlett-Packard' HP35 calculator. (FF 288). However the HP35 calculator did not become a reality until 1972, approximately five years after the Cal-Tech prototype became a reality. (FF 287). The Administrative Law Judge finds the testimony of Osborne and the HP35 further indicia of non-obviousness of the claimed subject matter.

The hearing respondents argue that while admittedly the Cal-Tech calculator was a lot smaller than the referenced prior art calculators, the Cal-Tech calculator and prior art calculators operate in the same way; that the arguments for validity relating to size differences are focused at a superficial level; that according to TI, from the difference in size it follows that a claim to a smaller calculator is ipso facto non-obvious; that the law, citing Frigidaire Corp. v. General Necessities Corp. 46 F.2d 58, 59 (6th Cir. 1931) is otherwise (RPHR p. 4). In the Frigidaire case however the court found that the proofs, as admitted by the patentee plaintiff, showed that the theory of the patent was exactly the same as that of the earlier prior art structures. Id. p. 59. In this investigation the hearing respondents have not established that the claimed calculator in issue operates in exactly the same way as the prior art calculators. In fact, the claimed calculator does not because it has an electronic means comprising an "integrated semiconductor circuit array" as defined in the '921 patent specification.

TI has urged additional considerations of non-obviousness, viz. commercial success, commercial acquiescence by acceptance of licensees, creation of an entirely new market, failure of others, use by others and recognition by others including awards. (CPH pp. 11-12, CPFF pp. 74-87).2/

2/ Obviousness or nonobviousness under 35 U.S.C. §103 is an ultimate legal conclusion to be determined on the basis of facts established by evidence, and evidence bearing on the facts is never of "no moment," is always to be considered, and is to be accorded whatever weight it may have. In re Mageli et al., 470 F.2d 1380,1384, 176 USPQ 305, 307 (CCPA 1973). Some courts however have not found it necessary to consider secondary factors when there are "substantial differences" between the prior art and the claimed subject matter. In Atlas Powder Co. v. E.I. Du Pont DeNemours 750 F.2d 1569, 1575, 1576 U.S.P.Q. (Fed. Cir. 1984), the Federal Circuit observed that the district court, in light of "substantial differences" between the prior art and the
(Footnote continued to page 22)

There are a number of TI licenses that include the '921 patent. However these licenses are not limited to only the '921 patent (FF 201-213) and in one of the licenses with Hewlett-Packard, TI paid Hewlett-Packard approximately one million dollars. (FF 203). Moreover the Administrative Law Judge is unable to find in the record any written contemporaneous documentation that the principal TI patent on which royalties are paid in the licenses is the '921 patent. TI has approximately 150 patents, exclusive of the '921 patent, related to and covering various aspects of portable calculators. (FF 210).

With respect to commercialization of the Cal-Tech prototype, TI and Canon Inc. did enter into a license and technical assistance agreement in October 1969 involving miniature portable calculators. (FF 189). The agreement was not however restricted to the '921 patent. (FF 189). A first Canon portable Pocketronic calculator was announced in 1970 and Canon sold several thousand of these units. (FF 190). While the Canon-TI agreement did include the '921 patent, a noticeable feature of the Pocketronic calculator was that it was the first calculator to have all its calculations performed by three MOS/LSI arrays. (FF 191, 193). One MOS/LSI chip provided timing and character generation for the printer, the second chip included key encoders, while the third chip provided various control circuits. For the control-logic chip, TI used then "new" technology which allowed logic functions to be defined on the chip merely by programing the connections on a single mask. (FF 193). Thus while the pocketronic calculator used MOS logic circuitry, the Cal-Tech calculator of the '921 patent used biploar logic circuitry. (FF 194). No discretionary wiring was used in the Pocketronic calculator. (FF 199).

(Footnote continued from page 21)
product claims, found it unnecessary to consider secondary factors, though they were raised by the patentee, and proceeded to find the patent in issue valid and agreed with the district court's conclusion of nonobviusness.

Discretionary wiring was used in the Cal-Tech calculator of the '921 patent. (FF 184). While one on the chips in the Pocketronic was a programmable logic array, the CAl-Tech calculator had no such programmable logic array. (FF 196). Hence there were substantial differences between the Cal-Tech prototype, which is based on the FIG. 14 preferred embodiment of the '921 patent, and the Pocketronic calculator.

TI has urged the creation of an entirely new market and recognition by others, including awards as indicia of non-obviousness of the claimed subject matter in issue. A 1976 publication, put in evidence by TI, did consider the Cal-Tech prototype the world's first miniature electronic calculator and the forerunner of more than 100 million in use as of January 1976. (FF 214). The publication also noted that the prototype has been accepted by the Smithsonian; for its permanent collection. (FF 214). However in the same publication it was said that a collection of integrated circuits, the working "heart" of electronic calculators also had been presented to the Smithsonian Institute; that included in the collection was the first "calculator-on-a-chip" which packed the equivalent of more than 6000 transistors on a tiny piece of silicon about one-quarter-inch square. It was said that it was this complex chip, introduced by TI in 1971, that made it possible to produce electronic calculators at prices more generally affordable and sparked an explosive market growth which hearlded the age of the low-cost consumer handheld calculator. (FF 214). An even more complex integrated circuit in the collection presented to the Smithsonian was the world's first general purpose "computer on a chip" introduced by TI in 1974. This mini-computer was said to contain both logic and memory functions - the equivalent of 8000 transistors in a chip two-tenths of an inch square which ten years ago would have required 500 integrated circuits to equal its data processing capability. (FF 214). While TI argues that the '921 patent created an entirely new market, the publication stated that the technological breakthrough that made the miniature electronic calculator possible was the invention of the integrated circuit by inventor Kilby in 1958. (FF 214).

Thus while the Cal-Tech calculator may have had a role in the commercialization of a portable handheld calculator, in the creation of an entirely new market, and in a licensing policy and has been recognized through awards, the record contains other decisive factors which contributed to these objective indicia.

Based on the foregoing, the Adninistrative Law Judge concludes that the hearing respondents have not met their burden of establishing the invalidity of claims 1, 2, 6, 7, 30, 37, 41 and 53 of the '921 patent by clear and convincing evidence over the prior art. The presumption of validity afforded those claims under 35 U.S.C. §282 remains unrebutted and in full effect.

III. INFRINGEMENT

TI has the burden of proving by a preponderance of evidence that the respondents have infringed claims 1, 2, 6, 7, 30, 37, 41 and 53 because TI is the patent owner. Envirotech Corp. v. Al George, Inc., 730 F.2d 753, 221 USPQ 473, 477 (Fed. Cir. 1984); Roberts Dairy Co. v. United States, 530 F. 2d 1342, 1357 182 USPQ 218, 225 (Ct. Cl. 1976); See Chisum Patents § 18.06 Vol. 4 (1982). Citing Hughes Aircraft Co. v. United States, 717 F. 2d 1351, 1361, 219 USPQ 473, 480 (Fed. Cir. 1983), TI admits that it has that burden (CPH p. 15). To find infringement it is necessary for the Administrative Law Judge determine that every element of a claim alleged to be infringed is found in the accused device, Mobil Oil Corp. v. Filtrol Corp., 501 F.2d 282, 291 (9th Cir. 1974) -- that the accused device is a copy either without variation, or with such variations as are consistent with its being in substance the same thing. Engelhard Industries, Inc. v. Research Instrument Corp., 324 F.2d 347, 352 (9th Cir. 1963), quoting Burr v. Duryee, 68 U.S. 531, 573, 17 L. Ed. 664 (1963). American Hoist & Derrick Co., v. Manitowac Co., 202 U.S.P.Q. 705, 706 (7th Cir. 1979).

Each of the claims in issue is for a miniature electronic calculator (FF 65). Each of said claims comprises a combination which includes means or steps for performing a specified function. These steps comprise: (a) an input means including a keyboard for entering digits and arithmetic commands and thereby generating signals; (b) electronic means responsive to said signals for performing arithmetic calculations and for generating control signals, said electronic means comprising an "integrated semiconductor circuit array" located in substantially one plane with its area being no greater than the keyboard, the array in turn comprising (i) memory means for storing the entered digits, (ii) arithmetic means for arithmetically combining said digits and storing the resulting answer in the memory means and (iii) means for selectively transferring numbers from the memory means to the arithmetic means and back to the memory means in a selectable manner depending upon the commands; and (c) display means for displaying a resulting answer. (FF 65). Accordingly any infringement analysis is governed by paragraph 6 of 35 U.S.C. §112 which reads:

> An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof. [Emphasis added]

In addition a threshold issue in this investigation, as to whether the accused calculators infringe the claims in issue, is a determination of the meaning of the phrase "integrated semiconductor circuit array" which appears in each of said claims. That phrase was coined by the inventors for use in the '921 patent. (FF 76).

Applicable Law

Means For Claims

Paragraph 6 of 35 U.S.C.§112 eliminates any need to find a definition for the input means, the electronic means or the display means per se in the claims in issue. Moreover to interpret "means for" limitations as limited to a particular means set forth in the specification or to a structure representing the preferred FIG. 14 embodiment of the '921 patent (the Cal-Tech prototype) (FF 179) would nullify the provision of § 112 requiring that the limitation shall be construed to cover the structures described in the specification and equivalents thereof. As the Federal Circuit said in D.M.I., Inc., v. Deere & Co. Appeal No. 84-1475 (slip opinion dated March 4, 1985):

> Patentees are required to disclose in the specification some enabling means for accomplishing the function set forth in the "means plus function" limitation. At the same time, there is and can be no requirement that applicants describe or predict every possible means of accomplishing that function. The statute, § 112-6, was written precisely to avoid a holding that a means-plus-function limitation must be read as covering only the means disclosed in the specification. [slip opinion p. 6].

However, "means for" claims according to § 112, are not to be read in a vacuum and only can be construed by reference to the specification. Hale Fire Pump Co. v. Tokai, Ltd. 614 F.2d 127, 205 USPQ 123,126 (CCPA 1980). In Hale the question presented to the Court was whether respondents' pumps included a "releasable means" recited in a claim 1. The releasable means was defined in claim 1, as:

> releasable means having means for moving said volute assembly into an assembled position interiorly of the casing and for moving said volute assembly into a disassembled position whereby on releasing of said releasable means alone permitting complete disassembly of said volute assembly from casing and any other interior parts of said pump.

Because the Court was dealing with a "means for" type claim, reference was made to 35 U.S.C. §112. The Court found that the only structure described in appellant's specification which corresponded to the releasable means was a reversible jack screw assembly. Therefore, the releasble means in claim 1 was construed to cover a reversible jack screw and "equivalents thereof". Because respondents' pumps "clearly" did not include a reversible jack screw, the Court looked to whether those pumps included "a functional equivalent." The Court noted that "[a]s properly stated by the ITC, under the doctrine of equivalents, the test is whether the allegedly infringing device employs substantially the same means to accomplish substantially the same result in <u>substantially the same way</u>." [Emphasis added] <u>Id</u>.

The Federal Circuit in <u>D.M.I.</u> set forth the analysis under 35 U.S.C. § 112 that must be made in determining whether an accused device infringes a "means for" claim. Initially it must be determined whether an accused device includes means which correspond to, or are equivalent of, the means, set forth in the claim in issue. An affirmative answer to that question establishes that the means of an accused device is at least an "equivalent" of the means in that claim. If an accused device includes all the other limitations of that claim, it establishes that said claim is literally infringed, because the entirety of the claim would "read" directly on the accused device. The Court in <u>D.M.I.</u> cautioned that the word "equivalent" in § 112 should not be confused with the "doctrine of equivalents"; that in applying the "means for" paragraph of § 112, the sole question is whether the means in an accused device, which performs the function stated in a claim, is the same as, or an equivalent of, the corresponding structure described in a patentee's specification for performing that function. Id. slip opinion pp. 8, 9.

If it is determined that an accused device does not include means which correspond to, or are equivalent of, the means in a claim in issue, the Federal Circuit in D.M.I. stated that the fact finder under the doctrine of equivalants must then determine the range of equivalents to which the claim is entitled, in light of the prosecution history, the pioneer-non-pioneer status of the invention, and the prior art; that in any such determination it must be determined whether the entirety of an accused device is so substantially the same thing, used in substantially the same way, to achieve substantially the same result as to fall within that range. Id. slip opinion at 8.

The role of the doctrine of equivalents in modern patent law was spelled out by the Supreme Court in Graver Tank & Mfg. Co. v. Linde Air Products Co., 339 U.S. 605, 610, 85 USPQ 328, 330 (1950) when the Court stated:

> Originating almost a century ago in the case of Winans v. Denmead, 15 How 330, it [doctrine of equivalents] has been consistently applied by this Court and the lower federal courts, and continues today ready and available for utilization when the proper circumstances for its application arise. 'To temper unsparing logic and prevent an infringer from stealing the benefit of an invention' [quoting from Judge L. Hand in Royal Typewriter Co. v. Remington Rand 1689 F.2d, 691,692, 77 U.S.P.Q. 517 518 (2nd Cir. 1948() a patentee may invoke this doctrine to proceed against the producer of a device 'if it performs substantially the same function in substantially the same way to obtain the same result. Sanitary Refrigerator Co. v. Winters, 280 U.S. 30, 42 [3 USPQ 40, 44] [Id.]

The doctrine of equivalents is applicable only when the accused device performs a function in substantially the same way even if the same functions is performed by a patented device. Hence the Administrative Law Judge, as a fact finder, must make a detailed analysis of how a function is performed in an accused device and a claimed device. In Sanitary Refrigerator, relied on by the Supreme Court in Graver Tank, at issue was whether a patent to a latch used in the manufacture of a refrigerators door was infringed. The Court found the accused latch, like the patented latch, had a keeper attached to the door casing, with a triangular head, and a lever latch with a handle and two arms whose functions were to trip or give a kick to the latch lever by their coaction with the keeper head, and wedge the lower arm under it, regardless of the position of the latch lever when the closing operation began. The Court stated that the only differences were that in the accused latch the keeper had on the inner or door side of the triangular head a lug projecting inwardly towards the latch lever with the upper arm of the latch lever being a short inclined cam placed at a pivot of the latch lever, and so constructed and at such an angle that it rode upon and contacted with the lug on the side of the keeper head, instead of with its upper curved side as in the patented structure. It was said that the coaction of this shortened arm with the lug operated, on the same principle, just as the coaction of the longer upper arm with the curved upper surface of the keeper head in the patented structure, to trip or kick the lower arm of the latch lever into the wedged position under the keeper head. 280 U.S. at 40, 41, 3 USPQ at 44.

Accordingly the Supreme Court in Sanitary Refrigerator found that despite the changes in the accused latch from the patented structure, the two devices were "substantially identical, operating upon the same principle, and accomplishing the same result in substantially the same way, and that the slight change in the form of the ...[accused] latch is merely a colorable departure from the ...[patented] structure". Id. at 41 and at 44. However only after the Court found that the accused and patented devices, irrespective of an identical result, operated in substantially the same way, was there an infringement.

Sanitary Refrigerator was decided by the Supreme Court in 1929. In 1946 the Supreme Court in Halliburton Oil Well Cementing Co. v. Walker 329 US 1, 71 USPQ 1 found a patent to an apparatus for measuring the depth of oil wells invalid on the ground that the claim in issue was "too broad" and "functional". In the Patent Act of 1952, Congress included in 35 USC § 112 the paragraph relating to functional claims. Direct legislative history concerning the purpose of that paragraph is meager. The Reviser's Notes stated simply that "A new paragraph relating to functional claims is added". Of interest however are the comments of P.J. Federico, then Examiner-in-Chief of the United States Patent Office:

> "The last paragraph of section 112 relating to so-called functinal claims is new. It provides that an element of a claim for a combination (and a combination may be not only a combination of mechanical elements, but also a combination of substances in a composition claim, or steps in a process claim) may be expressed as a means or step for performing a specified funtion, without the recital of structure, material or acts in support thereof. It is unquestionable that some measure of greater liberality in the use of functional expressions in combination claims is authorized than had been permitted by some court decisions, and that decisions such as that in Haliburton Oil Well Cementing Co. v. Walker ... are modified or rendered obsolete, but the exact limits of the enlargement remain to be determined. The language specifies 'an' element, which means 'any' element, and by this language, as well as by application of the general rule that the singular includes the plural, it follows that more than one of the elements of a combination claim may be expressed as different 'means' plus statements of function. The language does not go so far as to permit a so-called single means claim, that is a claim which recites merely one means plus a statement of function and nothing else. Attempts to evade this by adding purely nominal elements to such a claim will undoubtedly be condemned. The paragraph ends by stating that such a claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof. This relates primarily to the construction of such claims for the purpose of determining when the claim is infringed (note

> the use of the word 'cover'), and would not appear to have much, if any, applicability in determining the patentability of such claims over the prior art, that is, the Patent Office, is not authorized to allow a claim which 'reads' on the prior art."3/ [Emphasis added]

The Administrative Law Judge finds nothing in 35 U.S. § 112 nor its legislative history which overturns the finding in Sanitary Refrigerator that the doctrine of equivalents is applicable only when the accused device operates in substantially the same way as the patented device even when a means plus function claim is in issue.

Consistent with Sanitary Refrigerator is the CCPA's finding in Coleco Industries Inc. v. U.S. Intl. Trade Comm. supra. (1978). In that case an issue was whether the screws of imported swimming pools, as they cooperate with horizontal and vertical support members, constitute substantially the same means to accomplish substantially the same result in substantially the same way as the "depending retaining elements thereon" of the structure of a '917 patent. In a detailed analysis the Court stated that:

> [b]oth the screws in the allegedly infringing device and the tabs in [the device of a] '917 [patent] function as part of a locking structure. In '917 the tabs (92) or (95) extend from a plate-like piece, either a rail (26) or a locking plate (90), which, in an assembled state, is horizontal. The tabs extend through apertures (108) in the seating surface of the vertical support members (100) and thus cooperate with the apertures to restrict the relative movement of the horizontal and vertical support members (26) and (70).

The Court found that screws (A) of the imported pools employ substantially the same means, i.e., an elongated interlocking member. Furthermore, it was found that the screws (A) accomplish substantially the same result, i.e., restrict

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3/ Federico, "Commentary on the New Patent Act," 35 U.S.C.A. 1, 25-26 (1954).

relative movement between horizontal support members (C) and vertical support members (D), by extending through apertures in the horizontal support members (C), by resting on (although not permanently attached to) the horzintal support members (C), and by extending through apertures in the seating surface of the vertical support members (E). Finally, the screws (A) were said to function in substantially the same way, i.e., both the screws and tabs function by cooperating with matching apertures in vertical and horizontal members. It was only after this detailed analysis that the Court concluded that the screws were equivalent to the tabs, (573 F.2d at 1255, 197 U.S.P.Q. at 477).

The Commission, in determining whether a means for claim is infringed, looks at whether the accused device, which performs substantially the same function as the patented device, does it in substantially the same way or in different way. In <u>In re Certain Stablized Hull Units and Components</u> 218 USPQ 752,760 (1982) a claim 12 in issue included a claim 1. Claim 1 was a "means plus function" claim. Part of claim 1 required a vertical scan drive means operably coupled to a transducer to rotate said transducer about a transverse axis for vertical scanning without affecting the independent pivotability of said transducer and support means. Such vertical scan drive means was described in column 5, lines 1 to 4 of the specification of an '638 patent in issue as follows:

> The pinion and ring gears form a transducer drive mechanism for varying the orientation of transducer 29 relative to frame 39 without disturbing the alignment of the transducer with the gravity vector.

The Commission stated that the specification then went on to describe the elaborate gear mechanism that makes up the transducer drive mechanism, i.e., the vertical scan drive means. This mechanism was said to convey motion from a platform above the pendulum down to tilt the transducer without affecting the pendulous suspension of the transducer. By examining the accused device, the Commission found that the accused device did not conform to the specification of a '638 patent in issue. Also it did not find the accused device equivalent because, although it performed substantially the same function as the claimed device, it did so in a substantially different way. It was pointed out that the accused device uses a universal joint to stablize and tilt the transducer; that the patented device was suspended along only one axis while the accused device is freely suspended along many axes. (*See* 218 USPQ at 760).

Consistent with the statute, tribunals thus do not construe "means for" claims *only* by observing the words of the claims. Rather courts make a detailed analysis, by reference to the patent specification, with respect to *how* a claimed means performs a claimed function. While means for claims are not to be limited to a particular embodiment set forth in the patent specification, means for claims should not, and cannot, be read in a vacuum, divorced from the patent specification.

Coined phrase "integrated semiconductor circuit array"

An inventor is permitted to be his own lexicographer. *Lear Siegler, Inc. v. Aeroquip Corp*. 733 F.2d 881, 888, 889, 221 USPQ 1025,1031(Fed. Cir. '84). As the Court said in *Lear Siegler Id*. this is done in order to hold open the possibility of obtaining a patent where an inventor is not schooled in the terminology of the technical art to which his invention pertains or where there is a need to coin new expressions with which to communicate that invention. Inventor Kilby, who has been called the inventor in 1958 of the integrated circuit and for this achievement was awarded the National Medal of

Science in White House ceremonies in February 1970, (FF 129-143) is obviously schooled in the relevant terminology. Hence the claimed phrase "integrated semiconductor circuit array" had to have been coined to communicate the invention of the '921 patent. Although a claim can contain a coined phrase, as the Court said in Lear Siegler, Id., the meaning of the coined phrase is to be made reasonably clear and its use is to be consistent with the patent disclosure. The place to make the phrase reasonably clear "is in the specification of an inventor's application, and the time to do so is prior to that application acquiring its own independent life as a technical disclosure through its issuance as a United States patent". Lear Siegler Id.

Contentions of TI

TI argues that its technical expert witness, Jerald Leach (FF 322-326) examined each of the respondents' accused calculators in this investigation and found literal infringement of each such miniature calculator. It is said that in this respect each of claims 1, 2, 6, 7, 30, 37, 41 and 53 of the '921 patent were in turn applied against the accused calculators by Leach, and literal infringement thereof by the accused calculators was made out. (CPH p. 16).[4/]

4/ Paragraph 40 of Leach's direct testimony (CX-3) refers to an attached rather detailed claim chart. CX-3 has no attached claim chart. The last paragraph of CX-3 also makes refrence to "claim charts Exhibit CX-230". Exhibit CX-230 is not a claim chart; it is a photo of ALU, LI-3033M. Leach in his paragraph 38 of CX-3 does state that he evaluated the actual TI-3011 calculator (a TI calculator) and found that it includes certain features which are "all the elements of claims 1, 2, 6, 7, 30, 37, 41 and 53 as set forth in the claim chart of Exhibit CX-198" CX-198 is a claim chart. However the only reference by Leach to CX-198 is in relation to the TI-3011 calculator. Moreover while Leach has concluded that the TI calculator contains all the
(Footnote continued to page 35)

TI argues that Leach in reaching his determination of literal infringement, proceeded to conduct two separate tests of infringement. The first was said to be a detailed inquiry, including "reverse engineering" of the respective integrated circuit chip included in the accused calculators, followed by an analysis of each of the components of the accused calculators responsive to the "input means", the "visual display means", and the structural characteristics of the housing of the accused calculators. The second "less sophisticated but nevertheless appropriate infringement analysis" was said to be largely based upon visual observation by Leach of the respective accused calculators in which Leach operated the calculator by appropriately depressing selected keys on the keyboard thereof. (CPH pp. 16-17).

Alternatively, TI argues infringement by the doctrine of equivalents. With respect to the input means, the '921 patent is said to disclose two alternative structures that could be used for inputting a signal into the calculator; that col. 18 of the '921 patent states that the conductive pattern on the keyboard encoder may be simplified with encoding gates provided in the integrated semiconductor circuit array for encoding it into the binary language of the calculator; that in today's calculators a "unique" short circuit signal is provided; that the scanning approach used by respondents' calculators operates in substantially the same way to perform the same function, to achieve the same result. (CPH pp. 18-19).

With respect to the claimed integrated semiconductor circuit array, and the assetion of the hearing respondents that their calculators employ MOS

(Footnote continued from page 34)
elements of the asserted claim, construction of the claims to determine their meaning, prelimnary to a determination of infringement, is a matter of law for the Administrative Law Judge. Kalman v. Kimberly-Clark Corp. 713F.2d 760, 771 USPQ 789 (Fed. Cir. 1983), cert. denied, 104 S, Ct. 1284 (1984).

circuits and hence are not covered by the claims, TI argues that none of the claims in issue are limited to the bipolar technology disclosed in the '921 patent specification; that it is well recognized that bipolar technology is interchangeable with MOS technology and that the use of one over the other is simply a design choice; that the interchangeability is confirmed by the fact that Gaynell Lockhart, who worked under inventor Merryman's direction in the Cal-Tech program, took a Cal-Tech bread board and converted it to an all MOS bread board in two weeks; that TI's rebuttal expert Brantingham stated that one of the first tasks he was involved in was the conversion of bipolar circuits and MOS circuits. (CPH p. 19).

With respect to the assertion of the hearing respondents that use of a single chip is not within the scope of the '921 patent, TI argues that the '921 patent teaches forming the integrated semiconductor circuit array on a single substrate; that claim 41 and dependent claim 42 of the '921 patent, show that claim 41 was intended to include a single substrate and claim 42 was more limited in reciting plural substrates. Regarding the hearing respondents' assertion that RAM memories are not equivalent to the shift register memories in the '921 patent, TI argues that none of the claims asserted in this investigation require that the memory be a shift register; that only two of the respondents' many calculator models use RAM memory and the others use shift registers; that whether the memory is RAM or shift register is not important since they are equivalent for purposes of the '921 patent. With respect to the hearing respondents' assertion that their calculators use ROMs, TI argues that nothing in the asserted claims preclude the use of ROMs. (CPH pp. 19-20).

Referring to the claimed visual display means, TI argues that all of the asserted claims of the '921 patent require visual display means; that all of respondents' calculators do in fact have visual displays such as liquid crystal displays and LEDs. It is said that the purpose of these displays is to provide a visual display of the answer or other decimal number entered into the calculator; that while the hearing respondents argue that since only a thermal print type of visual display was disclosed in the '921 patent and thus the claims of the '921 patent should not be interpreted to cover displays such as LCDs and LEDs, the hearing respondents do not deny that LCDs and LEDs provide a visual display. TI argues that the thermal printer used in the Cal-Tech calculator was selected because of its low power and small size which permitted it to be in the same housing with all the calculator elements; that this is the very reason LEDs and LCDs are used today; that LCDs have replaced thermal printers because of their low power requirements, simple construction, small size and low cost and that these are the qualitites one looks for in interchanging any element within the calculator; that accordingly a skilled person in the art of semiconductor design with knowledge of LCDs or LEDs could easily design the logic necessary to convert a thermal printer display into an LCD or LED display. TI argues that in any event, for purposes of the '921 patent, LCD and LED displays are clearly interchangeable and equivalent to the disclosed thermal print display of the '921 patent. (CPH pp. 20-21).

Contentions of Hearing Respondents

The hearing respondents argue that TI, in an effort to show that the accused calculators do in fact share something more than the same result in common with the calculator of the '921 patent, has attempted to show that the sole aspect of the asserted claims where the invention is defined in concrete, rather than "means for" terms, viz. the recitation of "an integrated semiconductor circuit array located in substantially one plane", is "literally" found in the accused calculators; that again TI has failed to meet its burden of proving infringement because rather than using an array of integrated semiconductor circuit structures, the accused calculators embody their electronics in a single integrated semiconductor chip; that there is no level of construction of the accused calculators that can turn a single integrated semiconductor chip into an array of integrated semiconductor circuit structures. (RPH p. 4).

The hearing respondents further argue that TI has found it necessary to redefine the term "integrated semiconductor circuit array" so as to mean a semiconductor circuit which is integrated and which includes an array of (i.e., plural) logic functions. It is said that such re-definition is inconsistent with the '921 specification. Also they state that because any calculator must have plural logic functions or else it would not be a calculator, TI's re-definition actually completes the transmutation of the claims into a purported patent on the mere idea of a small calculator based upon integrated circuitry. (RPH pp. 4-5).

The hearing respondents argue that a single chip is not an array of integrated semiconductor circuit structures as required by the '921 patent; that in the patent, the integrated semiconductor circuit array is made up of plural, distinct circuit structures that are electrically interconnected (e.g., by printed circuitry of a common insulating substrate or by multi-level metal deposition on a common semiconductor wafer); that each individual circuit structure of the array has its own functional identity and spatial separation from the other structures. In contrast the hearing respondents' single chip is said to be totally integrated. It is said that there are no spatially separated, functionally distinct, components integrated semiconductor circuit structures and hence no array of such structures in the accused calculators. (RPH pp. 6, 7). The hearing respondents argue that any heart of the TI invention in the '921 patent is in how the calculator circuitry was made smaller; that achieving a threshold size for the circuitry was important and the chosen way to arrive at that size was to use a discretionarily wired structure; and that arrays of functionally and spatially separate circuit structures are essential to the discretionary wiring technique; that the accused single chip calculators do not use discretionarily wired arrays of functionally and spatially separate circuit structures. The hearing respondents argue that it is a fundamental part of discretionary wiring technique that "spare" elements are incorporated into a device; that discretion then can be exercised not to use bad circuit structures, even though the bad or other unused circuit structures remain in the device. In contrast it is said that the single chips of the accused calculators are made through conventional integrated circuit manufacturing techniques whereby the original "array of circuits" in a wafer is separated into single circuits, whereupon the bad ones are thrown away and the good ones are individually packaged for use; that the single chip in the accused calculators is a fully integrated, complete calculator circuit and is usable in its entirety; that while many chips are processed together on the same slice, only one chip is used per accused calculator. (RPH p. 9).

Referring to the doctrine of equivalents, as it relates to the input means the hearing respondents concede that the calculator disclosed in the '921 patent and the accused calculators provide the same result in the sense that, in each case, the calculator "knows" what numbers and commands have been input by the operator. They argue however that the means for reaching that result and their operations are substantially different; that the accused calculators employ scanning matrix encoders as the input means; that with scanning matrix encoders, the chip or "brain" of the calculator inferentially identifies which key has been depressed despite the fact that multiple key depressions produce the same output signals; that there is no structure in the '921 patent which operates that way; that instead, with the disclosed input of the patent, the keyboard itself provides the direct identification of the number and commands, either by shorting unique combinations of terminals or alternatively by establishing a unique short circuit signal for each key. (RPH p. 13).

Urging non-equivalence of the electronic means in the accused calculators and the calculator of the '921 patent, the hearing respondents argue that conventional integrated circuits at the time of the '921 invention were too large and used too much power for battery consumption; that to solve the size and power consumption problems, a new circuitry was created. It is argued that bipolar technology, which it is said has never been used in a commercial handheld calculator, was chosen for the circuit of the calculator of the '921 patent because that was the technology applicable to discretionary wiring which was the method of achieving the level of integration for the Cal-Tech project; that a bipolar circuit was specifically designed to be capable of low voltage operation by avoiding the use of stacked transistors; that in the Cal-Tech calculator the main current paths were arranged so that only one transistor switch would be traversed from power to ground. Large geometry load resistors were said to be used with the bipolar transistors to reduce power consumption also. It is argued that the TI approach to the electronic means provided not a single teaching which is used in the accused calculators; that the accused calculators do not use discretionarily wired circuitry; that the accused calculators employ a metal-oxide semiconductor (MOS) circuitry rather than bipolar circuitry and in so doing, are able to achieve low power consumption without using large geometry load resistors; that the MOS electronic circuit chips of the accused calculators do not need to avoid the stacking of transistors in order to achieve their low power consumption. (RPH pp.14-17).

Commenting on the display means, the hearing respondents argue that in the context of handheld calculators where size and power consumption are important, liquid crystal displays (LCDs) of the accused calculators cannot be considered to be equivalent to the thermal printer that constitutes the sole embodiment of a display means disclosed in the '921 patent. While it is conceded that both provide a visual representation of an answer, it is argued that there the similarity ends. The hearing respondents argue that that neither the '921 patent nor anything in the art since the '921 patent issued has taught how to implement the accused calculators with a thermal printer. The LCD is said to be a compact, low power consuming display which is, in effect, erasable and does not consume the medium on which the display is shown; that thermal printers consume significant power and require a paper supply and a paper advance which finds no correspondence in a liquid crystal display; that in the thermal printer, a one shot pulse is applied to "print", and the pulse is turned off to avoid getting merely a black spot rather than a discernible numeral; that with the liquid crystal displays of the accused device, the line segments that produce the visual display are and must be continuously pulsed. The hearing respondents argue that the "accused" solar powered calculators and thin calculators cannot be made using the display means of the '921 patent; that the entire theory of incorporating a thermal printer required separation of the display drive circuitry from the rest of the circuitry to solve interfacing problems, whereas the theory in the accused single ship calculators is to keep all the circuitry in one chip. (RPH pp. 18, 19).

The Accused Calculators

A deficiency in TI's evidence on infringement, as to each of the approximately 184 accused calculators indentified on CX-231A[5/] (FF 345) is

5/ The physical exhibit CPX's 203, 204, 205, 206 and 208 referred to on the fifth page of CX-231A, have been withdrawn by TI and their admissibility was not ruled on by the Administrative Law Judge.

evidence establishing in what way the display means, input means and electronic means perform their respective functions. TI's technical expert, Jerald Leach (1) identified a chip in each of the approximately 184 accused calculators as containing the electronic means (FF 346); (2) reverse engineered three chips which were found in <u>some</u> of the accused calculators and identified in each of those three chips a memory means, arithmetic means and transfer means (FF 332, 333, 335, 337); (3) as to other accused calculators merely identified the arithmetic means, memory means and transfer means by evaluating various functions but he did not determine how a means performs its respective function (FF 346); (4) identified a liquid crystal display in Nam Tai's accused COMPEX LC-827 calculator, Solar Calculator SC-90, and its SC-70, SC-92, SC-91, SC-50, LC-839, CS-111, CX-839, LC-625, LC-849, LC-857, LC-859, LC-84, LC-811, RC-22, LC-809, LC-615, MC-2808, MC-2605 and CX-827 calculators (Nam Tai's certain calculators); IMA's LC-610, IMA-LC-620. IMA LC-640 calculators; Radio Shack's EC-2 calculator; Sears' I.58400 calculator; Tronica's MBO MC-50, MOB Trav-Card, Sutronic LC-10 and LC-30, Viscount LC-12, LC-12 and M-72 calculators; Voesa's MOB Trav-Card, MOB Formel-40 and LC-28 calculators; Hua Chang's Diamond LC-333A and LC-783 calculators; Dah Sun D.S. LCD-19 calculator; Qualitro's Comus CCA-3220 calculator; and Taiwan's Calc/clock 6712 and Comus CC-741 calculators but for each of the remaining accused calculators Leach did not identify any specific display means (FF 344); 6/ and (5) determined that the certain Nam Tai

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6/ Leach testified that he performed the same evaluation of a CR600 calculator as was performed in the COMPEX LC-827 (Leach CX-3 ¶ 30). The Administrative Law Judge cannot find a CR600 calculator listed in CX-231A. Mr. Leach also testified that identical features exist in the Nam Tai COMPEX SC-90, Tronica TOZAI E-268, and the CR-6000 calculators as well as all of the other calculators Leach has studied. (Leach CX-3, ¶ 40). The Administrative (Footnote continued to page 43)

calculators use encoding in connection with the keyboard he but did not identify any specifics as to the input means in any of the other accused calculators. (FF 338, 344).

Mr. Leach did testify that an Exhibit CX-192 is a block diagram of a "typical" calculator circuit. (Leach CX-3, ¶ 11). That testimony does not establish that each of the approximately 184 accused calculators has the calculator circuit of Exhibit CX-192. Mr. Leach also testified that the patent specification of the '921 patent describes a bipolar process; and that "[m]ost portable calculators presently manufactured use MOS technology due to its advantages in small size and low power. (Leach CX-3 ¶ 16). That testimony does not establish that each of the approximately 184 accused calculators uses MOS technology. Mr. Leach testified that registers are the common memory storage means (Id.); that "[p]resent day calculators usually use keyboard scanning techniques to enter digits into the calculator" (Emphasis added) (Leach CX-3 ¶ 17), and that RAMs are used in many calculators (Leach CX-3 ¶ 18). That testimony does not establish that each of the approximately 184 accused calculators use registers as the common memory storage means, a keyboard scanning technique and RAMs. As to a visual display, Mr. Leach testified that given the goals of power, size, and simplicity, it appears that the type of visual display is not important so long as it meets the power, size and simplicity requirements; that any one skilled in the art would know that LCD's (liquid crystal display) and LED's (light-emitting-diode display) would be interchangeable with a thermal printer; that LCD's are the most common visual display today because of their low power requirements, simple

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(Footnote continued from page 42)
Law Judge cannot find the CR-6000 calculator listed on CX-231A. Moreover the reference to "identical features" in ¶ 40 of CX-3 is indefinite as to what specifically those features are.

construction, small size and low cost; and that he would not consider an audio output, punched card output, a magnetic tape or a magnetic disc a visual display. (Leach CX-3 ¶ 19). That testimony does not establish that each of the approximately 184 accused calculators has an LCD or LED display.

Under controlling law cited in the beginning of the INFRINGEMENT section of this opinion, TI has the burden of proving by a preponderance of evidence that each of the approximately 184 accused calculators, relied on by TI, allegedly infringes the asserted claims. For the Administrative Law Judge to find infringement as to each of the approximately 184 accused calculators he must determine if those accused calculators are copies either without variation, or with variation as are consistent with the accused calculators being in substance the same as the claimed calculator. See Engelhard Industries Inc. supra. Because of the lack of evidence the Administrative Law Judge is unable to make any such infringement determination as to each of the approximately 184 accused calculators. The Administrative Law Judge finds this lack of evidence fatal in TI's attempt to meet its burden in showing that each of the approximately 184 accused calculators infringed the asserted claims.

TI has agreed with the testimony of Thomas E. Osborne, a technical expert of the hearing respondents (FF 260-265), that "most modern portable calculators are constructed of a keyboard and associated printed circuit board, a liquid crystal display, a power source (regular battery or solar battery), a housing and a chip; and that "most" modern single chip calculators employ scanning matrix encoders. (FF 351) (CPFF pp. 106-107). TI's Leach testified that "most" portable calculators presently manufactured use MOS technology. (Leach CX-3 ¶ 16). Hence in this opinion the Administrative Law Judge will assume that each of the approximately 184 accused calculators contains a liquid crystal display, in its display means, employs a scanning matrix encoder in its input means and contains an electronic means based on MOS technology. He will also assume that each of the approximately 184 accused calculators is a miniature, portable, battery-operated electronic calculator, and that the entire calculator including the keyboard, the electronic means, the visual display and battery are contained within a "pocket-sized" housing as TI's Leach found for the Nam Tai COMPEX LC-827-calculator and certain of the other accused calculators. The Administrative Law Judge will further assume that the chip of each of the approximately 184 accused calculators is located in substantially one plane, has an area no greater than that of the keyboard, and includes memory means, arithmetic means and transfer means, as TI's Leach found for the three chips he reverse engineered. In addition, the Administrative Law Judge will assume, as found by TI's Leach for certain of the accused calculators, that the input means of each of the approximately 184 accused calculators includes a keyboard for entering digits of numbers and arithmetic commands into the calculator. whereby signals are generated corresponding to the digits and commands, and that the keyboard has only one set of decimal number keys for entering plural digits of decimal numbers in sequence and includes a plurality of command keys, the decimal number keys and command keys being visible on the calculator.

The Administrative Law Judge will also assume that the chip in each of the approximately 184 accused calculators is a fingernail sized piece of semiconductor material which comprises a single integrated circuit with individual wires or leads bonded to the chip to provide connections to the "non-integrated" outside world, such as a copper clad printed board. This is the definition that Thomas E. Osborne, a technical expert of the hearing respondents, attributed to the term "chip" in the phrase "single chip calculators" used to designate modern day calculators. (FF 353). The Administrative Law Judge finds nothing in the record contrary to such present day usage of the "chip" in today's "single chip calculators".

With respect to the assumptions made by the Administrative Law Judge, the hearing respondents admit that their accused calculators are portable handheld calculators which have (a) an input means including a keyboard.for presenting as arithmetic problem to the calculator, (b) an electronic means for solving the problem and (c) a display means for presenting the answer in visible form; that their calculators have plural logic functions; and that when their accused calculators are opened, a single chip will be found inside the calculator which contains all the "calculating circuitry. (FF 318-321).

Infringement Analysis

During closing argument TI's counsel defined the heart of the '921 invention[7/] as follows:

> MR. KAYE: It is the combination of the elements which are the input means for the keyboard and the single set of decimal digits having a memory in integrated circuit form, having an arithmetic logic unit in intergrated circuit form, having a transfer means which affects the connections between the arithmetic logic unit and the memory in integrated circuit form, all of this being done in a single plane, and in a size smaller than the keyboard, to provide a pocket sized housing, to have power requirements that were sufficiently low that a battery could be used.
>
> This is what was needed in order to provide a device that could be carried in a pocket or handheld.

7/ In Atlas Powder Co. v. E.I. Du Pont 588 F. Supp. 1455, 1472 221 USPQ 426, 440 (N.D. Ter. 1983, the district judge citing Weidman Meal Masters v. Glass Master Corp., 623 F.2d 1024, 1030, 207 USPQ 101, 106 (5th Cr. 80) stated that if an "accused product appropriates 'the heart of the invention'; the patent is infringed". On appeal Du Pont contended that the district court erred in considering the "heart of the invention" in its infringement analysis. The Federal Court disagreed stating that although there is no legally recognized "essence" or "heart" of an invention in determining validity, it can be applicable in a determination of infringement under the doctrine of equivalents. Atlas Powder Co. v. E. I. Du Pont De Numours 750 R.2d 1569, 1582, 224 USPQ 409, 418 (1984).

JUDGE LUCKERN: And is it your position that regardless of how that is done in a calculator, if the calculator has what you just said, then it infringes the '921 patent?

MR. KAYE: Yes. [Tr. p. 170 l. 18-p. 171 l.1]

This definition simply paraphases certain language in the claims in issue. (FF 65). However because the asserted claims recite the coined phrase "integrated semiconductor circuit array" and are mean-for claims, under the applicable law, supra, the Administrative Law Judge has to consider at least the effect the specification of the '921 patent has on any claim interpretation in his infringement analysis.

Integrated Semiconductor Circuit Array

TI's counsel in closing argument defined the coined phrase "integrated semiconductor circuit array", recited in each of the asserted claims, as an array of logic function units. (Tr. p. 18, ls. 24-25). Inventor Kilby testified that it means integrated semiconductor circuit array of logic functions.

(FF 105). The hearing respondents argue that the coined phrase means plural, distinct circuit structures that are electrically interconnected e.g., by printed circuitry of a common insulating substrate or by multi-level metal deposition on a common semiconductor wafer; that each individual circuit structure of the array has its own functional identity and spatial separation from the others. (RPH, p. 6).

Inventor Kilby when asked to point to the portions of the '921 patent where "integrated semiconductor circuit array" is defined referenced several portions of the specification and certain claims. (FF 105). The first reference under the subheading "Primary Electronics 7" in the '921 patent was to col. 9 around line 48 for the language:

The primary electronics of the calculator is embodied in an integrated circuit array located in substantially one plane. The integrated semiconductor circuit array comprises the control and arithmetic sections of the calculator for performing the arithmetic operations of the numbers entered into the calculator and generating the control and timing signals for appropriately carrying out the arithmetic operations, the printout of the entry data and answers and advancement of the tape. (FF 82, 85).

Although that language does not tell how the arithmetic operations are performed or how the control and timing signals are generated, the "Primary Electronics 7" of the '921 patent is illustrated in the FIG. 14 preferred embodiment. FIG. 14 shows that the integrated semiconductor circuit array comprises in one plane four "integrated semiconductor circuits" placed in the areas designated 72-75 and three integrated semiconductor shift registers SR 1, SR 2 and SR 3, all interconnected and arranged on the insulating substrate 7. (FF 82). 8/

Accordingly in the preferred embodiment of the '921 patent illustrating the Primary Electronics, the phrase "integrated semiconductor circuit array" refers to a plurality of integrated semiconductor circuits and three integrated semiconductor shift registers electrically connected by printed circuitry of a common insulating substrate (FF 82). It is because of these plurality of interconnected intergrated circuits each with its own functional identity and separated in space, that the FIG. 14 preferred embodiment results in plural logic functions. Hence the Administrative Law Judge finds that the intergrated semiconductor ciruit array shown at the passage starting at col.

8/ Inventor Kilby has testified that he had no understanding of the phrase "intergrated semiconductor circuit" in 1967. (FF 114). Yet in the specification of the "921 patent the inventors repeatedly used the phrase "intergrated semiconductor circuit" by itself and without the word "array" to describe multiple components of the "intergrated semiconductor circuit array". (FF 114). Moreover inventor Kilby in his U.S. Patent No. 3,643,232, based on an application filed in 1964 and incorporated by reference in the '921 patent (FF 88, 89) disclose that "semiconductor integrated circuits" have been widely accepted for certain electronic systems. (FF 89).

9, l. 48 means not merely an intergrated semiconductor circuit array of logic functions but rather a plurality of distinct circuit structures electrically interconnected by printed circuitry on a common insulating substrate, each of which has its own function and is separated in space.

The second reference by inventor Kilby for support in the specification of the '921 patent for the phrase "integrated semiconductor circuit array" is the alternative planar integrated semiconductor circuit array described at col. 17, starting at l. 34 of the '921 patent. (FF 100). Therein the array "may comprise a large integral semiconductor wafer smaller than the insulating substrate 7' comprising quadrants respectively embodying the logic circuits FIGS. 15-18 [of the '921 patent]". (FF 100). TI argues that the term "integral" here means single and not separated, and refers to all of the primary electronics being on the same silicon substrate. (CPFF p. 96).

However as inventor Kilby testified, the meaning of the term "wafer" was in 1967, and is even today, imprecise. Thus in 1967 the term "wafer" was used to mean something larger than the very small substrates of the day, which were usually less than 0.050 inches square. Today "wafer" means a substrate larger than those in common use, up to the full size of a slice from which a wafer can originate. (FF 109). Inventor Kilby in his intergrated circuit patent which issued in 1964 on an application filed in 1959 referred to all components of an electronic circuit being formed in or near <u>one</u> surface of a relatively thin semi-conductor wafer with gold wires or a silicon dioxide evaporation technique used to make electrical circuit connections. (FF 131). In inventor Kilby's U.S. Patent No. 3,643,232, which was based on an application filed in 1964 and incorporated by reference in the '921 patent, inventor Kilby refers to a wafer containing many circuits with discretionary interconnection. (F 94). Hence the mere use of the term "large integral semiconductor wafer" in the specification of the '921 patent does not necessarily connote one single integrated circuit. Moreover the word "comprise" in the phrase "the planar integrated circuit array may comprise a large integral semiconductor wafer..." is an open-ended word and one of enlargement. It does not preclude the presence of other structures. Parmelee Pharmaceutical Co. v. Zink 285 F.2d 465, 128 USPQ 271,275 (8th Cir. '61).

TI argues that the passage starting at col. 17, l. 34 of the '921 patent is to a reference that the entire circuit is one single integrated circuit because at col. 17, ls. 45-50 of the '921 patent it is stated that "the interconnections are made using integrated circuit techniques, such as 'RF sputtered silicon oxide photolithographic techniques and metal deposition techniques as discussed.'" (CPFF p. 96). The quoted phrase however when read in context clearly shows that an "integrated semiconductor circuit array" shown at the passage starting at col. 17, l. 34 comprises a plurality of integrated circuits interconnected by multi-level interconnections. Thus the relevent passage. (CX 10, RX 505, col. 17, ls. 34-58) reads:

> Alternatively, the planar integrated semiconduct or circuit array may comprise a large integral semiconductor wafer smaller than the insulating substrate 7' comprising quadrants respectively embodying the logic circuits of FIGS. 15-18. The closely grouped circuit elements comprising each functional unit NAND gate at the surface of the integral seminconductor wafer may be interconnected at a first level of interconnections to form the NAND gate, the NAND gates in each quadrant may be interconnected at multi-levels of interconnections to respectively embody the logic circuits of FIGS. 15-18 and the logic circuits of the quadrants may be interconnected at another level of interconnections using RF sputtered silicon oxide, photolithographic techniques and metal deposition techniques as discussed and remaining interconnections effected by printed conductors on the top or bottom surface of the insulating subsrtate 7'. Moreover, the integral semiconductor wafer may be made larger so that the shift registers SR 1, SR 2, and SR 3 and the two resistors 69-70 may be incorporated into the surface of the larger integral semiconductor wafer with their interconnections being effected at multi-levels of interconnections and remaining

interconnections being effected by printed conductors on the insulating substrate 7'. [Emphasis added].

As to the teaching of this portion of the '921 patent inventor Kilby testified:

Q All right, let's look at those words [at col. 17, ls. 34-41 and following], Mr. Kilby. It says that you may have a single wafer, single large integrated semiconductor wafer, but that wafer will comprise quadrants that embody the logic circuits, plural, of figures 15 through 18, doesn't it?

A Yes.

Q And then it later says you can also add the shift registers, plural, SRi-1, SR-2, and SR-3, doesn't it?

A That is correct.

Q Now then, what you end up with in this alternative version of the integrated semiconductor circuit array is still multiple integrated semiconductor circuits that are functionally and spatially separate, even though they happen to be on the same substrate, right?

A No, sir.

Q They are not functionally separate?

A No. Functionally they are interconnected, so that they form a single unit, the integrated semiconductor array.

Q Excuse me. I didn't mean to interrupt your answer.

A They form an integrated semiconductor array.

Q I understand that, but you still have the seven circuits, right, interconnected?

A Yes.

Q You have the same seven circuits you started with. Now they happen to be on the same substrate, right?

A Yes.

Q And each of those circuits, each of those seven circuits, are spatially separate from each other, just like they were when they were on a different substrate, right?

A They could be sp]atially separated if there were any particular advantages. They could be merged a bit.

Q Is there any disclosure here that shows them being not spatially separate?

A The embodiment that we chose to illustrate was the one where they were simply pushed together, to make it obvious that they were designed so that they would fit and that they would match, and the interconnections there between would disappear.

Q Now, when you put them all on the same substrate, though, you talked about having the interconnections on that substrate, right? That is what this paragraph on column 17 says, doesn't it?

A Are you referring to the interconnections on the quadrants or the interconnections between the quadrants?

Q This interconnections between the quadrants.

A Well, what I told you is that if you push these together as we suggest, that the interconnections between the quadrants disappear, that they are no longer present.

Q Is that your patent says?

(Pause.)

Q Let me direct your attention, Mr. Kilby, to column 17, line 45, where it says that: "These logic circuits of the quadrant may be interconnected at another level of interconections."

THE WITNESS: That is one way to do it, and you will see that that was permissive. It says "may be".

***

Q Did you disclose any other way of doing it?

A Yes.

Q Where?

A It is not explicit, but the section which talks about pushing them together points out, and the Figure 14 makes it very clear, that as those quadrants come together that the terminals between them coincide. And if this happens, there is not a necessity for any interconnection.

Q Mr. Kilby, can you point to any portion of our patent where that is said or implied, either way?

A Well, I can certainly refer you to figure 14, which illustrates that feature very clearly.

Q Figure 14 is on sheet 7 of the drawings of Exhibit 505 [the '921 patent], is that right?

A Yes, that's right. I would point out that the teaching we have made suggesting that those contracts could be made by multi-levels is also functionally correct.

Q Well, tell me again a little bit about Figure 14. Am I correct that Figure 14 is the embodiment where they weren't part of the same wafer, right?

A Figure 14 is described as the illustration of the integrated semiconductor circuit array.

Q And each one of those circuits, namely the circuit labeled Figure 15, the circuit labeled Figure 16, the circuit labeled Figure 17, and the circuit labeled Figure 18, were on a different wafer [quadrant], right?

A In that embodiment they were.

Q And the shift register labeled SR-1 and the shift register labeled SR-2 and the shift register labeled SR-3, they were all on a different chip, right?

A That is correct.

Q And all of these wafers and chips were interconnected in Figure 14, right?

A They were.

Q Now, I take it in column 17 you disclose an arrangement where you put all of the circuitry that we just mentioned on the same wafer, right?

A They were.

Q Now, I take it in column 17 you disclose an arrangement where you put all of the circuitry that we just mentioned on the same wafer, right?

A That is correct.

Q And when you put -- in the disclosure here, when you put it all on the same wafer, what you then have is still the spatially separate circuits that are interconnected to each other, but all on the same wafer, don't you?

A You could do it that way, and that would be an acceptable way to do it.

Q That is what your patent discloses doing, doesn't it?

A I don't see any restriction in there that says that you can't, for instance, change the shape of the quadrants as you do that. If fact, I would assume that you would do a little of that.

Q Do you see any description in there which suggests that you should change the shape of the quadrants?

A I see a little of it in the term "quadrant."

Q The term "quadrant" suggests to you that you should change the shape of the quadrants?

A It certa ly suggests that you could.

Q Is there anything else in this patent that suggests to you that you could change the shape of the quadrants?

A I don't think we felt it necessary to elaborate on that point. Each of those quadrants is made up of a multiplicity of integrated circuit nand gates, and when you put these all on one wafer it would be very logical to form these in a continuum.

Q On the other hand, -- well, let me put it this way. In column 17, beginning on line 34, it certainly doesn't tell you to do that, does it?

A It doesn't say you have to.

Q It in fact tells you that you could put each of these quadrants of Figures 15 through 18 on a single wafer and interconnect these quadrants, doesn't it?

A It does.

Q And it tells you you could also put the shift registers on and interconnect them the same way, right?

A You add it in the same way, and I don't know whether it is that explicit or not.

Q Well, I think if you will look at lines 54 plus, you will be able to confirm that. But you tell me.

A The wording is not identical, but it is certainly similar.

Q It is very similar. It talks about the multi-level interconnections, right?

A Right, that is correct.

Q Now, if you follow that teaching what you end up with then is a single wafer that has the same four quadrants that you had from Figure 14, the same three shift registers that you had from Figure 14, but now, instead of being on separate substrates, they are all on the same substrate and they are interconnected by multi-level interconnections, right?

A Yes. [Emphasis added] (Tr. 166, l. 2-p. 172, l. 17).

Thus while inventor Kilby testified, more than seventeen years after the orginal '921 patent application was filed on Sept. 29, 1967, that "when you put these [four quadrants] all on one wafer it would be very logical to form these in a continuum", he admitted that the teaching starting at col. 17, l. 34 of the '921 patent involved multi-level interconnections. The Administrative Law Judge finds no support in the '921 patent specification that "it would be logical to form these in a continuum,". Accordingly the

Administrative Law Judge finds that this alternative integrated semiconductor circuit array means not merely an integrated semiconductor circuit array of logic functions but rather a plurality of distinct, circuit components or structures that are electrically interconnected by multi-level metal deposition on a common semiconductor wafer each with its own function and separated in space. It is this structure which results in plural logic functions in the alternative embodiment.

TI's technical expert, Jerald Leach on direct testimony testified:

> Array is a common word used in semiconductor terminology. Some examples are PLA's and gate arrays. PLA stands for programmable logic array, which is a <u>structure of transistors</u> used on a chip. Therefore, it would follow that a semiconductor circuit array would be an <u>array of logic gates, or transistors</u>. Single chip integrated circuits used in calculators today contain <u>arrays of transistors, NAND and NOR gates, and other circuit elements</u> and constitute a semiconductor array. When I read the claims of the patent, without prior knowledge of the calculator construction, I assumed there was only one chip. ... (CX-3, p. 8). [Emphasis added]

Mr. Leach's assumption was incorrect because the preferred FIG. 14 embodiment of the specification of the '921 patent discloses seven integrated circuits, each with its own functional identity and each separated by space from the other. (FF 82). Leach's incorrect assumption is excusable because the phrase "integrated semiconductor circuit array" was a phrase coined by the inventors (FF 76) which meaning can <u>only</u> be interpreted by refernce to the '921 patent specification.

Leach's testimony about the word "array" however shows that the term is conventionally used with reference to a plurality of specific structures, not merely a plurality of logic function units. Such a interpretation is consistent with the usuage of the term "array" at TI when the application for the '921 patent was filed. U.S. Patent No. 3,484,534 based on an application in July 1966 filed by inventors Kilby and Van Tassel and Harold D. Toombs who was also involved with the Cal-Tech project (FF 157) and which patent is incorporated by reference in the '921 patent (FF 97) states that a semiconductor device may be an entire semiconductor slice, which is nominally about one and one-eighth inch in diameter and about 0.010 inch thick on which an array of many logic circuits may be formed; that the large number of components such as diodes, transistors, resistors and capacitors formed in the semiconductor slice are interconnected into circuits and arrays of circuits by one or more layers of conductors fabricated using conventional thin film technique. (FF 98(a)). In addition the term "array" in the Cal-Tech project was repeatedly used to refer to a plurality of gates on the quadrants shown in FIGS. 15, 16, 17 and 18 of the '921 patent. For example the quadrant of FIG. 15 had 151 gates in its array. (FF 151, 166-173, 176(a)). To inventor Kilby "gate array" implies that there are interconnections among the gates. (FF 107). To inventor Merryman the common everyday meaning of the term "array", as it is used with gate, was "distinct from the way it is used in the ['921] patent". (FF 111). He testified that a plurality of gates did not become an array until the gates were interconnected. (FF 111).

The inventors in the '921 patent specification repeatedly use the term "array" to characterize a plurality of integrated semiconductor heater elements located in the thermal printer. (FF 116, 118). Also the term "functional" and "logic" in the '921 patent specification is associated with structures. For example reference is made to "135 functional unit NAND gates" (CX-10, col. 10, l. 19) and the "logic circuits of FIG. 15-18". (CX-10, col. 10, l. 63).

Inventor Kilby referenced claims 41, 57 and 58 of the '921 patent to support his testimony that the term "integrated semiconductor circuit array" means an integrated semiconductor circuit array of logic functions. (FF 105). Claim 41 (FF 65) dependent on claim 30, specifies that the integrated semiconductor circuit array comprise a semiconductor substrate having a large plurality of similar functional units adjacent one surface thereof interconnected by multilevels of insulators and conductors on said one surface. While TI argues that claim 41 is a reference to the singular substrate (CPFF p. 96), claim 41 specifies multilevel connections.

In a similar manner each of claims 57 and 58 (FF 105) specifies multilevel interconnections. TI argues that other claims, such as claim 42 (FF 106), states that the integrated semiconductor circuit array can include more than one substrate and therefore that this limitation must not be read into a broader claim. (CPFF p. 96). However as col. 17, l. 34 and following of the '921 patent teaches multilevel interconnections are involved whether the integrated semiconductor circuit array involves a plurality of substrates or a single substrate.

The Administrative Law Judge can find nothing in the specification of the '921 patent that shows that the phrase "integrated semiconductor circuit array" means merely a plurality of logic function units as urged by TI's counsel in closing argument. (Tr. p.18 ls. 24-25). Rather the judge finds that the phrase, in light of the specification of the '921 patent means a plurality of distinct, circuit structures or components that are electrically interconnected, each individual circuit structure or component of the array, whether the array is on a wafer or a plurality of wafers, having its own functional identity and separated in space.

Literal Infringement

For literal infringement the means in the accused calculators, which performs the same function as the means in a claimed device, must be the same as, or an equivalent of, the corresponding structure described in the '921 patent specification. D.M.I. case under "Applicable Law" section, *supra*.

Display Means

The sole display means disclosed in the '921 patent specification is a thermal printer. (FF 38). This fact has not been denied by TI. (RPF p. 13; CPFFR pp. 6, 7). The accused calculators have a liquid crystal display (LCD) means. In a LCD, two glass sheets are separated by a sealed-in liquid crystal material. The application of a voltage between the front and back electrode coatings effects the orderly arrangement of the molecules enough to form visible characters, even though no light is generated. (FF 381). In contrast to a LCD, a thermal printer basically causes a change in the structure of the molecules held in a paper matrix. Thus it changes the color of paper in an irreversible way. (FF 382). A thermal printer has a tape advance and produces a hard copy while a LCD has nothing like a tape advance and is basically erasible. (FF 382). There is a continuous input of new paper into a thermal printer; there is not a continuous input of liquid crystal material into a calculator that has a LCD. (FF 383). Inventor Kilby has never seen a thermal printer in a thin credit card kind of a calculator and it would be a "significant invention" to put a thermal printer in such a calculator. (FF 384). Inventor Kilby has never seen a thermal printer in a solar-powered calculator. (FF 385). When inventor Kilby began to consider the Cal-Tech project and the use of a thermal printer display, there was a power consumption problem. The thermal printer used a high voltage. Inventor Merryman taught how to integrate a drive electronics within the thermal printer for the Cal Tech project. Merryman's solution would not teach how to implement a LCD into a hand-held calculator. Meeryman's approach minimized leads, a problem which does not arise with LCDs. (FF 386). The driver for the LCD is maintained with the rest of the integrated circuitry while the drive electronics in the thermal printer is in the printhead. (FF 389). The LCD relies on line segment displays while the thermal printer has a dot element which is not a line segment display. (FF 390). With a thermal printer, a pulse is applied to the printer element to heat it, and that pulse is turned off to avoid getting merely a black spot rather than a discernable numeral. In contrast with the LCD, the line segments which produce the visual display are continuously pulsed. (FF 387). Inventor Kilby testified that the substitution of a LCD in a calculator that already had a thermal printer would be guesswork and he did not know of anyone who had performed such a task. (FF 388). Inventor Kilby admitted that he could not express an opinion on the level of skill involved in implementing a LCD into a calculator. (FF 391). Osborne, a technical expert of the hearing respondents (FF 260-265) testified that a thermal printer and tape advance disclosed in the '921 patent would consume too much power to be solar powered and even at today's state of the art, a thermal printer requires too much space to be used in the thin calculators now being made. (FF 392). The Administrtaive Law Judge finds nothing in the record to contradict this testimony of Osborne.

Based on the foregoing, the Administrative Law Judge finds TI has not proven, by a preponderance of evidence, that the LCD means of the accused calculators is the same as, or an equivalent of, the display means in the '921 patent.

Input Means

The keyboard input means illustrated in the specification of the '921 patent and which is used with the preferred FIG. 14 embodiment (CPFF p. 135) involves the pressing of a key and making contact with printed circuitry underneath the key to directly encode the number into binary language that the calculator works with. (FF 67-70). As an alternative embodiment the '921 patent discloses, in words, that the conductive pattern on the keyboard encoder may be simplified to provide a unique short circuit signal indicative of the particular key entry rather than directly encoding the key entry into the excess three binary code and encoding gates provided in the integrated semiconductor circuit array. (FF 71).

In the preferred illustrated FIG. 14 embodiment a keyboard encoder (6) directly encodes the digits and commands into the binary language of the calculator by each key short circuiting multiple conductive strips (32) which lead to plural terminals. (FF 67). FIG. 5 of the '921 patent shows the feature whereby a stroke of each key shorts from three to five printed leads to produce a unique coded signal. (FF 69). In operation while individual terminals may be shorted by more than one key, each key also shorts several other terminals, with the combination of multiple shorted terminals being unique in its correspondence to any given key. (FF 68). In the alternative embodiment a single contact is closed when a key is depressed and then the key closure becomes a unique chort circuit signal for direct encoding into binary language. (FF 71).

In contrast to the illustrative preferred embodiment and the alternative embodiment in the '921 patent, in the scanning technique of the input means of the accused calculators, the integrated circuit chip scans the keyboard and inferentially determines which key is depressed. In other words after sensing that a key has been depressed, the chip scans the keyboard in a pattern at a very rapid rate to determine, by clock intervals, the key which has been depressed. (FF 394(a)).

At the hearing inventor Kilby testified to the alleged equivalence of the input means disclosed in the '921 specification with the scanning matrix encoders of the accused calculators by pointing to the fact that in both cases the result is the same i.e., depression of a key is eventually translated into binary language, so that the calculator knows what number was pushed. For example he testified:

Q Now, the scaning matrix encoders don't use either [the preferred or alternative embodiments of the '921 patent]..., do they?

A No.

Q And they don't operate that way either, do they?

A There are differences in operation, yes.

Q These differences in operation are substantal, aren't they?

A Well, we have already established it from a result standpoint. They are trivial.

Q Well, we will acknowledge that.
In each case, everyone agrees the calculator knows what button was pushed.
We wanted to talk about operation now.
What is the similarity in operation?

A The similarity is that the basic function of the key is the same in both cases, and that is that when the key is depressed, the input function presents that information to the computer or calculator in a form in which it is useful. That is an a binary coded number or binary coded command in the forms of ones and zeroes.

Q And that is what you call similarity of operation?

A Yes.

Q Now, are they similar in any other way other than the fact that they both know the number that you push, and they both use the binary language which is common for computers and calculators?

A Well, as I have already mentioned, there is a similarity in mechanical structues.

Q They use keys, right?

A Yes.

Q And that is how you came to your conclusion of equivalence?

A It is [Emphasis added]. [Tr. 272, l. 2-p 273, l. 11]

The fact however that a depression of key in the accused calculators and the claimed calculator causes the input function to present information to the calculator in a useful form does not establish an equivalence in operation of the two input means and the evidence establishes a non-eqivalence in operation. Thus while the scanning techniques of the accused calculators, through the chip, inferentially identifies the key which has been depressed. (FF 394(a)), in the '921 patent embodiments keyboard encoded signals are employed and no scanning technique is used. In the acused systems, the keyboard does not generate signals corresponding to digits and commands as in the claimed calculator of the '921 patent. (FF 394(b)).

Based on the foregoing, the Administrative Law Judge finds that TI has not proven, by a preponderance of evidence, that the scanning matrix input means of the accused calculators is the same as, or equivalent of, the input means of the claimed calculators of the '921 patent.

Electronic means

The electronic means in the calculators of the '921 patent contains an integrated semiconductor circuit array which the Administrative Law Judge has found is a plurality of distinct circuit structures that are electrically interconnected, the structures having their own functional identity and separated in space. The electronic means in the accused calculators comprise a single integrated circuit and hence identity or equivalence has not been established.

In addition '921 "patent specification decribes a bipolar [electronic means] process "as TI's technical expert Leach so testified in his direct testimony. (Leach, CX-3, p. 8). The electronic means of the accused calculators is based on MOS technology.

TI argues that from FIG. 15 in the '921 patent, a person skilled in the art would have a choice of the technology available in which to build a circuit; that FIG. 15 does teach one skilled in the art how to build circuits using MOS or any other technology; and that it would have been within the ordinary skill of persons in the art to substitute MOS integrated circuits for bipolar integrated circuits in 1966. (CPFF p. 142). The Administrative Law Judge finds no support for this argument. As already noted TI's expert Jerald Leach testified in his direct testimony that "The ['921] patent specification describes a bipolar process". (CX-3, p. 9). Later inventor Kilby testified on redirect examination:

> Q Looking at Figure 15 again of the '921 patent, what technology would a person skilled in the art today use to build that circuit?
>
> A He would have choices between whether conventional bipolar or what I've referred to as I-squared L logic ... be built. It could be built in PMOS, it could be built in NMOS, it could be built in CMOS. It could be built using conjuction field effect transistors.
> There are no technology connotations in that drawing that I'm aware of.
>
> Q Does Figure 15, then, teach one skilled in the art how to build the circuits shown there in MOS technology?
>
> A It does. (Tr. p. 442, ls. 7-21).

However inventor Kilby on recross examination testified:

> Q Now, Mr. Kilby, you were asked to look at Figure 15 of your ['921] patent, and I would like you again to look at Figure 15 of RX-505.
>
> A All right.
>
> Q I believe you were asked whether you could tell from Figure 15 that bipolar technology was used.
>
> A That is correct.
>
> Q And can you?
>
> A No. What this drawing shows is gates, and gates can be fabricated with a very wide variety of technology.
>
> Q Can you tell from Figure 15 whether discrete technology was used?
>
> A No, you cannot.

Q Now, you were asked whether Figure 15 would teach a person skilled in the art how to build that circuit in MOS technology. Do you recall that?

A I do.

Q Do you recall what your answer was?

A I do.

Q And what was it?

A It was that it would, because if you substituted an MOS gate for the bipolar gates that are shown here are connected them in this configuration, that you would perform exactly the same functions in the same way.

Q Does Figure 15 teach you how to build that circuit in MOS technology any more that it teaches you how to build that circuitry in discrete technology?

A No.

Q Have you ever seen that circuit built in MOS technology?

A No, nor have I ever seen it built in discrete technology.

Q You've only seen it built in the Cal-Tech calculator, right?

A I think that is correct. (Emphasis added) (Tr. p. 472 l. 1- p. 473, l. 12).

It is a fact that the Cal-Tech calculator which was based on the '921 patent was built with bipolar or discrete technology using discretionary wiring. (FF 184, 185, 187). Also as TI's Leach testified the '921 patent specification describes bipolar technology. (CX-3, p. 8).

TI argues that the use of MOS integrated circuits, are interchangeable with bipolar integrated circuits in the context of the working electronics of an electrical calculator, as discussed by a Japanese Technical Report (CX-19) which was a publication prior to the filing of the application which resulted in the '921 patent. (CPFF p. 142). This publication was before the Patent and Trademark Office during the prosecution of the '921 patent. (FF 249).

The Japanese Technical Report described an electronic desk calculator (CPFF p. 94). TI has argued strenuously that desk calculator art and in particular CX-19, is not pertinent on the issue of validity of the '921 patent over the prior art. For example in its post trial brief TI argues:

> The National Technical Report (a Japanese publication) [CX-19] is the most pertinent prior art, and it was officially cited by the Patent Examiner. (FF 167 -169, 273). It shows an electronic desk type calculator of large dimensions and describes the use of integrated circuits. For this reason, it is a better reference than any of the references relied upon by respondents (the Wang patent, the Green Machine, or Moore). The desk type calculator disclosed in the National Technical Report uses about 950 integrated circuits, each of which is packaged in a manner requiring at least 12 circuit boards in the assembly. (FF 167-169).
> Even though the Japenese reference used integrated circuits in the desk type calculator described, these are used in the form of individual components, rather than as "an integrated semiconductor circuit array located in substantially one plane" and including "memory means ...", "arithmetic means" and "means for selectively transferring numbers ...", resulting in a desk calculator approximately 66 times larger than the Cal-Tech miniature electronic calculator (using the keyboard size as a unit of measure) and operating on an AC supply at a high power consumption, instead of small batteries. (FF 167-169). [Emphasis added]. [CPH p. 7].

Based on the foregoing the Administrative Law Judge finds that the Japanese publication does not teach any interchange of bipolar and MOS technologies in the miniature calculator claimed in the '921 patent.

Inventor Kilby in his direct testimony testified that "It was recognized at the outset [of the Cal-Tech project] that a number of new technologies would be required to achieve . . . [the] objective [of the Cal-Tech project]. . . If implemented with the integrated circuts of the day, the logic would have been too large, consumed too much power and been much too expensive for our purpose." (CX-1, p. 6). This testimony also teaches away from any interchange.

TI argues that interchangeability of bipolar technology with MOS technology is confirmed by the fact that Gaynell Lockhart took a CAL-TEch bread board and converted it to an all MOS bread board in two weeks. (CPH p. 19). However as inventor Kilby testified the breadboard fitted on three conventional sized desktops, i.e. three 24 inch by 60 inch tops and "did not meet the requirements of claim one" of the '921 patent. (Tr. p. 388, ls. 20-23; p. 394, ls. 20-25).

Contrasting the arguments of TI, Prof. Sodini, a technical expect of the hearing respondents (FF 354, 357, 358), testified that there are substantial differences in operation and construction of the electronic means of calculators based on bipolar technology as against calculators with electronic means based on MOS technology. The Administrative Law Judge finds nothing in the record that contradicts his testimony. As Prof. Sodini testified, bipolar technology employs integrated bipolar transistors as the active elements. Bipolar transistors employ charge carriers of both polarities (positive and negative), hence the name bipolar. The N and P regions are adjacent and define emitter, base and collector regions in an NPN or PNP configuration. All regions are formed from semiconductor materials. doped with electron donor impurities (N regions) with other regions doped with electron acceptor impurities (P regions). N and P regions are located adjacent to each other to form either an NPN or PNP transistor configuration. (FF 361). The operation of a bipolar transistor is basically that an emitter-to-collector current is controlled by a much smaller emitter base current (typically in a ratio of 100 to 1). (FF 362). In required low power applications such as portable calculators, the implementation of logic functions with a bipolar transistor structure as shown in FIGS. 20 and 31 of the '921 patent suffered from several major disadvantages, viz. (1) a base current must flow to control the transistor, (2) losses of current during an "off state" are significant in comparision to an MOS transistor, and (3) bipolar transistors require a relatively large silicon area compared to MOS transistors. In essence this meant that thousands of bipolar transistors which must be employed to construct the logic gates and shift registers needed for the calculator will continuously draw a substantial amount of current which will quickly drain portable batteries and draw far too much power to premit powering of the calculator with shirt pocket sized solar cells. (FF 363).

Looking at an MOS chip of the type used in the accused calculators, Prof. Sodini testified that it is a chip employing integrated metal-oxide-semiconductor field effect transistors in which a metallized gate (M) of the transistor is separated from a silicon semiconductor substrate (S) by an insulating layer of oxide (O). Such MOS chips have substantially different structures and operate in a substantial different way from anything using bipolar technology. For example, Prof. Sodini testified that in MOS chips, capacitors are formed from metal areas separated from the substrate by oxide. Memory sections of some dynamic MOS devices rely on stored charges. Unlike bipolar structures, shown in FIG. 20 of the '921 patent, where current must flow in at least one transistor in the "logic" gate at all times so that there is a continuous draw of substantial current, an MOS implementation of that logic function could be accomplished without a continuous draw of current. (FF 364). In contrast to the logic functions implemented with bipolar transistors as shown in Figure 20 of the Kilby et al '921 patent. MOS transistor implementation draws less current by at least a factor of ten. Prof. Sodini testified that MOS integrated circuits have a number of operational differences which are significant advantages over bipolar integrated circuits as disclosed in the '921 patent, especially in portable calculator low power applications where there are size and cost contraints. Thus he specified: (1) no gating current flows to control the MOS field effect transistor; (2) current losses during an "off state" are insignificant; (3) transistors and memory can be more compactly fitted on individual chips. Because of such advantages thousands of MOS field effect transistors and capacitors can be fabricated on a single chip, yet require a very small amount of power. In fact, Prof. Sodini testified that so little power is required that the entire calculator can be powered with a solar cell about one square inch in area. 9/ (FF 365).

According to Prof. Sodini the making of a practical single MOS chip portable calculator required major advances on a number of technological fronts. Among these were: (1) control of threshold stability, and (2) control of the electrical properties of the silicon/silicon dioxide interface. These advances were said to be made independently of bipolar technology. To Prof. Sodini's knowledge no one has ever produced a single chip calculator using the bipolar technology represented in FIGS. 20 and 31 of the '921 patent. To Prof. Sodini's knowledge, no one has ever produced a commercial battery powered calculator using only such technology. It was his opinion that such a calculator would involve high power consumption, and would yield only a short operating period before requiring battery replacement. (FF 366).

TI argues that TI's Brantingham in his rebuttal testimony testified that a single chips calculator using bipolar technology was built and proven by TI and met all goals. However TI admits that it was not put into commercial production because of a "slight" cost disadvantage. (CPFFR p. 78). Significantly Brantingham on cross-examination admitted that he has never seen a commercially distributed hand-held calculator that had bipolar primary electronics. (FF 378). TI argues that Hewlett Packard's commercial HP-35 pocket calculator contained bipolar electronics as part of the primary

9/ Inventor Kilby admitted that bipolar transistors used in the Cal-Tech calculator had a high linear resistor; that in general the accused calculators do not use a linear resistor load (FF 395, 369) that the difference in load in MOS load resistors of the accused calculators as compared to the loads of the '921 claimed calculator enable MOS circuits to be much smaller and to consume a lot less power. (FF 398). He also admitted that today's MOS circuits occupy significantly less areas and consumers significantly less power than the biploar circuits of the '921 patent. (FF 397).

electronics including MOS circuitry. However a 1972 Hewlett Packard publication discloses that the HP-35 calculator contained five MOS/LSI (metal-oxide semiconductor/large scale-integration) circuits for the three read-only memories, an arithmetic and register circuit and a control and timing circuit. Three custom bipolar circuits are used only for a two-phase clock driver, and LED (light-emitting-diode) anode driver/clock generator, and an LED cathode driver. (CX-236, p. 4). The MOS logic is thus the prime contributor to the HP-35 calculator. The record is absent any evidence contradictory of Prof. Sodini's statement that no one has ever produced a commercial battery powered hand held portable calculator using <u>only</u> bipolar technology as the claimed calculator of the '921 patent uses.

TI's expert Mr. Leach testified that Prof. Sodini's claim that MOS operates substantially different from bipolar was incorrect; that one of ordinary skill in the art could easily substitute MOS for bipolar and bipolar for MOS. To show similarities of bipolar and MOS he relied on a drawing A for an early bipolar inverter, a drawing B for an an early MOS inverter and a drawing C for an improved MOS inverter. (FF 370). Drawing A was said to represent a prior art discrete bipolar inverter and a bipolar inverter used in an embodiment of the '921 patent. (FF 370, 371). Drawing B represented an early MOS inverter not used in any of the accused calculators. However even the inverter of drawing C was not used in any of the accused calculators. (FF 370).

The accused calculators that Mr. Leach examined did use MOS technology represented by the inverter of a drawing D. However when the device of drawing A is on, there is a DC path from power to ground and power is being consumed and the device consumes significantly more power than the MOS inverter of the accused calculators. (FF 374). TI does not deny a <u>significant</u> power consumption decrease in the accused calculatiors and argues only that there has to be an allowance for the "natural and steady evolution of the technology in hand held electronic calculators". (RPF, p. 68; CPFFR, p. 74). TI however has the burden of proving the accused electronic means operates in substantially the same way as the claimed electronic means. TI has not met its burden.

Based in the foregoing the Administrative Law Judge finds that Ti has not proven, by a preponderance of evidence that the electronic means of the accused calculators is the same as, or equivalent of, the electronic means of the claimed calculators of the '921 patent.

Accordingly the Administrative Law Judge concludes that TI has not sustained its burden by a preponderance of evidence that the asserted claims are literally infringed by the accused calculators.

Doctrine of Equivalents

Because there is no literal infringement, the Administrative Law Judge must determine the range of equivalents to which the claimed subject matter is entitled in light of the prosecution history, the pioneer-non-pioneer status of the claimed invention, and the prior art and whether the accused calculators are applicable to the doctrine of equivalents as set forth in Graver Tank. D.M.I. supara.

An exmination of the prosecution history of the '921 patent (FF 216-258) shows that applicants' arguments were not limited to merely what TI's counsel has defined as the heart of the invention. (pp. 46-47 supra). For example in an amendment dated June 8 1970, it was argued that the invention provides a novel co-action of parts. (FF 225). In an amendment filed June 12, 1972 it was argued that applicants show the use of variable connections; that applicants use only two registers; that there are distinctions in the claimed subject matter other than limitations regarding integrated circuitry; that claimed details of the integrated circuits are not disclosed in the cited art

(FF 237); and that the claims are distinct from prior art due to the way the registers are connected to the arithmetic unit and the way commands and numbers are encoded and entered. (FF 236). It was also argued that, each key of the keyboard of the prior art calculators does not generate a "unique code". (FF 237). In preliminary comments dated June 25, 1973 applicants argued that miniaturization of a prior art calculator would require a "complete redesign and the use of entirely different components". (FF 248). Accordingly the Administrative Law Judge finds that the prosecution history supports a consideration of the components and design of the electronic means, input means and display means as disclosed in the specification of the '921 patent in interpreting the scope of the claimed subject matter.

TI argues that the Cal-Tech project created a new device which opened up a totally new and different market for electronic calculating devies; that the project created a battery-operated calculator small enough to fit into a pocket all at a cost which made electronic calculators affordable for nearly everyone; that there is nothing even remotely similar in the prior art; and hence "[t]his protable, miniature, battery-opeated calculator is a dramatic advance deserving pioneer status." (CPH p. 15).

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

> Morely, having been the first person who succeeded in producing an automatic machine for sewing buttoms of the kind in question upon fabrics, is entitled to a liberal construction of the claims of his patent. He was not a mere improver upon a prior machine, which was capable of accomplishing the same general result, in which case his claims would properly receive a narrower interpretation. This principle is well settled in the patent law, both in this country and in England. Where an invention is one of

> a primary character, and the mechanical functions performed by the machine are, as a whole, entirely new, all subsequent machines which employ substantially the same means to accomplish the same result are infringements, although the subsequent machine may contain improvement in the separate mechanisms which go to make up the machine. [Emphasis added] [129 U.S. at 273].

Thus the concept of a "pioneer patent" whereby a claimed device is given a wide range of equivalents such that an accused device is said to infringe a claim in issue is grounded on the theory that the accused device employs substantally the same means. The Administrative Law Judge has found that the record establishes that the accused calculators do not employ substantially the same electronic means, input means and display means as the claimed calculator. Hence the claimed calculator does not have the concept of a "pioneer" patent enunciated in the Morley Sewing-Machine case.

TI argued that the Cal-Tech calculator opened up a "totally new and different" market. As already noted in the opinion (pp. 22-24 supra). there were substantial differences between the Cal-Tech prototype and what has been alleged to be the commercialization of that prototype; that it was the complex chip, introduced by TI in 1971, that sparked an explosive market; that the technological breakthrough that made the miniature electronic calculator possible was the invention of the integrated circuit in 1958. Moreover as already pointed out in this opinion, no commercial battery powered, hand held portable calculator has been commercially produced using only a bipolar process which TI's technical expert Leach testified the '921 patent specification describes. (CX-3, p. 8).

Accordingly the Administrative Law Judge finds that the claimed calculator is not entitled to the broad range of equivalents to which pioneer inventions are normally entitled.

TI argues that post invention improvments are covered by the claims in issue, citing Atlas Powder v. E.I. du Pont de Nemours, supra and Hughes

Aircraft Co. v. United States 717 F.2d 1351, 1362, 219 U.S.P.Q. 471,481 (Fed. Cir. 1983 (CPH p. 22). In the E.I du Pont case, the Federal Circuit agreed with Bendix Corp. v. United States, 199 U.S.P.Q. 203 (Ct. C. Trial Div. 1978, aff'd 600 F.2d 1364, 204 U.S.P.Q. 617 (1979) where the trial judge said that "where defendant has appropriated the material features of the patent in suit, infringement will be found even when those feature have been supplemented and modified to such an extent tht the defendant may be entitled to a patent for the improvement 199 U.S.P.Q. at 231-22" (Emphasis added) 750 F.2d at 1580, 224 U.S.P.Q. at 417. In the record of this investigation TI has not proven by a preponderance of evidence that respondents have appropriated the material operational features of each of the electronic means, display means and input means of the claimed calculator.

In the Hughes case the finding of infringement was made only after it was found that the accused S/E spacecraft performs substantially the same function as that performed by the claimed invention in substantially the same way as the claimed invention to obtain the same result, 717 F.2d at 1363, 219 U.S.P.Q. at 482. In this investigation, TI has not established that each of the electronic means, display means and input means of the accused calculators performs substantially the same function in substantially the same way as the claimed calculator.

TI argues that the Cal-Tech project created a calculator that was small enough to fit into a pocket. (CPH, p. 15). The concept of a small calculator did not however originate with the inventors of the '921 patent. TI's President Haggerty in 1964 felt that the integrated circuit could provide a small calculator, "perhaps using a slide rule as a size reference" and conveyed his feeling to inventor Kilby in 1964. (FF 152). Also as inventor Merryman testified, simply "making a determination that parts need to be small and interacted to fit in a pocket-sized housing does not take other than ordinary skill" (Tr. p. 1240 ls. 1-5). Rather as Merryman further testified "[c]hoosing, developing and interacting, and all of those had to be done." (Tr. p. 1240 ls. 18-19). New technologies were required. (Kilby, CX-3, p. 6).

As Prof. Sodini testified new technologies had to be developed for the accused calculators (FF 366), which calculators can be about 100 times smaller than the Cal-Tech calculator. (FF 408).10/

Based on the foregoing, the Administrative Law Judge finds that TI has not sustained its burden in proving by a prepondereance of evidence that the accused calculators are equivalent to the claimed calculator and that the accused calculators infringe the claims in issue.

IV. VALIDITY OF THE '921 PATENT AS TO BEST MODE

The hearing respondents allege three instances where the best mode for carrying out the claimed invention were not disclosed. The first instance concerns a memorandum to inventor Merryman from inventor Van Tassel wherein Van Tassel described a problem of copper cracking during ultrasonic bonding, that was eliminated by vacuum annealing. The problem involved interconnections between the wafers in the Cal-Tech project that made up the "integrated semiconductor circuit array"of the FIG. 14 embodiment. It is argued that the '921 patent does not disclose the solution to the problem although the problem and solution were known before the filing of the originial application on September 29, 1967 for the '921 patent. (RPF pp. 107-108).

10/ The prototype of the '921 patent was argued to be about 66 times smaller than the prior art desk calculator. (CPH p. 7). Thus the accused calculators can be considerably smaller than the preferred FIG. 14 embodiment prototype of the '921 patent.

The second instance is in the same Van Tassel memorandum and involved a problem which prevented copper from being etched or plated for bonding in the interconnections and a need for certain steps to be taken to prevent such occurence. The hearing respondents argue that neither the problem nor solution was disclosed in the original application. (RPH pp. 107-108).

The third instance for alleging that the best mode for carrying out the invention is not disclosed, involved the the Pocketronic calculator. The hearing respondents argue that that calculator was suppose to be a commercial implementation of the Cal-Tech technology; that the decision to so proceed with the Pocketronic calculator with MOS technology was made in 1969 at which time TI, with the concurrence of inventor Kilby, believed that was "the best was of doing it"; that during the refiles of the Cal-Tech application, no one informed the Patent and Trademark Office that the Pocketronic calculator was supposedly the best way of implementing the Cal-Tech technology. (RPH pp. 108-109).

TI agrees that Van Tassel in a February 20, 1967 memorandum raised the matter referred to by the hearing respondents but argue that the problems raised, in the over-all context of the miniature electronic calculator disclosed in the '921 patent, are trivia and that these problems would be routinely investigated and solved through the use of conventional techniques. It is argued that it is not the purpose of a patent specification to include a "cookbook" recipe, wherein every instance of the development of the described structure is detailed in minutiae. (CPFF pp. 113-114).

TI argues that the Cal-Tech technology was commercially implemented by the Canon Pocketronic but that inventor Kilby testified, in response to a question as to whether MOS was the best way of doing it, only "probably yes". TI further argues that since the weight of evidence establishes equivalence as between bipolar and MOS technology, no basis exists for the proposition that the inventors were required to inform the Patent and Trademark Office that MOS was supposedly the best way of implementing the Cal-Tech technology in a subsequent application which became the '921 patent. TI asserts that during the particular time period extending generally from September 29, 1967 to December 21, 1972, when the third application which resulted in the '921 patent was filed, there was no degree of certainty that MOS would necessarily come to be regarded as the best way of implementing Cal-Tech technology. (CPFFR pp. 115-116).

The first paragraph of 35 U.S.C. § 112 requires that an inventor set forth the best mode of practicing the invention known to him at the time the application was filed. W. L. Gore & Associates, Inc. v. Garlock, Inc. supra F.2d at, 1557, 220 USPQ at, 316. Inventor Van Tassel in his February 20, 1967 memorandum discusses a problem with 1 oz. copper. However he states that the most satisfactory copper material used has been 2 oz. rolled material and no problem is stated with the use of 2 oz. rolled copper. (FF 174). A '535 patent incorporated by reference into the '921 patent specification (FF 175) further discloses that "copper" is suitable. Hence disclosure of copper is considered adequate for defining a "most satisfactory material" used for interconnections in the '921 patent.

Concerning the problem which prevented the copper from being etched or plated, Van Tassel in his February 20, 1967 memorandum disclose that one of the real problems was in finding an adhesive which would provide adequate bond strength, stand up through all the plating operations and present a decent appearance; that the most satisfactory solution has been to use a low flow B-stage preparation similar to what was used in conventional multilayer boards and that it is necessary to use the minimum of fill on the B-stage to prevent extrusion of epoxy during processing so that the copper can be etched or plated for bonding. (FF 174). However there is testimony that this is a problem in conventional printed circuitboard manufacture and its solution would be known to anyone who built circuitboards. (FF 176). Moreover Van Tassel states the use of low flow B-stage preparation in conventional multilayer boards. (FF 174). The Administrative Law Judge finds in the record no evidence to the contrary, nor evidence that undue experimentation would be required to determine that a minimum of fill on the B-stage would be necessary so that the copper can be etched or plated for bonding. A patent is not invalid because of a need for experimentation. W. L. Gore & Associates, Inc v. Garlock, Inc. , supra, Id.

As to the argument of the hearing respondents that during the refiling involved in the '921 patent, no one informed the Patent and Trademark Office that the Pocketronic calculator was "supposedly the best way of implementing the Cal-Tech Technology" (RPF p. 109), it is well established that the date with regard to disclosing the best mode contemplated is the date of the filing of an application. W. L. Gore & Associates, Inc. v. Garlock, Inc., supra, Id. However the hearing respondents admit that the decision to proceed with MOS technology was not made until 1969 which was more than a year after the original patent application was filed on September 29, 1967. Admittedly the inventors filed a streamlined continuation application on May 13, 1971 and a continuation application on December 21, 1972. (FF 230, 242). However a requisite for a continuation application is that its specification contain no matter extraneous to that in the original application Sylgab Steel & Wire Corp. v. Imoco-Gateway Corp., 357 F. Supp. 657, 178 USPQ 22,23 (N. D. Ill. 1973). Accordingly, assuming that the '921 patent encompassed the Pocketronic calculator, the Administrative Law Judge finds that it was unnecessary for the inventors to disclose the Pocketronic calculator in the '921 patent specification in the two subsequent continuation applications.

Based on the foregoing, the Administrative Law Judge finds that the hearing respondents have not proven, by a preproderance of evidence, that the best mode for carrying out the invention in the '921 patent was not disclosed in the specification of the '921 patent.

V. RELEASE AND IMPLIED LICENSE DEFENSES

The hearing respondents argue, as an affirmative defense, that Nam Tai is the clear beneficiary of an express release executed in by TI in favor of

It is argued that that release covers

from the beginning of time until the effective date of the release (sometime after

; that as defined in the Release include

. . .

The hearing respondents argue that TI's 921 patent covering portable electronic calculators and TI's chip patents clearly fall within this definition.

The hearing respondents argue that Nam Tai, as of calculator chips under the Release, is an express beneficiary of that Release from all claims of infringement of the '921 patent, to the extent that the alleged acts of infringement involve purchases from prior to the effective date of the Release; that therefore, the only issue is whether Nam Tai's use of calculator chips in sales to the U.S. and/or knowing sales of those chips to Nam tai were possible "acts of infringement" of the '921 patent that were released by the agreement. It is argued that according to 35 U.S.C. § 271(c),[11/]

11/ 35 U.S.C. § 271(c) reads:
(c) Whoever sells a component of a patented machine, manufacture, combination of composition, or a material or apparatus for use in practicing a patented process, constituting a material part of the invention, knowing the same to be especially made or especially adapted for use in an infringement of such patent, and not a staple article or commodity of commerce suitable for substantial noninfringing use, shall be liable as a contributory infringer.

sale of calculator chips could have made liable to TI as a contributory infringer of the '921 patent had it not been for the express release. It is said that the evidence is clear that there is no substantial noninfringing use of the calculator chips purchased by Nam Tai; that there is also no question that was at all time fully aware that the chips are to be used by Nam Tai in the manufacture of portable electronic calculators, since that is their stated use and their only practical, significant use; that was also aware that Nam Tai exported many calculators empoying chips to the United States since was itself a manufacture of such calculators and was a competitive in the U.S. market, and since Nam Tai and representatives had frequently discussed who Nam Tai's customers were(RPH pp. 28, 29).

TI argues that the release in question was an alternative to a license agreement under which TI obtained royalties on its standard terms for calculators sold under the '921 patent through when was scheduled to . It urges that the TI- agreement concerned only sale of calculators, and not sale of chips; that the sale of chips by to Nam Tai did not constitute contributory infringement of the '921 patent or even its counterpart because Nam Tai bought its chips from in ; and that Nam Tai has not shown that the chips used in its calculators sold in the United States are within the time scope of the TI- agreement(CPH pp.27-29)

The hearing respondents further argue, as an affirmative defense, that respondent Nam Tai did not infringe the '921 patent because it had an implied license from TI to make and sell calculators containing calculator chips licensed for sale by TI. It is argued that in TI granted each of 12/ a license to make, use and sell a

12/ The hearing respondents state

are essentially

or

the world; that the te... is defined of ; and that the terms and were admitted by TI witnesses to cover . Thus it is said that virtually all the allegedly unlicensed Nam Tai calculators sold in the U.S. through at least were assembled from a or . It is argued that these have no practical use other than as components of the portable electronic calculators to which they are dedicated; that TI was fully aware of sales of these to Nam Tai and others at the time TI granted the license to . (RPH pp. 29, 30).

TI argues that TI and its clearly understood that no license under the '921 patent was granted; that an implied license of the '921 patent was not necessary to enable to enjoy their ; and that Nam Tai has not shown that its calculators imported into the United States contain covered by the . (CPH pp. 26, 27).

The hearing respondents have the burden of proof on these affirmative defenses. TI does not challenge Nam Tai's statement that the TI- agreement containing the release clause is to be construed according to Texas law, and that under Texas law a release is construed according to general rules of contract construction. (CPHR p. 28).

Implied License

The TI- agreement was executed in and the TI- agreement in . (FF 416, 419). Since Nam Tai did not commence production of

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(Continued from page 79)
the same in all critical respects for purposes of the implied license deference as to TI- license. (RPH pp. 28, 29). The proposed findings of the hearing respondents make reference to the TI- and TI- license.
(Continued to page 81)

calculators until 1980 (FF 438), TI when it executed the agreements could not have known of any sale of calculator chips by to Nam Tai. TI, a party to the agreement argues that the agreements do not cover . Moreover there is testimony to that effect from a TI official involved in the negotiations. (FF 428). The hearing respondents have offered no testimony or documentary evidence from , the other parties to the agreements, that the agreements include . Moreover the fact that later excuted a separate agreement with TI involving (FF 423) indicates that did not intend the agreement to cover . Furthermore, the specific language of the agreements supports the allegation of TI that the agreements do not cover . In both agreements TI grants . (FF 417, 421). The term may include (FF 422) but the term also includes products completely unrelated to . (FF 424). Moreover according to the definition of when it includes , the . (FF 417, 421). A is not a , which the claims of the '921 patent are directed to, and the record contains no evidence that any purchased by Nam Tai were .

Accordingly based on the foregoing, and assuming Nam Tai has been infringing the '921 patent, Nam Tai has not sustained its burden by a preponderance of evidence that it had an implied license from TI through at least 1983 to utilize and to manufacture calculators for sale in the United States.

Release

The essence of the hearing respondents position is that past sale of calculator chips to Nam Tai in Asia and Nam Tai's subsequent use of those

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(Continued from page 81)
in support of the implied license affirmative defence. (RPF, pp. 110-116). In its post hearing filings, the hearing respondents do not rely on any TI- license. Presumably it is because the TI license with expired in . (CPH p. 27).

chips in making, in Asia, calculators alleged to have been shipped to the United States and to have infringed the '921 patent would have made a contributory infringer, under 35 U.S.C. § 271(c), had it not been for a release and accordingly respondent Nam Tai is a clear beneficiary of the release.

In general four criteria must be met in order to prove contributory infringement. There must be (1) a sale (2) of a material component of a patented invention which component is sent to the United States where direct infringement occurs, (3) with knowledge that the component was especially made for use in the infringement of such invention in the United States and (4) that the component was not a stable article of commerce capable of substantial infringing use. In re Certain Apparatus for Continuous Production of Copper Rod 644 F. 2d 869, 206 USPQ 138, 149 (U.S.I.T.C. 1979). In this case there was a sale of chips by in Asia but to Nam Tai in Asia for making calculators in Asia with Nam Tai allegedly exporting calculators with those chips to the United States.

The hearing respondents have cited no case law that establishes that actions as performed by followed by subsequent intervening acts abroad, constitute comtributory infringement. Also the hearing respondents have offered no documentary evidence or testimony from that had knowledge that the chips it sold to Nam Tai were especially made for use in an infringement of a United States patent. The evidence shows that Nam Tai has been exporting calculators to China. (FF 435).

In addition an express or implied agreement between the parties can limit the terms of an agreement. Edison Electric Light Co. v. Peninsular Light, Power & Heat Co. 101 F. 831, 836 (6th Cir. 1900). On this point there is testimony, by a TI participant in negotiations that led to the TI-agreement corroborated by language in the agreement that and TI intended that the release in the agreement, relate only to patents that claim . (FF 436). This testimony was to the effect that the negotiations were delayed because was ; that the parties wished if possible to delay any agreement until had ended so that only , rather than a , would be required. (FF 429). This testimony is supported by the actual wording of the agreement which states that if

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(FF 427). There is additional testimony by the TI participant involved in the negotiations that the parties to the agreement understood the term in the agreement to include only patents that cover . (FF 430). Nam Tai has offered no evidence from that even though was and would enter into negotiations with TI for a fair and equitable compensation to TI if, after , it sold understood that when it was selling chips to Nam Tai it was infringing the '921 patent. If Nam Tai's theory is correct, and intended the release to cover , would now be in violation of the agreement because it is still selling to Nam Tai. (FF 439).

Accordingly based on the foregoing, and assuming Nam Tai has been infringing the '921 patent, Nam Tai has not sustained its burden by a preponderance of evidence that it was a clear beneficiary of any express release by TI in the TI- agreement.

VI. IMPORTATION AND SALE

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

The record establishes that the following respondents have imported into or sold allegedly infringing portable electronic calculators in the U.S.: Nam Tai; IMA; Enterprex; Far East; Hua Chang; Integrated Display; MBO; Promoters; Luks; General Electronics; Cosmo; Tronica; Dah Sun; and APF. (FF 441-502,838-966; CX-231-A).

With respect to those respondents who have been terminated from the investigation, the record evidences importation and sale of allegedly infringing calculators by Sears and RJP. (FF 473; CX-231-A).

Finally, there is evidence of record of importation and sale of allegedly infringing calculators by the following non-parties: Kin Sung; San Sung; Time Proc.; Zeny; Sentek; Qualitro; Qualitron; and Beare/Taiw, as well as by unknown entities. (CX-231-A).

VII. DOMESTIC INDUSTRY

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

In patent-based §337 investigations, the Commission has customarily defined the domestic industry as the domestic operations of the patent owner and its domestic licensees devoted to the exploitation of the patent. Certain Methods for Extruding Plastic Tubing, Inv. No. 337-TA- 110 (1982) (Plastic Tubing); Certain Slide Fastener Stringers and Machines and Components Thereof for Producing Such Slide Fastener Stringers, Inv. No. 337-TA-85 (1981) (Slide Fastener Stringers); Trade Reform Act of 1973: Report of the House Committee on Ways and Means, p. 78, H. Rep. No. 93-571 (93d Cong., 1st Sess. 1973). Since the term "domestic industry" is not precisely defined in §337, the Commission does not adhere to any rigid formula in determining the scope of the domestic industry, but examines each case in light of the realities of the marketplace. Certain Apparatus for the Continuous Production of Copper Rod, Inv. No. 337-TA-52 (1979) (Copper Rod); Slide Fastener Stringers.

TI has not sustained its burden in proving that it is producing calculators in accordance with the claims in issue under the '921 patent.13/ Thus, the Administrative Law Judge finds that complainant has failed to meet its burden of proof that a domestic industry exists. See Certain Spherical Roller Bearings And Components Thereof, 337-TA-179, ID at 79 (1984); Certain Stabilized Hull Units And Components Thereof And Sonar Units Utilizing Said Stabilizing Hull Units, 337-TA-103 at 38 (1982). However, in order to reach all issues pertaining to violation, including the remaining issues relating to domestic industry, the calculators in issue will be regarded as covered by the claims of the '921 patent in issue and the domestic industry will be defined as including TI's operations in the United States devoted to the exploitation of the '921 patent.

The hearing respondents Nam Tai, IMA and Enterprex argue that the domestic industry consists only of the U.S facilities devoted to the production of professional calculators under the '921 patent, that the

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13/ TI's technical expert Leach has shown that TI's calculators alleged to be made under the '921 patent contain a single integrated circuit chip with an LCD display having the same features as he found for Nam Tai's accused COMPEX LC-827 calculator. (FF 409-415). For the same reasons that the Administrative Law Judge has found that the accused calculators do not infringe the '921 patent, he finds that TI has not sustained its burden in proving that it is producing calculators under the '921 patent. On this point it is noted that each of TI's calculators in evidence in this investigation either has no patent marking or have been identified with several TI patents, not merely the '921 patent. (FF 415).

domestic operations devoted to the four-function calculators are insufficient to constitute a domestic industry and that the four-function calculators made by TI are so distinct from the professional calculator models as to constitute a separate industry. (RPH, pp. 31,38; RPHR, 19,22; Closing Arguments, Tr. pp. 285-286). TI and the Commission investigative attorney contend that TI's domestic operations with respect to TI's full line of calculators which come under the claims in issue of the '921 patent, including the four-function and professional models, constitute one domestic industry and that TI engages in sufficient domestic activities with respect to its four-function calculators to consider such activities as part of the domestic industry. (CPH, pp 34-35,37; SPHR, pp. 4-5; SPH, p.16; Closing Arguments, Tr., p. 239).

Hewlett-Packard Company

In the present investigation, TI and the Commission investigative attorney take the position that the domestic industry is confined to TI's facilities which are engaged in the exploitation of the '921 patent and do not include the operations of Hewlett-Packard Company (H-P), TI's domestic licensee under the '921 patent. (Closing Arguments, Tr. pp. 179-180, 298). Both TI and the staff state that the record contains no evidence that H-P is engaged in the exploitation of the '921 patent. (CPH, p. 31, ftn. 16; Closing Arguments, Tr. p. 298). Hearing respondents, on the other hand, assert that H-P is part of the domestic industry. (Closing Arguments, Tr. p. 224).

There is no evidence of record that either of the two H-P calculators in evidence, the HP-35 or the HP-11C Slim Line Advanced Programmaable Scientific Calculator or any other H-P calculators fall within the claims in issue under the '921 patent. (FF 751, 752). There is insufficient evidence, as well, of the scope of H-P's activities allegedly devoted to exploitation of the '921 patent. (See FF 749-57). Accordingly, the domesic industry does not encompass the operations of H-P.

Date For Defining Domestic Industry

As a preliminary matter, TI urges that the date of filing of the complaint in this investigation should not be controlling in determining the existence and nature of the domestic industry. (CPHR, pp. 25-27). Citing Rotary Wheel Printing Systems, Inv. No. 337-TA-185, ID (March 1, 1985) (Rotary Wheel II), TI argues that account should be taken of certain economic realities pertaining to TI's production of calculators in determining the time frame for a proper assessment of domestic industry.

In Bally/Midway Mfg. Co. v. U.S. International Trade Commission, 219 U.S.P.Q. 97 (Fed. Cir. 1983), the Federal Circuit concluded that under the circumstances of that case the proper date for determining whether there was a domestic industry "was the date on which the complaint was filed rather than the date on which the Commission rendered its decision". Id. at 100. The Court went on to say that in circumstances wherein an industry exists at the time a complaint is filed, but is destroyed by the unfair practices in issue during the pendency of the Commission proceedings, it would "vitiate the statutory proscription of unfair practices" to assess the existence of a domestic industry as of the date the Commission rendered its decision. Id.

Citing Bally/Midway, the Administrative Law Judge in Rotary Wheels II determined that a proper definition of industry must be derived from an analysis of market realities. Rotary Wheels II, ID at 243. In that case the complainant urged that the domestic industry be defined as it existed on the date it filed its earlier complaint in Certain Rotary Wheel Printers, Inv. No. 337-TA-145 (Rotary Wheels I), rather than on the filing date in Rotary Wheels II, some ten months later. Noting the special circumstances of that case, wherein both investigations involved the same patent, the same products and the same industry, Judge Mathias determined that "[i]n a very real sense, Rotary Wheels II is a continuation of Rotary Wheels I." Id. at 244. Concluding that the "date of filing the complaint [in Rotary Wheels II] [had] less significance than in most Section 337 investigations", Judge Mathias defined the domestic industry as it existed at the date of filing of the complaint in Rotary Wheels I. Id. at 243,245.

In the present investigation, the record shows that TI made the decision in the fall of to subcontract the of certain of its calculator models but that currently TI has plans to bring the of all of its back to its lines in Lubbock, Texas by the end of and hopes to begin of its four-function calculators at Lubbock in early . (FF 511, 570, 571). TI contends that its subcontracting of was precipitated, at least in part, by from import competition and that if a change in the nature of the domestic industry arises as a consequence of an unfair act, the policy considerations behind §337 would be best served by considering the nature of the domestic industry as it existed prior to the effect of the unfair act. (CPHR ,pp. 26-27; Closing Arguments, Tr. pp. 192-193).

Unlike the circumstances in Bally/Midway, there has been no showing in this investigation that the change in the nature of the domestic industry (i.e. the locating of operations for certain calculator models) was a result of the alleged unfair acts. (See injury discussion, infra.). In any event, the Court in Bally/Midway did not address the propriety of considering a date before the filing of the complaint. Further, none of the unique circumstances of Rotary Wheels I/Rotary Wheels II are present in this investigation.

While any effect upon the domestic industry in this investigation of alleged unfair acts is considered pertinent to the issues of injury, there exist no compelling reasons for determing the scope of the domestic industry as of a date prior to the initiation of this investigation.

TI's Domestic Operations

TI's Consumer Products Division employs approximately people engaged in various aspects of the production and sale of portable electronic calculators for the U.S. market. (FF 504). All of TI's four-function and professional (including "business" and "scientific") portable calculators are alleged to be covered by the '921 patent except for its printer and desktop models. (FF 61, 62).

All of TI's product development and qualification, quality control, skin-wrapping, manual and packaging design and repair and replacement service with respect to all of the calculators in issue is performed by TI at its facilities in the United States. (FF 577-81, 584, 605, 608, 616, 639). With respect to calculator assembly, approximately of TI's professional calculators are assembled at TI's facilities in Lubbock, Texas, although TI expects to temporarily of them beginning in the first quarter of , during the development of an process in Lubbock. All of TI's four-function calculators were in and will be in , as well. (FF 515).

When a portion or all of the production of a product made in accordance with the claims of a patent occurs , a determination of the existence of a domestic industry requires an evaluation of the nature and significance of the activities in the United States carried out in connection with that product. Certain Fluidized Supporting Apparatus and Components Thereof, Inv. Nos. 337-TA-182/188 (1984) (Supporting Apparatus); Certain Miniature, Battery-Operated, All-Terrain Wheeled Vehicles, Inv. No 337-TA-122 (1982), aff'd sub. nom. Schaper Manufacturing Co. v. U.S. International Trade Commission, 717 F2d 1368 (Fed. Cir. 1983) (Schaper); Certain Cube Puzzles, Inv. No. 337-TA-112 (1982) (Cube Puzzles).

In order to meaningfully assess the significance of TI's domestic activities, it is useful to consider the nature of the entire calculator production cycle, from design and qualification to quality control and repair. After a new calculator model has been conceived and TI has prepared product specifications for all components, TI then arranges for the necessary tooling and molds to begin prototype assembly. (FF 578, 585). Once a prototype has been assembled, the unit itself and are subjected to qualification testing, as are at least lots of approximately calculators each. (FF 592, 593, 596, 600). The entire qualification process for a new calculator model requires a minimum of weeks to complete, but may last as long as . (FF 595). During the entire process of taking a new calculator model from conception through product qualification, TI engineers will work approximately . (FF 602).

The relationship between design and testing to the overall competitive capabilities of the semiconductor industry is comparable to the same relationship in the calculator industry. Process steps in the semiconductor industry can be separated into four elements: device design; fabrication of the chip; assembly of the device; and final testing or quality control. Device design, chip fabrication and increasingly, final testing or quality control are considered the most complex steps, while assembly is not considered a difficult production step. (FF 650). Design and testing operations are critical steps in the semiconductor industry. Product designs influence both product manufacturing costs as well as the reliability of the product, and competitive market pressures have led to the requirement that firms maintain an extremely high reliability rate for devices in the field. (FF 652).

TI considers product development, design and quality to be critical for success in the calculator business and in considering options for subcontract

, TI rejected proposals to buy curre models and decided that the critical aspects of the business, from product design through product qualification and quality control, to inventory and shipping, would continue to be conducted by TI employees. (FF 655, 656).

In Schaper, while the Federal Circuit determined that an "industry" may encompass more than the manufacturing of a patented product, it found that where all of the manufacturing of the toy vehicles at issue, as well as most of their packaging and quality control, occured in Hong Kong and that complainant's domestic inspection activities were not substantially different from those that a mere importer would perform, complainant's activities did not rise to the stature of a domestic industry for purposes of §337. Schaper, 717 F.2d at 1372-73. The Court in Schaper cited with approval Cube Puzzles, wherein the Commission concluded that complainant Ideal's U.S. operations including quality control, repair and packaging constituted a domestic industry. Cube Puzzles, 219 U.S.P.Q. at 334-35.

In the present case, TI performs not only all of the domestic activities of quality control, repair and packaging with respect to its calculators that were said to constitute a domestic industry in Cube Puzzles, but it conducts significant calculator development and qualification operations of a nature not present in either Schaper or Cube Puzzles.

Significantly, TI is engaged in a continual process of redesigning its portable calculator models and developing new models to enhance marketability. TI redesigns more than of the portable calculator models in its product line each year and will introduce new calculator models in , respectively. (FF 573, 574, 576). Through the efforts of TI's new product design employees, working jointly with TI's research and development staff, TI controls the layout, design and product specification of every portable calculator sold in the U.S., including models

. (FF 580). TI evaluates the designs of all of its calculators, develops test requirements to qualify each of its calculators, engages in qualification testing, evaluation of test results and determines what design changes, if any, are required. (FF 583). TI will at times qualify an existing model of calculator , but in such instances the unit must meet TI specifications. (FF 581).

TI's Quality and Reliability Assurance Department in Lubbock conducts qualification testing of

model sold by TI before the model is approved for commercial production. (FF 592-94). An initial prototype batch of approximately calculators are submitted to a series of qualifying tests. If calculator fails to operate after , TI determines the cause of the malfunction, develops any necessary changes and requires that an additional prototype batch of calculators be submitted for further testing. (FF 596-602).

The extent of TI's new product development and qualification operations is considerable and in the context of an industry which experiences frequent model turnover, is considered significant relative to the entire calculator production process. Compare Cube Puzzles, 219 U.S.P.Q. at 335 (efforts made to improve the design and materials of the puzzles were considered in the analysis of domestic industry) with Schaper, 717 F.2d at 1371 (design activities of patentee who was not involved in the manufacture or sale of the product considered nothing more than that of any inventor and therefore, not part of domestic industry).

TI prepares the instruction manuals for all of its calculators and designs the packaging for all of those calculators which are sold in a box. (FF 605). Approximately of the calculators are packaged by TI in the U.S. using a skinwrapping process, which typically includes wrapping of the manual along with the unit. (FF 608, 610-12, 714, 715). The packaging done by TI in the instant case is distinguishable from that in Schaper wherein most of the packaging was done in Hong Kong and the only packaging in the U.S. was in boxes containing accessories, the production of which was specifically excluded from consideration as part of the domestic industry. Schaper, Id. at 1371-72. Though TI packages fewer of its products in the U.S. than did complainant in Cube Puzzles, where almost all of the puzzles were U.S.-packaged (Cube Puzzles, 219 U.S.P.Q. at 335 n.113), to the extent to which TI engages in packaging, such activity should be considered in a comprehensive analysis of the nature and significance of TI's domestic activities relating to its offshore-assembled calculators. See Certain Cloisonne Jewelry, Inv. No. 337-TA-195, ID at 61 (March, 1985) (Cloisonne Jewelry).

Regardless of where calculator occurs, all TI portable calculators sold undergo a quality control program conducted in the U.S. and acceptance of any calculator is not complete until it has passed TI's incoming inspection in Lubbock. (FF 616, 635). While the quality control activities of complainant in Schaper were regarded as insufficient and not "substantially 7ifferent from the random sampling and testing that a normal importer would perform" (Schaper 717 F.2d at 1372-73) and the quality control tests performed in the U.S. in In re Certain Limited-Charge Cell Culture Microcarriers, 221 U.S.P.Q. 1165 (U.S.I.T.C. 1984) were considered "essentially redundant" to those carried out in Scotland, id. at 1181, the Commission in Cube Puzzles found Ideal's quality control operations extensive and worthy of consideration as part of the domestic industry. Quality control activities were also considered an aspect of the domestic industry in Cloisonne Jewelry, ID at 60-61.

Once the first commercial lot of a calculator model is released, TI thereafter conducts quality control tests on a sample of calculators from , the sample size ranging from , depending on the size of the incoming lot. The quality control tests for each model are tailored to fully test the functions of all features on the particular model. Every unit from each sample is checked for applicable defects from a list of possible defects. (FF 620, 621, 623). TI initially performs a so-called test on in the sample, consisting of . All units which pass the test are then subjected to the test in which a calculator's functions are tested after the unit for hours. (FF 624, 625). The tests control the release of each commercial lot. A lot will be released to customers only if an acceptable quality level is met for both tests and will be reviewed by TI's quality control, engineering and manufacturing divisions. A lot's rejection will be cause for the lot to be . (FF 632-34).

The quality control or inspection operations of TI must be considered in association with its development and qualification operations, discussed supra. Considered in the aggregate, these activities evidence an industry which maintains consistent and strict control over the nature and quality of all of the calculators it sells, including those . Viewed in this context, the degree of control exercised by TI over the production of its calculators - both and - is considered substantial, far in excess of the random sampling and testing of a normal importer, as discussed in Schaper (See FF 658-84), and at least qualitatively equivalent to the inspection procedures in Cube Puzzles.

TI's marketing and promotional activities are not considered part of the domestic industry. Rotary Wheels II, ID at 248; Schaper, 717 F.2d 1373; Cube

Puzzles, 219 U.S.P.Q. at 335 n.121. Similarly, warehousing is considered an activity of the type typically engaged in by importers and also will not be considered part of the domestic industry.

TI's repair center in Lubbock services all of the models in TI's calculator line. Only approximately of the net units billed of four-function calculators are currently being returned for repair and those that are generally are by TI with . (FF 639, 642, 645). There is no evidence of record as to the percentage of professional calculators being repaired in the U.S. Though repair services may be properly considered part of the domestic industry, see Cube Puzzles, id. at 335, the extent of such services in this investigation is de minimus.

Value Added

The significance of TI's domestic activities relative to its offshore-assembled calculators may be elucidated by considering the value added in the U.S. by TI's research and development (including product qualification), skinwrapping, quality control and repair/replacement operations.

TI's research and development costs for calculators include OST and PCC tooling. PCC (profit control center) tooling represents the initial start-up tooling for a new product and OST (objective strategy tactics) includes market research, initial product launch, design, product specification and product qualification costs. (FF 688, 689). Excluding market research and product launch expenses, the per unit value added to TI's four-function calculators in , resulting from OST costs, is estimated at approximately . (FF 690, 691, 693-97). As it is not clear from the record whether OST costs for 1984 included PCC costs (See FF 690), the total value added as a result of research and development expenses may be somewhat higher. Excluding market research and product launch expenses, the per unit value added to TI's four-function calculators in as a result of OST and PCC costs, is estimated at approximately . (FF 691, 693, 694, 698). The cost of skinwrapping a four-function calculator is approximately per unit. (FF 713-19). The value added to TI's four-function calculators as a result of quality control activities (on a per unit basis) is approximately . (FF 704-12). An approximate value added by TI's repair/replacement activities in , directed at its four-function calculators (on a per unit basis), is approximately . (FF 699-703). Though the record indicates that approximately of value added to TI's four-function calculators on a per unit basis may be attributed to overhead and administrative costs, such activities are not considered sufficiently related to the production of TI's calculators to warrant their inclusion in an assessment of value added. (FF 720-31). See Rotary Wheels II, ID at 249. The total value added to TI's four-function calculators (on a per unit basis), by its activities pertaining to those calculators, of research and development, repair/replacement, quality control and skinwrapping is approximately , or approximately of the average selling price of a four-function calculator.[14/] (FF 685, 731).

As an alternative method of ascertaining the value added to TI's four-function calculators by its domestic activities, the average per unit cost to TI of its four-function calculators from its subcontractors, including freight and duty, may be subtracted from TI's average unit selling price,

14/ The foregoing value added figures do not pertain to professional calculators as there was insufficient evidence in the record to allow such an allocation of costs.

deducting from that figure the expenditures for market research and product launch as well as allocated overhead and administrative costs. Such a calculation yields a value added figure of approximately or approximately of the average selling price of a TI four-function calculator for .15/ (FF 732-39).

While the value added in the U.S. by Ideal's quality control, packaging and repair operations in <u>Cube Puzzles</u> was estimated at 50% of the value of the product at issue, it is significant that the quality control and repair activities combined comprised only .7% of the value added, that Ideal's packaging activities constituted the principal source of value added to the product in the U.S. <u>Cube Puzzles</u>, 219 U.S.P.Q. at 339 n.9 (Views of Commissioner Stern). While little value indeed was ascribed to the activities of quality control alone in <u>Cube Puzzles</u> (some percentage of .7%), it is noteworthy that the Commission nonetheless considered this activity sufficiently significant to constitute part of the complainant's domestic industry. <u>Cube Puzzles</u>, <u>id</u>. at 335. In the present investigation, TI's domestic operations devoted to research and development (including product qualification) and quality control - both activities which excercise a significant degree of influence over the nature and quality of TI's calculators - comprise approximately of the value added to TI's four-function calculators. (<u>See</u> discussion, <u>supra</u>).
The extent to which domestic activities add value to a product is evidence of those activities' significance, but as merely one factor in the comprehensive evaluation of the nature and significance of a party's domestic operations, is

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15/ This calculation assumes that TI made on the average sale of a four-function calculator in . (FF 736). Alternatively, if TI realized on its average four-function calculator sale in , the value added would be reduced accordingly.

not necessarily dispositive. Supporting Apparatus, Commission Memorandum Opinion at 15; See also Cube Puzzles, 219 U.S.P.Q. at 335. The allocated cost to TI of its domestic operations devoted to its four-function calculators does not reflect the qualitative significance of those activities.

In sum, TI's domestic operations including product development and qualification, quality control, skinwrapping, manual and packaging design and repair and replacement activities devoted to its four-function and professional calculators assembled offshore are of the appropiate nature and of sufficient significance to constitute part of the domestic industry in this investigation.

Scope Of The Domestic Industry

It is the position of the hearing respodents that TI's four function calculators are so distinct from its professional line of calculators that the operations devoted to TI's four-function calculators should be regarded as a seperate industry. (RPH, p. 38; RPHR, p. 19; Closing Arguments, Tr. 285-86). Hearing respondents cite to Certain Amino Acid Formulations, 337-TA-127 (1983) (Amino Acid), Certain Drill Point Screws For Drywall Construction, 337-TA-116 (1983) (Drill Point Screws) and Certain Headboxes And Papermaking Machine Forming Sections For The Continuous Production Of Paper, And Components Thereof, 337-TA-82 (1981) (Headboxes), (RPH, p. 38 n.24,25), for the "proposition that the statute [§337] does not require the Commission to ignore basic differences between two or more products just because they are covered by a single patent." (RPHR, p. 21 n.13).

In each of the cases cited by the hearing respondents the scope of the domestic industry was limited to a portion of the exploitation of the patent(s) at issue, i.e., the domestic industry was limited to the operations related to the production of one of the two or more products being produced under the patent(s) in issue. Circumstances of the nature which compelled the

Commission to reach such a conclusion in the cited investigations do not exist here.

In Headboxes, the Commission limited the relevant domestic industry to that portion of complainant's facilities devoted to the production of multi-ply headboxes, even though complainant manufactured both single-ply and multi-ply headboxes in accordance with the claims of the suit patent. In evaluating the scope of the domestic industry the Commission found that there were no allegations that imports of single-ply headboxes infringed either of the two patents and that multi-ply headboxes and single-ply headboxes generally competed in separate markets. Id. at 29. The Commission concluded that the domestic industry was properly defined as only that portion of complainant's facilities which produced articles under the suit patents which were adversely affected by the infringing imported articles, namely, those facilities devoted to the production of multi-ply headboxes. Id at 29. Similarly, in Drill Point Screws, where the suit patent covered screws sold in the drywall construction market, automotive market and appliance market, the Commission limited the domestic industry to screws manufactured for the drywall construction market only because: 1) the facilities of complainant were segregated according to the intended use of the screws; 2) respondent produced only screws for the drywall construction market; and 3) it was found that it would be difficult for drywall screw manufacturers to divert facilities to the production of screws for use in either the automobile or appliance industries. Drill Point Screws, Commission Action And Order, at 12-13. Finally, in the most recent case, Amino Acid, the Administrative Law Judge limited the scope of the domestic industry to one of two products made under the patent in issue, recognizing that a domestic industry in a patent case may be more narrowly defined where the allegedly infringing imports compete with only one part of a domestic business. Amino Acid, ID at 74.

Judge Saxon noted that the two products produced under the suit patent were produced by complainant in separate facilities, using different production methods and equipment, that the two products were intended for different consumers and that the respondent sold only one of the two types of products made by complainant. Id. at 74-75.

The hearing respondents acknowledge that the factors set forth in the aforementioned cases are relevant to the issue of whether only one of two domestically produced products may be considered to comprise a domestic industry. (RPHR, p. 21). In this case, the record shows that both four-function and professional calculators have been imported by at least respondents Nam Tai (FF 925, 942, 955-61); that both types of calculators compete to some extent with each other in the U.S. market (FF 784-800); that the full range of portable electronic calculators, including four-function and professional models, are generally sold through the same channels of trade (FF 744-46,784); and that all portable calculator models can be made in the same facilities. (FF 740-43, 935). (See injury discussion, infra.).

Accordingly, it is not considered appropriate under the present circumstances to segment the domestic industry as suggested by the hearing respondents, and therefore the Administrative Law Judge finds that were a domestic industry to exist in this investigation, it would consist of the domestic operations of TI devoted to the exploitation of the '921 patent, including the operations associated with both its four-function and professional calculator models. See Plastic Tubing, RD at 107-09. Any consideration of a varying impact upon TI's four-function and professional lines of calculators resulting from allegedly infringing imports is a factor to be considered in assessing whether and to what extent the domestic industry has been injured or may be injured in the future. Plastic Tubing, id. at 109.

In conclusion, were a domestic industry to exist in this investigation, it would consist of the domestic operations of TI devoted to product development and qualification, quality control, skinwrapping, manual and packaging design and repair and replacement activities associated with both its four-function and professional calculators as well as TI's domestic assembly operations devoted to its professional calculators.

VIII. EFFICIENT AND ECONOMIC OPERATION

To prevail under §337, TI must establish that the relevant domestic industry is efficiently and economically operated. The traditional guidelines set forth by the Commission to assess efficient and economic operation include the use of modern equipment, effective quality control programs and substantial investment in research and development. Certain Foam Earplugs, Inv. No. 337-TA-184 (1984); Certain Heavy Duty Staple Gun Tackers, Inv. No. 337-TA-137 (1983); Certain Coin-Operated Audio Visual Games and Components Thereof, 216 U.S.P.Q. 1106 (1982).

The hearing respondents concede that TI's operations devoted to its production of professional portable electronic calculators are efficiently and economically operated. (FF 766).

From , TI's annual research and development budget for portable calculators averaged approximately million. TI's research and development facilities utilize modern research apparatus and computer facilities, valued at some million. (FF 758, 759). TI's research and development efforts with respect to portable calculators have continually enhanced and improved TI's line of calculator products. Through licensing of the '921 patent, TI obtained cross-licensing rights to key inventions in the calculator field developed by other firms and generated a substantial flow of royalty income to the calculator business useful in supporting further research and development efforts. (FF 760,761). TI's research engineers conduct ongoing research regarding calculator components, and in particular the design of new . TI also strives to in its calculators and to introduce other cost-saving techniques to make its products more duraable, more reliable and less expensive. (FF 763, 764).

Regardless of where calculator occurs, all TI portable calculators sold in the U.S. undergo strict product qualification procedures before assembly and a strict quality control program . (FF 573-603,616-36,765).

The Administrative Law Judge concludes that if a domestic industry comprised of the operations of TI devoted to its four-function and professional calculators existed, it would be considered efficiently and economically operated.

IX. INJURY

In order to prevail under Section 337, TI must establish that the effect or tendency of respondents' unfair acts and unfair methods of competition is to destroy or substantially injure the domestic industry. This element requires proof separate and independent from proof of the unfair act. Furthermore TI must establish a causal connection between the injury suffered and the unfair acts of respondents. Certain Spring Assemblies and Components Thereof and Methods of Their Manufacture, Inv. No. 337-TA-88, at 43-44, 216 USPQ 225,243 (1981) (Spring Assemblies); Certain Limited-Charge Cell Culture Microcarriers, Inv. No. 337-TA-129, 221 USPQ 1165,1182 (1983).

The Administrative Law Judge has found that TI has not sustained its burden in proving that any of the approximately 184 accused calculators (CX-231A) infringe the claims in issue of the '921 patent. Hence TI has not proven an unfair act and there can be no finding of injury. However in order to reach the injury issue pertaining to violation, the Administrative Law Judge will assume that each of the approximately 184 accused calculators infringe the asserted claims of the '921 patent.

Substantial Injury

Factors the Commission has considered in reaching a determination on injury include: (1)lost sales, (2)volume of imports and their degree of market penetration and capacity to increase imports, (3) loss of profits, (4) loss of market share, (5) underselling, (6) declining sales, (7) excess domestic capacity, (8) inability to raise prices to meet increased production costs, (9) trends in market demand, (10) decrease in domestic production and profitability, and (11) reduction in complainant's prices. Certain Drill Point Screws for Drywall Construction; Inv. No. 337-TA-116, at 18 (1982) (Drill Point Screws); Certain Vaccum Bottles and Components Thereof, Inv. No. 337-TA-108, RD at 72 (1982); Spring Assemblies, at 42-49, 216 U.S.P.Q. 242, 245;; Certain Flexible Foam Sandals, Inv. No. 337-TA-47, RD at 4 (1979); Certain Roller Units, Inv. No. 337-TA-44, at 10, 208 U.S.P.Q. 141, 144, (1979); Certain Vertical Milling Machine and Parts, Attachments, and Accessories Thereto, Inv. No. 337-TA-133, 223 U.S.P.Q. 332, 348 (1984). Certain Recloseable Plastic Bags, Inv. No. 337-TA-22, 192 U.S.P.Q. 674, 680 (1977). However the determination of injury must be based upon the peculiar facts of each case. Drill Point Screw, RD at 144.

TI argues that respondents and other foreign calculator suppliers have imported and sold substantial quantities of infringing products during the period 1981 to 1984; that these infringing portable calculators have successfully penetrated the U.S. market and gained a substantial market share by at the of the calculator line, and taking advantage of their avcidance of research and development costs and royalty payments.It is argued that in the same period, TI has experienced a entire calculator line, , and ; that cost pressures generated by respondents when TI's (CPH p. 39).

TI argues that approximately of all four function calculators, or more than million units, sold in the U.S. in were produced by unlicensed "Southeast Asian manufactures," with respondent Nam Tai alone accounting for almost . By contrast it is said that TI's total unit sales of portable calculators in were million, of which million were low end models, and that in terms of volume alone, the flow of infringing imports has been enormous. TI relies further on (1) underselling, (2) , (3) , (4) decrease in and (5) (CPH pp.40-42).

The hearing respondents argue, assuming <u>arguendo</u>, that there is enough value-added to find that four function calculators are "produced" in the U.S., or that TI is some how entitled to an "all-calculator" industry or market definition even though TI "makes no four function calculators" in the United States that, there is insufficient evidence of injury, causation or tendency to sustain a finding of substantial injury. If is said first, that TI's position in the overall calculator market has been unaffected by "low end" imports; that its market share has ; and that TI's organization profit for all calculators were by the absorption of overhead by .

The second factor argued is that TI made no showing of calculators to any customer. The hearing respondents argue that even if the Commission were to focus solely on TI's four function calculators, TI has in that segment the last three years. (RPH, pp. 45-46).

The hearing respondents further argue that the domestic production of professional calculators by TI and Hewlett-Packard has suffered no injury during any period that might be considered by the Commission and that even if the Commission were to somehow find that injury to the professional calculator industry has occurred, the hearing respondents cannot be the cause because sales by Hong Kong respondents of professional calculators in the United States are practically non-existent. As for four-function calculators, the hearing respondents argue that TI prices for professional calculators have stayed high in relation to four-function calculator prices, high enough to . (RPH, pp. 40-43).

The hearing respondents also argue that any injury TI's domestic "all calculator" industry may have suffered has not been caused by imports of the hearing respondents. It is argued that TI voluntarily chose to license all potential worldwide competitors, sometimes in exchange for cross licenses, or otherwise at a rate, and in fact ; that foreign licensees are now more important competitors in the market than TI is itself; and that even TI's own economic expert estimated that .

Another independent cause argued is agreements that TI made with , in under which TI is said to have paid them dollars to supply TI with calculators per year. It is said that pursuant to these agreements, TI transferred technology to and lengthened their production runs, while fully tolerating their sale of over calculators a year to the U.S. and that TI now claims that "it is injured by such as , which are supplied not by respondents but by TI's own suppliers, .

The hearing respondents argue that a third independent cause of TI's "injury" in four function calculators was TI's own ; that TI chose to push over calculators as , and professional calculators over four function calculators for the same reason; that its program reached its height in and that after TI cut its research and development and engineering staff, necessitating a reduction in its four function line from models to ; and that TI has not offered ultra-thin credit card calculators (a major comsumer item), or ruler calculators, key chain calculators or calculators in a wallet, which models were popular as premiums and with mass retailers. (RPH, pp. 47-49).

The Commission investigative attorney, during oral argument, stated that the Commission investigative staff's position, is that TI has not proven substantial injury. (Tr. p. 250, ls.6-10).

Calculator Sales in the United States by Hearing Respondents

Nam Tai began manufacturing calculators in early 1980 (FF 917) and first exported calculators to the United States around 1981 (FF 918). Nam Tai was able to break into the U.S. market simply by placing an advertisement in Asian Sources magazine (FF 963). In 1981 Nam Tai manufactured six to seven models of calculators that were exported to the United States, two of which had scientific functions (FF 487). Since 1981 and 1982 Nam Tai's sales of calculators in the United States have increased. (FF 920). In 1982, between five and twenty United States customers placed orders with Nam Tai for calculators. (FF 921). Nam Tai manufactures only calculators which operate on either a dry cell or solar cell battery. It does not manufacture any calculators that plug into the wall (FF 923). of the calculators manufactured by Nam Tai are scientific calculators. (FF 924).

in 1983 Nam Tai sold calculators at and in 1984 calculators at . (FF 486). In Nam Tai sold calculators at a price of to (FF 955) and calculators at to (FF 960) and between Nam Tai sold calculators at a price of to . (FF 956). Nam Tai sold calculators at a price of in and calculators at a price of in to . (FF 957). In Nam Tai sold calculators to (FF 958); it also sold calculators at to (FF 959) and calculators at to . (FF 959). In 1984 Nam Tai sold model calculators at calculators at calculators at , calculators at and calculators at to . (FF 961). In 1984, Nam Tai sold calculators in the United States with a value of . (FF 488). Of these less than were scientific calculators. (FF 925).

IMA coordinates the purchase and export of electronic products, including calculators, from Hong Kong to the United States. (FF 496). IMA, in its capacity as a liaison office between calculator manufacturers and its clients, has dealt with the following calculator manufacturers, among others and appears occasionally as the shipper of record for their products: . (FF 497). IMA calculator Model Nos. with corresponding manufacturer are recited in finding 348. IMA is a service company to Spectra Merchandising International, Inc. (Spectra) and . through Spectra (FF 851). Spectra imports electronic products, including calculators from Hong Kong. (FF 849). Spectra sells most of its calculators under the IMA name (FF 850). Spectra has never imported or sold professional calculators. (FF 852). Spectra sells its calculators mainly to mass merchandise stores such as Target Stores, Gold Circle and Shopko, supermarkets and premium distribution channels in the United States. (FF 869). Spectra sells "novelty" calculators such as ruler calculators, keychain calculators and watches with calculators mainly to premium distribution channels. (FF 870). Spectra's sales of calculators to Shopko decreased in 1984. (FF 871). In 1984, 30% of Spectra's sales to Target were credit card calculators and approximately 5 percent of such sales were of novelty calculators. (FF 872). Beginning in 1973, Spectra developed its own engineering standards for calculators. (FF 873). Spectra leases a warehouse in Northbrook, Illinois and owns the calculators there. (FF 874). Spectra provides warranty replacement on IMA calculators. (FF 875). In 1984 Spectra sold approximately calculators in the United States. Approximately of the calculators were purchased by Spectra from . (FF 876).

Enterprex has been importing low-end calculators for approximately eight years. (FF 877). of the calculators Enterprex now imports are sold in the United States and this percentage has over the years. (FF 876). Enterprex has purchased calculators from and and from , in . (FF 499). Enterprex has purchased approximately calculators from . (FF 501). Enterprex representatives attend Chicago and Las Vegas electronics trade shows every year and New York trade shows several times a year to promote Enterprex calculators. (FF 502). In 1983 Enterprex purchased approximately calculators from and sold overall approximately calculators in 1983. Through the end of July 1984, Enterprex purchased approximately calculators from and sold overall approximately calculators for the same time period. (FF 500). Almost all of Enterprex's calculators from come from and the amount of purchases from has been over the past three years. (FF 879). In 1982, Enterprex realized a gross profit of approximately for its sales of calculators; in 1983, approximately ; and in 1984 through July 31, approximately . (FF 881). Enterprex sold approximately calculators in 1983. (FF 883). In the first seven months of 1984, Enterprex sold approximately worth of calculators. (FF 884). It has purchased Nam Tai calculators through its sales representative for sale to . (FF 885). In 1983 Enterprex asked for a quote on calculators for sale to through to and . (FF 886). Enterprex has sold calculators through to and . (FF 887). It sells more battery calculators (MC-2808) than solar calculators (MC-2892) (FF 888).

has lowered some of the prices of its calculators at Enterprex's request so Enterprex could compete with the lower prices of Japanese calculators. (FF 889). Nam Tai and other Hong Kong manufacturers and representatives send representatives to the U.S. trade shows to display their calculators. (FF 892). Enterprex has never sold any scientific calculators and is not considering doing so now. (FF 893).

The hearing respondents have admitted that their accused calculators are portable calculators which have an (a) input means including a keyboard for presenting the arithmetic problem to the calculator, (b) an electronic means for solving the problem and (c) a display means for presenting the answer in visible form; that their accused calculators have plural logic functions; and that when their accused calculators are opened, a single chip will be found inside which contains all the calculating circuitry. (FF 318-321). Thus the accused calculators of the hearing respondents substantially meet a "TI infringment test". Hence the Administrative Law Judge in his injury analysis will assume that the above identified imports constitute unfair acts.

The above analysis does establish that in 1983 Nam Tai, sold infringing calculators in the United States at a total value of . In 1984 Nam Tai, through import, sold infringing calculators in the United States at a total value of . Also from 1981 to 1984 Nam Tai, sold another infringing calculators in the United States at a total value of although the record is unclear as to what portion of the calculators have been already accounted for in the 1984 sale.

As to specific sales of calculators by IMA, other than through Nam Tai, the picture is unclear. The evidence does show that is 1984 Spectra, through IMA, sold approximately of infringing calculators in the United States with about purchased from . The picture is unclear also with respect to Enterprex because calculators Enterprex has sold in the United States were purchased from . There is evidence that Enterprex purchased approximately infringing calculators from . (FF 501).

Calculator Sales in the United States by Non-hearing Respondents Who Were Ordered to Show Cause

The following non-hearing respondents have not responded to an Order to Show Cause which issued on February 8, 1985: Fordstech, Hua Chang, Integrated Display, MBO, Mino, Promoters, Success, Luks, Voesa, General Electronics and

Cosmo. In addition on December 12, 1984 an Order to Show Cause was issued against Tronica. Tronica did not respond. Accordingly these parties are found in default. Thus where there is evidence of specific imports as to these respondents and evidence that TI has established a prima facie showing of infringement by one of its infringement tests as to one or more calculators imported by these respondents, the Administrative Law Judge will infer that all of the imported calculators by any of these respondents meet a test of TI for infringement.

The Order to Show Cause of February 8, 1985 was issued against Far East. However as shown infra. Far East is in a special category.

Fordstech

Fordstech has not produced portable electronic calculators, nor has it exported electronic calculators to the United States. (FF 450).

Hua Chang

Hua Chang has a calculator advertisement in the October 1984 issue of Asian Sources Electronics magazine. (FF 455).

has been selling calculators for approximately 18 months, and purchased calculators from Hua Chang in Hong Kong. (FF 456).

However the record does not show how many calculators has been selling for approximately 18 months nor where these calculators were obtained. Although TI's physical exhibits CPX-114, 114.1 and 115 identified on CX-231A are portable calculators manufactured by Hua Chang, CX-231A shows that CPX-114 and CPX-115 were obtained in Hong Kong. Hence there is only one calculator exported by Hua Chang which is alleged to have met a TI infringement test. With respect tothe use of the "alleged", see pp. 41-44 supra.

Integrated Display

While Integrated Display had a calculator advertisement (FF 457), in the January 1979 issue of Asian Sources Electronics, the record shows no testimony nor documentary evidence that Integrated Display exported calculators to the United States. Physical exhibit CPX 118 is an Integrated Display calculator but CX-231A shows it was bought in Hong Kong. CPX 128 is another Integrated Display calculator and the absence of a statement in CX-231A that it was obtained in Hong Kong on CX-231A shows it was exported to the United States. Nevertheless, the record shows only one calculator exported by Integrated Display which is alleged to have met a TI infringement test.

MBO

While MBO has advertised portable calculators in Asian Sources Electronics, (FF 458) there is no documentary evidence nor testimony that it exported calculators to the United States. While CX-231A shows that TI physical exhibits CPX-107, CPX-108 and CPX-109 are MBO brand calculators, CX-231A shows these calculators were obtained in Hong Kong. CPX-129 and CPX-130 are identified as MBO brand calculators in CX-231A. This shows however only two calculators exported by MBO which is alleged to have met TI infringement test.

Mino

The record shows no export of calculators to the United States by Mino. (FF 459). CX-231A does show that TI conducted one of its infringement test on physical exhibit CPX 113 calculator produced by Mino. However, CX-231A shows that the calculator was obtained in Hong Kong.

Promoters

has been selling calculators in the United States since 1975. (FF 460). has purchased calculators from Promoters. (FF 461). The record does not establish the quantity nor type of calculators it purchased. TI's physical exhibit CPX-47 is a portable calculator manufactured by Promoters which is alleged to have met a TI infringement test. However, CX-231A shows that this calculator was obtained in Hong Kong.

Success

The record shows no export of calculators to the United States by Success. (FF 462).

Luks

purchased through from Luks in , Model No. 263A calculators, and Model No. 300A-1 calculators, in Model No. 263A calculators and in 1983, 42,350 Model No. 263A calculators. (FF 469). purchased calculators Model Nos. LC-3322 and 33-916 manufactured by Luks in . (FF 470). In January obtained calculators from Luks designed to look like a Stanley tool or tape measure and in February it purchased calculators of a basic, four-function type from Luks. (FF 471).

has purchased calculators from Luks since 1976. In , it purchased calculators from Luks at a dollar value of . (FF 472). TI physical exhibits CPX-18, 23, 24, 39, 40, 172, 181, 182, 184, 188 and 189 are portable calculators manufactured by Luks. (CX-231-A) andit has been alleged that they meet a TI test for infringement. In shipped to calculators manufactured by Luks. (FF 1079).

In a Hong Kong trading company, and/or shipped to calculators manufactured by Luks. (FF 1080). In shipped calculators manufactured by Luks to in the Western United States. (FF 1095). In shipped to calculators manufactured by Luks. (FF 1096). Also CPX-23 caculcator is an IMA brand model number LC-640 produced by Luks. (FF 856).

Voesa

The record shows no exports of calculators to the United States by Voesa. (FF 489). On CX-231A TI's physical exhibits CPX-110, 111 and 126 are calculators stated to have been produced by Voesa. However CX-231A states that those calculators were obtained in Hong Kong. CMI has purchased calculators from Voesa but these were printing calculators (FF 490) which are not in issue in this investigation.

General Electronics

General Electronics has manufactured calculators distributed by IMA in the United States. (FF 492). However the record does not show the quantity made for IMA. TI physical exhibits CPX-19, 20, 22, 28, 28.1, 29-32, 48 and 121 are portable calculators manufactured by General Electronics (CX-231A). This shows however only twelve calculators exported by General Electronics which have been alleged to meet a TI infringement test.

Cosmo

Cosmo imports for sale in the United States portable electronic calculators manufactured by Nam Tai. (FF 498). The record does not show the quantity of calculators Cosmo has so imported.

However TI phy[illegible]al exhibits CPX-11, 12, 12.1, [illegible] and 14 are portable calculators carrying the brand name "Cosmo" and have been alleged to have meet a TI infringement test. (CX-231-A).

Tronica

Tronica sold calculators in and calculators in to . (FF 477). Tronica in sold credit card calculators at solar calculators at and key chain calculators at to . (FF 478). Tronica in sold credit card calculators at and key chain calculators at , also to . (FF 479). imports calculators into the United States from Tronica. (FF 481). has purchased approximately calculators at a dollar value of from Tronica. (FF 482). bought calculators from Tronica in . (FF 1079). in bought calculators from Tronica. (FF 1089). shipped calculators manufactured by Tronica to . (FF 1089). In shipped to calculators manufactured by Tronica. (FF 1090). Specific quantities of such calculators were so shipped to in . (FF 1091). In and/or shipped to specific quantities of calculators manufactured by Tronica. (FF 1095, 1096, 1097). TI physical exhibits CPX-50, 55, 58, 59, 59.1, 61, 61.1, 64, 68, 108, 116, 117, 131, 171, 180, 185, 191-95, and 203 are portable calculators manufactured by Tronica and have been alleged to have meet a TI infringement test. (CX-231-A).

Far East

Far East manufactures portable calculators in Hong Kong. (FF 441). Far East sold calculators in to . (FF 443). , a California corporation, purchased calculators from the Conic Group in Hong Kong of which Far East is a subsidiary. (FF 444). began importing calculators into the United States in . (FF 446). has imported one calculator model from Far East. (FF 447). It purchased calculators from Far East in and . (FF 448). Since Los Angeles, Calif. has purchased calculators at a value of from Far EAst. With respect to these imports, the record does not show any model numbers. (FF 449).TI's physical exhibits CPX-49, CPX-125, CPX-158 and CPX-159, shown in CX-231A, are portable calculators manufactured by Far East and have been alleged to have met a TI's test for infringement. However although Far East was served with an Order to Show Cause, there was no acknowledgment of receipt of the complaint and Notice of Investigation by the Office of the Secretary. Hence the Administrative Law Judge will not make the adverse inference he has made with other Show cause respondents with respect to Far East.

Respondent Dah Sun

No Order To Show Cause was issued against Dah Sun. CX-231A shows that TI conducted one of its tests for infringement on each of CPX-63 (model Clip), CPX-19 (model LCD-199) and CPX-132 (model LCD-380) calculators, each of which was produced by Dah Sun. CX-231A shows that model nos. LCD-199 and LCD 380 calculators however were obtained in Hong Kong.

Dah Sun has shipped portable electronic calculators to the United States since . (FF 463). obtained calculators from Dah Sun on . (FF 465). purchased calculators from Dah Sun in . (FF 467). purchased calculators, model LC-3322, manufactured by Dah Sun in . (FF 468). Respondent Dah Sun has also experienced a in its U.S. sales. (FF 909-911). These imports from Dah Dun, supra, either have model number or do not have mo numbers that correspond to the model numbers of calculators which TI tested and were produced by Dah Sun.

Because no Order to Show Cause was issued against Dah Sun, the Administrative Law Judge will not make the inference he did as to the identified imports of the Order to Show Cause respondents. Thus, the record shows the export of only one calculator by Dah Sun to the United States which has been alleged to have met a TI infringement test.

Respondent APF

No acknowledgment of receipt of the complaint and Notice of Investigation was received by the Office of the Secretary from respondent APF. The record however does show that APF sold unidentified calculators with a value of , with a value of and with a value of , to . (FF 494). TI and the Commission investigative attorney make reference to other alleged imports of calculators from APF. They rely however on deposition testimony of Seymour Lipper. (CX-458). The deposition testimony of Lipper shows that Lipper was making reference to . CX-231A does show that TI conducted one of its tests of infringement on CPX-4 (model no. 1903), CPX 36 (model no. 1.58510) CPX 37(model no. 1.58510) and CPX-38 (model no.1.58580) calculators which were produced by APF. Hence the record shows the export of only four Calculators by APF to the United States which has been alleged to have met a TI infringement test.

Settling Respondents

In the Commission's decision dated January 22, 1985 not to review an Initial Determination in CERTAIN FOAM EARPLUGS Inv. No. 337-TA-184, the Commission noted its agreement with this Administrative Law Judge that the imports of certain respondents terminated from the investigation on the basis of settlement agreements should be considered in determining whether substantial injury or tendency to substantially injure exists when there has been a finding of an unfair act with respect to those imports.

Respondents Sears, FLX and RJP have settled with TI. imported units of calculator model LC128L, which were manufactured by FLX in Hong Kong. (FF 451). has imported calculators into the United States from FLX. (FF 452). On purchased approximately checkbook calculators, model number , directly from for sale to . These calculators were manufactured by FLX. (FF 453). purchased some calculators for a test market in the fall of and these calculators were manufactured by FLX. (FF 454). The Administrative Law Judge finds the record lacking any evidence that any of the specific exports made by FLX are alleged to have met infringing by any TI test of infringement. The calculator is manufactured by FLX. (FF 860). However LC683 is not identified on CX-231A. Also none of the accused calculators identified on CX-231A have been identified with FLX.

As to Sears, TI, has alleged each of TI's physical exhibits CPX-35, 36, 37 and 38 (Sears brand calculators) has met a TI infringement test. However, only four imports are involved.

Of the imports by RJP, the only model no of RJP which TI has alleged has met one its infringement test was model No 2910 (CPX-34) and this involved which had imported. (FF 473). imported several models of calculators from RJP -- of Model SL4, units of Model SL3, and approximately units of Model SL2. (FF 475). However, TI has presented no evidence that these models are infringing.

Other Calculator Imports in the Record

TI, through CX-231A has alleged that the following imported calculators produced by non-parties has met one of its infringement tests: CPX 35, CPX 53, CPX 54 CPX 66 CPX 120 CPX 122, CPX 123 CPX 124 CPX 155 CPX 156 CPX 186, CPX 187 and CPX 190 each produced by an unknown entity; CPX 42, CPX 43, CPX 44, CPX 76, CPX 130, CPX 148, CPX 149 CPX 152, CPX 153, CPX 154 CPX 165, CPX 167 CPX 177 CPX 179 each produced by "Taiwan"; CPX 65 produced by Kin Sung; CPX 71, CPX 72 each produced by San Sung; CPX 75 and CPX 150 produced by Time Proc.; CPX 78 produced by Zeny; CPX 151 produced by "China"; CPX 157, CPX 161, CPX 162, CPX 163 each produced by Sentek; CPX 160, CPX 174, CPX 175 , CPX 176 each produced by Qualitro or Qualitron; CPX 168 produced by Beare/Taiwan; CPX 183 produced by Hong Kong.[16/]

While the evidence shows that there has been imports by non-parties of calculators into the United States (See, e.g., FF 1091 and its reference to Aurora), TI has not established an identity of the model number of the physical exhibits examined and shown on CX-231A as against the actual models exported by the non-parties to the United States.

Effect of Calculator Imports

The issue before the Administrative Law Judge, based on the evidence in the record, is whether the imports of calculators, which have been alleged by TI to meet at least one of its tests for infringement and which have been identified supra, have substantially injured the domestic market.

In 1974, calculators were viewed as quasi-scientific instruments. TI's lowest-end calculators were sold at a suggested retail price of .

16/ Some of these calculators have a relationship with a respondent. For example, TI's physical exhibit CPX-66 is an IMA brand.

Calculators were packaged in boxes and sold by clerks who assisted the consumer. Consumers were very conscious of brand names and anxious about quality and longevity. TI's quality image was a substantial advantage at all levels of the calculator market. (FF 767). However the increasing U.S. consumer familiarity with portable calculators, and the cost-reducing expansion of the calculator market led by TI, changed the nature of calculator marketing. Low-end calculators, in particular, began to be salable as house brand or secondary brand items. This permitted retailers to source calculators abroad and induced large numbers of wholesalers to begin importing and selling foreign calculators. (FF 768). Foreign manufacturers and the trading companies, wholesalers and retailers who work with them, have been increasingly able to penetrate the low-end market by cutting prices and taking advantage of the diminishing importance of quality factors as prices fall and consumers perceive low-end calculators as throw-away items. (FF 771).

TI has broad-based distribution of its calculator products across all channels of distribution. TI's customers include

. (FF 772). Both brand name and private brand calculators sit on the retail shelf, side by side, and are presented to the consumer together in the same outlets. (FF 773). TI is interested in increasing its calculator business. (FF 777).

Almost all of TI's customers carry a full range of calculator products, including both four-function and professional models. Similarly, and other accounts which are not market type stores carry both types of calculators. (FF 784). There is also an overlap between the prices of some four function and scientific calculators. (FF 787). In , TI conducted a of the consumer's for calculators. (FF 785-787). Among the summary findings of that study were the following: (a)

; (b)

; (c)

; and (d)

. (FF 788). This study suggested that there is a between the

. (FF 789). Thus the

suggested a exists between calculator models of

. (FF 790).

. (FF 791).

A study of TI and Nam Tai calculators indicated that there is a

which runs across the calculators produced by Nam Tai; and that calculator prices are

. The study also indicated that

. The study further showed that there was a significant erosion in the between

with the

; and that there is a large number of permutations and combinations of which at least suggested that there should be a

. (FF 793).

The portable calculator market is characterized by a large number of models designed to appeal to a variety of consumer interests. TI has eighteen models in its 1985 calculator line. TI's features range from the TI-1100's four function, automatic constant, percentage and square root simplicity to the TI-66's 500 merged program steps, 64 multi-use memory and engineering functions complexity. TI's suggested retail prices range from for the TI-100 to for the TI-66. Nam Tai's most recent catalog includes models ranging from relatively limited low end features to Nam Tai's P-201 programmable. (FF 794). Consumers are thus presented with a wide range of choice within and between low end, mid-range and high end model groups, and sellers must ensure that the price relationships between their models are appropriately adjusted to differences in features. (FF 795). Some consumers, who require the scientific, financial or programmable features which distinguish mid-range and high end calculators, may not be satisfied by low end calculators. Many other consumers, however, may have only a limited need for such additional features, but will spend additional money to buy them if the price/feature trade-off is attractive. The presence of such consumers in the market prompts calculator sellers to accommodate the relationship between the highest four function/low end price and the lowest available professional price and prices will be determined by the need to attract these consumers even if other consumers cannot be shifted between low end and mid-range calculators. (FF 796). Similar price/feature trade-offs are evidence between the mid-range and high end of the calculator line. For example, Hewlett-Packard's evaluation of competitive products for its HP-10C, a fully programmable scientific model with a suggested retail price of , includes models ranging in price from . Hewlett-Packard's competitive analysis for the HP-11C, with a suggested retail price of , includes models with prices down to and Hewlett-Packard's analysis for its HP-12C includes calculators priced as low as . (FF 797).

The impact of price/feature trade-offs on calculator pricing is enhanced by the fact that consumers from all ranges of education, income and occupations purchase all types of calculators. Even the generally high-end scientific and financial models offered by Hewlett-Packard are including and . (FF 798). Thus price/feature trade-off characteristic, which arises from demand cross-elasticity in the unitary calculator market, meant that price changes at any point in the line may ultimately affect all other calculator prices through a series of interactions between segments. (FF 799). The testimony showed that one manner in which unfair competition at the low-end effects high-end calculator prices involved the promotional price point. Thus in the past a promotional price point was used to offer a four-function calculator. Due to price pressure, that price point no longer belongs to a four function calculator unit but rather to a scientific calculator. (FF 800).

The evidence shows that TI recognized the need to participate in the low-end segment to maintain brand awareness by keeping the TI name in front of consumers. Ownership of TI basic four function calculators helps the consumer to upgrade to more advanced TI calculators. (FF 801). prevent the "trading up" process from operating and impairs TI's overall brand awareness.

If a consumer is not introduced to a TI product when he makes his first purchase of a low-end calculator, he will be less likely to trade-up to the more expensive scientific and business models. (FF 802). In addition,

portable calculators. Besides TI, licensees of TI, viz.

, feature full lines of calculators and thus compete with TI for principal brand placement at retail outlets. (FF 803). The development of brand loyalty and a full line of calculators are two factors illustrating the interdependence of the four function and professional calculator classes. In addition the high volume base of four function calculators helps TI maintain its competitive position in manufacturing technology. (FF 805).

The foregoing analysis convinces the Administrative Law Judge that the importation of four function calculators could have an effect upon TI's sales of professional calculators.

The Administrative Law Judge has found that the domestic industry in this investigation consists of the domestic operations of TI devoted to its four function and professional calculators. However in this investigation there are other parties active in the United States calculator market. Thus TI experiences competition from Hewlett-Packard which manufactures only professional calculators and specializes in high-end programmable calculators targeting its effort on professional users. (FF 829). Hewlett-Packard is a

and TI is a

. (FF 828). Hewlett-Packard's calculators are

. (FF 830).

In addition to the presence of Hewlett-Packard, the following Japanese companies sell portable electronic calculators in the United States under

. (FF 832).

Also , both calculator manufacturers, are licensed under TI patents which include the '921 patent. (FF 833). The validations of the agreements were finalized in (Donaldson Tr. p.2601). each sell over calculators in the United States in a year, competing for sales with TI. (FF 834).

The market for portable electronic calculators in the United States is "mature". (FF 2003). Most sales are now made on a replacement basis, rather than reaching new, previously untapped groups of consumers. (FF 824). The total size of the calculator market is thus relatively stagnant. (FF 827). In 1983, total sales of low-end four-function models in the United States represented some 25 million units valued at $115 million wholesale. Approximately of those sales, or some million units, were captured by manufacturers from Hong Kong and Taiwan, rather than TI or its licensees . (FF 825). TI's sale of four-function calculators in was approximately million units worth some million. (FF 826). It is significant that figures demonstrating TI's total revenues from four function calculators, the number of units sold, and the average unit price show a market but do show per unit. (FF 827). TI's U.S. sales revenue of professional and four-function line portable calculators did as follows: , , , and . However TI's sales of professional and four-function units (million) in that period as follows: 1979 , 1980 ,1981 , 1982 and 1983 . (FF 2079). TI's total gross profits from for its four-function calculators were as follows ($ millions) 1979 , 1980 , 1981 , 1982 and 1983 . (FF 1068).

The record establishes that respondent Nam Tai's United States sales of primarily four-function calculators increased from 1981 to 1984 as follows: $

FOB HK and for the same period the units of said calculators sold by Nam Tai were: . (FF 1057). Also respondent Dah Sun experienced a similar in Thus in $ FOB HK (million) and units (million) it was for and and for and . (FF 1058). Hong Kong export statistics show that the following exports in units (million) of "Calculator Machines Electronic Pocket Type" to the United States since 1981 were as follows: 1981 (4.6), 1982 (3.8) and 1983(6.3). (FF 1059).

While the foregoing analysis shows that TI's U.S. of professional and four-function line pocket calculator

and that respondent Nam Tai's United States sales of primarily four-function calculators increased from 1981 to 1984, TI <u>must</u> establish a nexus between respondents' sales and to the domestic industry. <u>See</u>, <u>Drill Point Screws</u>, RD at 145. The requisite connection between the accused imports and substantial injury is established when:

> [a]n infringer holds a significant share of the domestic market for articles covered by the patent or that the infringer has made a significant amount of domestic sales of the covered articles, as such sales rightfully belong only to the patentee (and/or any licensees).

<u>Spring Assemblies</u>, <u>supra</u> at 44.

On the record the Administrative Law Judge finds that TI has not proven by a preponderance of evidence that the sales of the accused calculators by the respondents, <u>and</u> which TI has alleged meets one of its infringement tests, rightfully belong to TI nor that TI's for professional and four-function calculators have been due to sales of those accused calculators. The evidence, for example, shows that foreign licensees of TI are competitors of TI in the United States calculator market and that

Hewlett-Packard, , at least competes th TI for the sale of professional calculators in the United States market.

In addition, even to some of the named respondents TI has not proven that sales of their calculators exported to the United States rightfully belong to TI. Illustrative is respondent Dah Sun who was not involved in a Show Cause order. Respondent Dah Sun's sales of calculators in the United States have . (FF 1058). However CX 231-A, which identifies the accused calculators that TI alleges their tests show an infringement of the '921 patent, refers only to three calculators produced by Dah Sun and two of these calculators (CPX 119 and CPX 132) were obtained in Hong Kong. Thus CX-231A shows but one calculator (CPX 63-model clip) produced by Dah Sun and exported to the United States. There is nothing in the record to establish that other calculators that have been shipped by Dah Sun to the United States are a model clip. Admittedly the record shows that obtained calculators from Dah Sun in (FF 466). However the record does not identify those calculators by model number etc. Based on the record before the Administrative Law Judge, he will not assume the TI allegation that these calculators is alleged to meet a TI infringement test merely because one model clip calculator met a TI infringement test. In a similar manner the Administrative Law Judge finds TI's statement that between 1981 and 1984 there has been an ever increasing flood of unlicensed portable calculator imports from Taiwan into the United States (CPFF p. 110), and presumably allegedly infringing, unsupported in the record. CX-231A does show that TI conducted one of its infringement tests on each of fifteen calculators with producer listed as "Taiwan" which presumably means that the calculators were imported from Taiwan.17/ The record lacks any connection of the model number of these

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17/ CPX 208 with the producer Taiwan is not included in the fifteen calculators because the physical exhibit was withdrawn from evidence by TI fifteen tested calcula .s with the "ever increasing flo. . of unlicensed portable calculator imports from Taiwan".

TI argues that its alleged infringement analysis of "more than 190 representative physical exhibits shows each calculator to be infringing and permits the reasonable inference that all modern portable calculators follow the teachings

of the '921 patent." (CPH p. 30). This allegation of TI is inconsistent with TI's earlier admission that it has the burden of proving infringement by a preponderance of evidence. (CPH p. 15). TI has cited no support for its later position that an infringement, and thus unfair act, can be found on the basis of a "reasonable inference."

TI argues that it has clearly demonstrated substantial

as new entrants from Hong Kong and Taiwan intentionally in order to gain a market share. (CPH p. 40). The record shows however that TI has been faced with from TI's licensees. (FF 2015). Also the record has not demonstrated that all the imports from Taiwan, nor even from Hong Kong that can result in a lower price are allegedly infringing the '921 patent by a TI infringement test.

TI argues that severe price pressures from "unlicensed" imports forced TI to . (CPH p. 41). Yet the evidence shows that when TI chose to , it was prompted by factors other than those of low cost imports. Thus the growth in TI's

and TI's . TI did not

. (FF 2032, 2067).

The was taking a great deal of space, facilities and capital. Therefore TI concentrated its resources on their

program and moved calculator . (FF 2067).

Based on the foregoing, the Administrative Law Judge finds that TI has not proven by a preponderance of evidence a causal nexus between substantial injury and the activities of the named respondents.

Tendency to Substantially Injure

To show a tendency to substantially injure the domestic industry an assessment of the market in the presence of the accused imported product should demonstrate relevant conditions or circumstances from which probable future injury can be inferred. Certain Combination Locks. Inv. No. 337-TA-45, RD at 24 (1979). The legislative history of Section 337 indicates that "[w]here unfair methods and acts have resulted in conceivable loss of sales, a tendency to substantially injure such industry has been established." Trade Reform Act of 1973, Report of the House Comm. on Ways and Means, H. Rep. No. 93-571. 93 Cong. 1st Sess. at 78 (1973), citing In re Von Clemm 108 USPQ 371. (CCPA 1955). Although this legislative history suggests a low threshold with respect to the "tendency" language of section 337, the draftsmen never meant to permit findings based on purely hypothetical injury. There must be some positive evidence that the unfair acts, if allowed to continue, will cause substantial injury in the future. The injury contemplated under the "tendency to substantially injure" provision of 337 has to be one of a substantive and clearly forseen threat to the future of the industry, not based on allegation, conjecture or mere possibility. In the Matter of Certain Braiding Machines, Inc. No. 337-TA-130 (1983); In the Matter of Expanded Unsintered Polytetraflouroethylene in Tape Form, Inv. No. 337-TA-4 (1976).

In 1984, Nam Tai did sell calculators in the United States at a dollar value of . (FF 488). In 1983 Enterprex sold approximately calculators. (FF 500). Enterprex representatives attend trade shows every year to promote Enterprex calculators. Nam Tai is the third largest calculator manufacturer in the world. (FF 502). In 1984 Nam Tai produced assembled and semi-assembled calculators. (FF 930). Nam Tai can produce fully assmebled calculators in one month.

(FF 932). Its total capacity for fully-assembled and partially assembled calculators is per month. (FF 933). Nam Tai could increase its capacity by in one year. Although Nam Tai may not always know if calculators it sells to a Hong Kong Trading Company are eventually sold in the United States the record shows the existence of trading companies in Hong Kong. (FF 934, 945). Although Nam Tai believes that its major growth market for calculators will be the People's Republic of China, from January through August 1984, of Nam Tai's calculator sales were to the United States and Canada and of such sales were to the People's Republic of China. (FF 949, 950). Nam Tai displays its calculators at trade shows in Hong Kong and U.S. customers attend Hong Kong Trade shows. (FF 952). Nam Tai advertizes in the <u>Asian Sources Electronics</u> magazine. (FF 963).

At any one time Nam Tai generally offers 40 calculator products across the model spectrum and has different models in on-line production. (FF 965). Fortec Corporation is a trading company in Canada with a staff of three people. owns of the stock and owns of Fortec's stock. Nam Tai has recently started selling calculators to Fortec. (FF 915). Since its incorporation in May 1984, Fortec has started to trade calculators products in Canada and there is nothing preventing Fortec from selling calculators in the United States. (FF 916).

. (FF 851).

Spectra sells most of its calculators under the IMA name. (FF 850). An IMA calculator is manufactured by Luks in Hong Kong. (FF 856). Also IMA calculators are manufactured by Nam Tai and other foreign producers. (FF 857, 854,-857, 859). In 1984 Spectra sold approximately calculators in the United States with approximately of these calculators purchased from Nam Tai. Spectra expects to sell approximately calculators in 1985 . (FF 876).

of the calculators Enterprex now imports are sold in the United States. Significantly this percentage has over the years. (FF 878). Nam Tai's sales of calculators in the United States have over the years. (FF 488, 920). Although Nam Tai has sold scientific calculators in the United States in 1984 (FF 925), these sales demonstrates that it has sold scientific calculators in the United States. Moreover the Administrative Law Judge has concluded that sales of accused four-function calculators could have an effect on the sale of TI's professional calculators.

At the most recent Consumer Electronics Show held in Las Vegas in January 1985, Enterprex, Nam Tai and Tronica displayed calculators. (FF 2042). Luks has advertised calculators for sale in Asian Sources Electronics. (FF 2044). Tronica has also advertised (FF 2046) as have General Electronics (FF 2047), Far East (FF 2049), Dah Sun (FF 2051), Hua Chang (FF 2052), and MBO (FF 2054). Along with price cutting activities of TI's foreign licensees, there is evidence of price cutting by respondents (FF 1062).

Upon consideration of the record as a whole, the Administrative Law Judge finds that were a domestic industry to exist and were if the accused calculators of the hearing respondents infringed and if certain other accused calculators which met a TI infringement test (see supra pp. 41-44) infringed, importation of the aforementioned portable electronic calculators would have the tendency to substantially injure the domestic industry.

FINDINGS OF FACT

I. JURISDICTION

1. The Commission has in rem and subject matter jurisdiction in this investigation, under § 337, since the alleged unfair methods of competition and unfair arts involved the importation into, and sale in, the United States of portable calculators, the alleged effect or tendency of which is to destroy or substantially injure an industry, efficiently and economically operated, in the United States.

2. Service of the complaint and Notice of Investigation was perfected on nineteen of the named respondents Cosmo, Dah Sun, Enterprex, FLX, Fordstech, General Electronics, Hua Chang, Integrated, IMA, Luks, MBO, Mino, Nam Tai, Promoters, RJP, Sears, Success, Tronica ad Voesa. (Return receipts in the Office of the Secretary). (SX-2).

3. No acknowledgment of receipt of the complaint and Notice of investigation was received by the Office of the Secretary from two of the named respondents, viz. APF or Far East. (SX-2). This fact was confirmed with the Office of the Secretary on March 11, 1985.

II. PARTIES

Complainant

4. Complainant TI is a Delaware corporation with headquarters at 13500 North Central Expressway, Dallas, Texas. TI manufactures and sells

portable electronic calculators in the United States. (Notice of Investigation; Heye, CX-5, p. 2).

Respondents

APF

5. APF's principal place of business is at 43-28 37th Ave., Long Island City, New York 11101. (Notice of Investigation).

6. APF has sold the portable calculator model no. 1903, made in Hong Kong. (CPX-4).

Cosmo

7. Cosmo has a principal place of business at 16502 N.W. 16 Court, Miami, Florida 33169. (SX-2, pp. 4, 8).

8. Cosmo imports for sale in the United States portable electronic calculators manufactured by Nam Tai. (Response of Cosmo Corporation to Complaint, ¶ 3.29).

Dah Sun

9. Dah Sun has a principal place of business at 7th Floor, Flat A on Loong Fry Bldg., 11-13 Luk Hop St., San Po Kong, Kowloon, Hong Kong. (SX-2, p. 10; CX-530, p. 2).

10. Dah Sun has shipped portable electronic calculators to the United States since . (CX-532, Interrogatory No. 59, p. 10).

Enterprex

11. Enterprex has a principal place of business at P.O. Box 30408, Los Angeles, California 90030. (SX-2, p. 7).

12. Enterprex is involved in the importation, exportation and distribution of electronic products. (Yuan, CX-459, pp. 5, 7).

13. Enterprex commenced importation into, and sale, distribution, and marketing of calculators in, the United States in 1975. (SX-6, Interrogatory No. 4, p. 3).

Far East

14. Far East has a principal place of business at 171 Bun Hoi Road, Kwun Tong, Kowloon, Hong Kong. (Notice of Investigation).

15. Far East is a corporation which sells a wide variety of electronic items manufactured by various divisions. Its watch and calculator division, which manufactures ruler calculators, clocks, calculator watches, game watches and credit card calculators, is called Conic. (Peress, CX-401, pp. 44-45).

16. In , Far East was involved in exporting calculators to the United States and Europe. (Koo, CX-402, p. 25).

FLX

17. FLX has a principal place of business at Block 1, Flat E-J, 5/F Vigor Industrial Building Dallas, Ta Cheun Ping Street, Upper Kwai Chung N.T., Kowloon, Hong Kong. (SX-2, p. 12).

18. is a California corporation which acts as an importer selling to wholesalers digital products consisting of time pieces and calculators. (Ruwin, CX-461, p. 3).

19. During , imported calculators, which were manufactured by FLX in Hong Kong. (Ruwin, CX-461, p. 11).

20. imports calculators into the United States from FLX for under the brand name , CX-458, p. 47).

21. The investigation was terminated as to FLX. (See Procedural History, <u>supra</u>).

<u>Fordstech</u>

22. Fordstech has a principal place of business at 4th Floor, Block C, Hop Hing Industrial Building, 702-4 Castle Peak Road, G.P.O. Box 7295, Hong Kong. (SX-2, p. 10).

<u>General Electronics</u>

23. General Electronics has a principal place of business at Yuen Shing Industrial Bldg., 5/F, 64 Hoi Yuen Road, Kwun Tong, Hong Kong. (SX-2, p. 10).

24. General Electronics began manufacturing calculators years ago. (Chow, CX-402, p. 210).

25. General Electronics has manufactured calculators distributed by IMA in the United States. (SX-5, Interrogatory No. 11, p. 8).

<u>Hua Chang</u>

26. Hua Chang has a principal place of business at Flat A, 6th Floor, Hua Yuan Bldg., 10-12 Steward Road, Wanchai, Hong Kong. (SX-2, p. 11).

27. Hua Chang manufactures calculators, including the Diamond brand. (CX-516, p. 19; CPX-114.1; CPX-115).

<u>Integrated Display</u>

28. Integrated Display has a principal place of business at 9th

Floor, Block E/E1, Kaiser Estate, 41 Man Yue Street, Hunghom, Kowloon, Hong Kong. (SX-2, p. 9).

29. Integrated Display is a manufacturer of calculators located in Hong Kong. Integrated Display has been making one model of calculator for approximately years. (Chow, CX-402, pp. 208-209).

IMA

30. IMA has a principal place of business at 3501 Woodherd Drive, Northbrook, Illinois 60062. (SX-2, p. 7).

31. IMA coordinates the purchase and export of electronic products, including calculators, from Hong Kong to the United States and other markets. (Schoenberg, RX-88, p. 1).

Luks

32. Luks has a principal place of business at 5th Floor, Lee Kee Commercial Bldg., 39-41 Sheung Heung Road, Kowloon, Hong Kong. (Notice of Investigation).

33. Luks sold calculators in to and calculators in to . (Hanig, CX-494, ¶ 4; CX-506).

MBO

34. MBO has a principal place of business at Room 514, 5th Floor, Tsimshatsui Centre, 60 Mody Road, Kowloon, Hong Kong. (SX-2, p. 12).

35. MBO is a trading firm in Hong Kong established for its headquarters in West Germany. MBO purchases calculators from . (Chow, CX-402, p. 209).

36. Respondent MBO is a Hong Kong trading firm which deals in calculators. (Nam Tai, CX-402C, p. 209; CX-512, p. 12).

Mino

37. Mino has a principal place of business at 13th Floor, Flat B, C & D, Mai Wah Industrial Building, 1-7 Wah Sing Street, Kwai Chung, Kowloon, Hong Kong. (SX-2, p. 11).

38. Mino sells portable calculators. (Nam Tai, CX-402C, p. 191).

Nam Tai

39. Nam Tai is a manufacturer and exporter of electronic products with its headquarters at Kaiser Estate, 7th F, Block J. Phase 2, 51 Man Yue St., Hunghom, Kowloon, Hong Kong. (Notice of Investigation; Admissions in Nam Tai Response to Complaint, ¶ 3.20)

40. The following comprise the Nam Tai group of companies: Nam Tai Management Services Limited; Nam Tai Electronics & Electrical Products Limited; Nam Tai Electronic Manufacturing Limited; Nam Tai Supplies Limited; Nam Tai Research & Development Limited; Nam Tai Electrical Products (China Trade) Limited; Nam Tai Finance Services Limited; Nam Tai Electronic Co., Ltd.; Nam Tai Plastic Factory Limited; Merrion Limited; Ballinteer Limited; and Tolka Limited. (CX-425).

41. Calculators which Nam Tai started manufacturing in 1980 were exported to the United States. (Koo, CX-402, p. 22).

42. Nam Tai manufactured calculators in 1981 that were exported to the United States. (Koo, CX-402, p. 23).

43. In 1984, Nam Tai sold calculators in the United States. (Koo, RX-87, p. 3).

Promoters

44. Promoters has a principal place of business at International Industrial Building, 175 Hoi Bun Rd., 3/F & 11/F, Kwun Tong, Kowloon, Hong Kong. (SX-2, p. 9).

45.

has been selling calculators in the United States since 1975. (CX-483, p. 1).

46. has purchased calculators from Promoters in Hong Kong. (CX-483, p. 3).

RJP

47. RJP has a principal place of business at 2nd F, Lee Kee Commercial Bldg., 223 Queen's Road Central, Hong Kong. (SX-2, p. 8).

48. Enterprex has purchased calculators from RJP. (Yuan, CX-459, pp. 78-80).

49. purchased calculators from RJP in 1983 and calculators from RJP in 1984. (CX-477, p. 5).

50. The investigation was terminated as to RJP. (See Procedural History, supra).

51. has purchased calculators from RJP. (Ruwin, CX-461, p. 33).

Sears

52. Sears has represented that it has not imported unlicensed portable calculators as described in the complaint since October 1981, that it is not importing, and that it will not import, such unlicensed calculators until such time as the Commission may find that importation of such

merchandise is not in violation of § 337. (Order No. 11, issued August 24, 1984).

53. The investigation was terminated as to Sears. (See Procedural History, supra).

Success

54. Success has a principal place of business at 32 Sand's St., 2nd F, Sun Bldg. West Point, Hong Kong. (SX-2, p. 12).

55. Success produced calculators from November 1978 to December 1979 with chips purchased from TI. (SX-4).

56. Success manufactures portable calculators in Hong Kong. (Nam Tai, CX-402C, p. 196).

Tronica

57. Tronica Electronic Engineering Co. Ltd. (Tronica) has a principal place of business at 6/8/9/12/14/15/F, Sang Hing Ind. Bldg., 83 Ta Cheun Ping St., Kwai Chung, N.T., Hong Kong. (SX-2, p. 11).

58. Tronica sold calculators in 1983 and calculators in 1984 in the United States. (CX-494).

Voesa

59. Voesa has a principal place of business at Room 1301 Tak Shing House, 20 Des Voeux Road Central, Hong Kong. (Notice of Investigation).

60. Voesa makes portable calculators in Hong Kong. (Nam Tai, CX-402C, p. 198).

III. PRODUCTS IN ISSUE

61. The products in issue in this investigation are certain non-printing portable electronic calculators which allegedly fall under certain claims of the '921 patent. Desktop calculators are excluded from the products in issue. (Notice of Investigation, Finan, Tr. 1549).

62. The portable electronic calculators in issue in this investigation can be divided into two main classes: "four-function"[18/] and "professional." Professional calculators include both "scientific" and "business" (or "financial") calculators. (RX-57 ¶ 2.4; RX-26 p. 8302; CX-363; CX-558).

IV. PATENT IN SUIT

63. U.S. Letters Patent 3,819,921 ('921 patent) entitled "Miniature Electronic Calculator" issued on June 25, 1974 to inventors Jack S. Kilby, Jerry D. Merryman, and James H. Van Tassel. The patent is assigned to TI. (CX-10, RX-505; CX-11).

64. The '921 patent is based on application Ser. No. 317,493 filed Dec. 21, 1972. Ser. No. 317,493 is a continuation of abandoned application Ser. No. 143,192 filed May 13, 1971. Ser. No. 143,192 is a continuation of

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18/ The term "four-function" calculator has been used interchangeably with "consumer handheld," "basic-handheld," or "general purpose" calculators. Today even the most basic four function calculator, in addition to the original four functions of addition, subtraction , multiplication and division, includes a memory function, a percentage key and a square root key. (CX-363; CX-558; CX-553; Schoenberg, Tr. p. 2287; RX-57, ¶ 2.5). In this Initial Determination, the terms "four-function" and "professional" will be used to define the two main classes of calculators.

abandoned application Ser. No. 671,777 filed Sept. 29, 1967. The '921 patent contains fifty-nine claims. (CX-10, RX-505).

Claims in Issue

65. Claims 1, 2, 6, 7, 30, 37, 41, and 53 of the '921 patent are in issue in this investigation (Order No. 31 issued November 16, 1984; Notice of Commission Decision Not to Review an Initial Determination Amending Complaint and Notice of Investigation, issued December 19, 1984). The eight claims in issue read:

1. A miniature, portable, battery operated electronic calculator comprising:

a. input means including a keyboard for entering digits of numbers and arithmetic commands into said calculator and generating signals corresponding to said digits and said commands, the keyboard including only one set of decimal number keys for entering plural digits of decimal numbers in sequence and including a plurality of command keys;

b. electronic means responsive to said signals for performing arithmetic calculations on the numbers entered into the calculator and for generating control signals, said electronic means comprising an integrated semiconductor circuit array located in substantially one plane, the area occupied by the integrated semiconductor array being no greater than that of the keyboard, said integrated semiconductor circuit array comprising:

i. memory means for storing the digits of the numbers entered into the calculator,

ii. arithmetic means coupled to said memory means for adding, subtracting, multiplying and dividing said numbers and storing the resulting answers in the memory means, and

iii. means for selectively transferring numbers from the memory means through the arithmetic means and back to the memory means in a manner dependent upon the commands to effect the desired arithmetic operation:

c. means for providing a visual display coupled to said integrated semiconductor circuit array and responsive to said control signals for indicating said answer, and

d. the entire calculator including keyboard, electronic means, means for providing a visual display, and battery being contained within a "pocket sized" housing.

2. A miniature electronic calculator according to claim 1 wherein the integrated semiconductor array essentially consists of a single semiconductor wafer.

6. A miniature electronic calculator comprising :

a. input means including a keyboard for entering digits of numbers and arithmetic commands into said calculator and generating unique signals corresponding to said digits and said commands, the keyboard including only one set of decimal number keys for entering plural digits of decimal numbers in sequence and including a plurality of command keys;

b. electronic means responsive to said signals for performing arithmetic calculations on the numbers entered into the calculator and for generating control signals, said electronic means comprising an integrated semiconductor circuit array located in substantially one plane, the integrated semiconductor array having lateral dimensions at most not substantially greater than that of the keyboard, said integrated semiconductor circuit array comprising:
   i. memory means for storing the digits of the numbers entered into the calculator,
   ii. arithmetic means coupled to said memory means for adding, subtracting, multiplying and dividing said numbers and storing the resulting answer in the memory means, and
   iii. means for selectively transferring numbers from the memory means through the arithmetic means and back to the memory means in a manner dependent upon the commands to effect the desired arithmetic operation; and

c. means for providing a visual display coupled to said integrated semiconductor circuit array and responsive to said control signals for indicating said answer.

7. A miniature electronic calculator according to claim 6 wherein the integrated semiconductor array essentially consists of a single semiconductor wafer.

30. A miniature electronic calculator comprising:

a. keyboard input means for entering digits of numbers and commands into said calculator and generating unique coded signals corresponding to said digits and said commands, the keyboard input including only one set of ten decimal numbers in keys for entering plural digits of decimal numbers in sequence, and including a plurality of command keys;

b. electronic means coupled to said input means and being responsive to said unique signals for performing arithmetic calculations on the numbers entered into the calculator and for generating control signals, said electronic means comprising an integrated semiconductor circuit array located in substantially one plane;

c. said integrated semiconductor circuit array comprising;

   i. memory means including a plurality of registers for storing the digits of the numbers entered into the calculator and the coded commands, and

   ii. arithmetic means coupled to said memory means for arithmetically combining said digits and storing the resulting answer, the numbers being transferred from registers in the memory means to the arithmetic means and back to the memory means in a selectable manner depending upon the commands; and

d. display means coupled to said integrated semiconductor circuit array and responsive to said control signals for displaying said resulting answer.

37. An electronic calculator according to claim 30 wherein said integrated semiconductor circuit array includes decoding means responsive to the stored answer for generating electrical signals indicative of the shape in which the stored answer is to be displayed, the display means being coupled to said decoding means.

41. An electronic calculator according to claim 30 wherein said integrated semiconductor circuit array comprises a semiconductor substrate having a large plurality of similar functional units adjacent one surface thereof interconnected by multilevels of insulators and conductors on said one surface.

53. A miniature electronic calculator comprising:

a. keyboard input means for entering digits of numbers and arithmetic commands into said calculator and generating unique signals corresponding to said digits and said commands, the keyboard input means including only one set of decimal number keys for entering plural digits of decimal numbers in sequence and a plurality of command keys;

b. electronic means responsive to said unique signals for performing arithmetic calculations on the numbers entered into the calculator and for generating control signals, said electronic means substantially comprising an integrated semiconductor circuit array located in substantially one plane, said integrated semiconductor circuit array comprising:

i. memory means including a plurality of registers for storing the digits of the numbers and the commands entered into the calculator,

ii. arithmetic means coupled to said memory means for adding, subtracting, multiplying and dividing said numbers and storing the resulting answer, and

iii. variable means for selectively transferring numbers serially from the registers through the arithmetic means and back to the registers in a manner dependent upon the commands to effect the desired arithmetic operation; and

c. means for providing a visual display coupled to said integrated semiconductor circuit array and responsive to said control signals for indicating said answer.

(CX-10, RX-505, cols. 39-50)

Input Means

66. Each of the independent claims 1, 6, 30 and 53 in issue recites an "input means including a keyboard for..." (claims 1, 6) or a "keyboard input means for..." (claims 30 and 53). (CX-10, RX-505, cols. 39-50).

67. The keyboard input means illustrated in the preferred embodiment of the '921 patent specification employs a keyboard encoder identified at 6 in FIG. 5 which directly encodes the digits and commands into the binary language of the calculator by each key short circuiting multiple conductive strips identified at 32 in FIGS. 4 and 5 which lead to plural terminals. Thus this input means involved pressing of a key and making contact with printed circuitry underneath the key to directly encode the number into binary language that the calculator works with. (CX-10, RX-505, col. 3, l. 54 - col. 5, l. 40, FIG. 4 and FIG. 5).

68. The keyboard encoder 6 in the FIG. 5 embodiment accomplishes in substantially one plane the generation of unique electrical signals at its output terminals corresponding to the selected information inscribed on the caps of the keys. In operation, while individual terminals may be shortened by more than one key, each key may also short several other terminals. (CX-10, RX-505, col. 5, ls. 5-30, Table II).

69. FIG. 5 of the '921 patent illustrates the preferred embodiment wherein a stroke of each key shotrs from three to five printed leads to produce a unique signal. (Osborne, RX-500, pp. 37-38).

70. The '921 patent specification discloses that a detailed description of the keys and keyboard encoder illustrated in the FIGS. 4 and 5 embodiments is found in U.S. Pat. No. 3,696,411 ('411 patent), entitled "Keyboard Encoder" filed by Jack S. Kilby and James H. Van Tassel and assigned to TI. The disclosure of the '411 patent is incorporated by reference in the '921 patent. (CX-10, RX-505, col. 5, ls. 30-40).

71. The '921 patent specification discloses as an alternative embodiment that the conductive pattern on the keyboard encoder may be simplified to provide a "unique short circuit signal" indicative of the particular key entry rather than directly encoding the key entry into the excess three binary code and encoding gates provided in the integrated semiconductor circuit array responsive to the unique shorting signal for encoding it into the binary language of the calculator. (CX-10, RX-505, col. 18, ls. 8-15).

72. The input means of the '921 patent as claimed specifies a keyboard "for" entering digits of numbers and arithmetic commands into the calculator and generating signals corresponding to said digits and said

commands, the keyboard including only one set of decimal numbers keys for entering plural digits of decimal numbers in sequence and including a plurality of command keys. The patent claims in issue do not specify any other limitation in the claimed input means. (CX-10, RX-505, claims 1, 6, 30 and 53).

Electronic Means

73. Independent claim 1 in issue requires an electronic means comprising an integrated semiconductor circuit array located in substantially one plane, the area occupied by the integrated semiconductor array being no greater than that of the keyboard, said integrated semiconductor array comprising memory means, arithmetic means and transfer means. Similar language is found in independent claim 6 in issue. (CX-10, RX-505, col. 39, ls. 48-64, col. 40, ls. 58-70, col. 41, ls. 1-4).

74. Independent claim 30 requires an electronic means comprising an integrated semiconductor circuit array located in substantially one plane, said integrated semiconductor circuit array comprising memory means, arithmetic means and transfer means. Similar language is found in remaining independent claim 53 in issue. (CX-10, RX-505, col. 45, ls. 64-68, col. 46, ls. 1-10, col. 49, ls. 34-50).

75. The '921 patent specification discloses that the primary electronics of the claimed calculator can be embodied in an integrated semiconductor circuit array located in substantially one plane. (CX-10, RX-505, col. 9, ls. 48-50).

76. The phrase "integrated semiconductor circuit array" itself is not used in the industry and is a term coined by the inventors for the '921

patent. The individual words in the phrase have been used in the industry. (Leach, Tr. p. 1699, l. 24, Tr. p. 1700, l. 3).

77. The electronic means in the claims in issue is in functional language stating that electronic means responsive to said signals (claims 1 and 6) or to said unique signals (claims 30 and 53) are for performing arithmetic calculations on the numbers entered into the calculators and for generating control signals. Claim 30 states that the electric means is coupled to said input means. The only structual limitation of the electronic means recited in the claims in issue is that the electronic means comprise an integrated semiconductor circuit array in one plane (CX-10, RX-505, cols. 39-50).

78. Independent claims 1, 6, 30 and 53 recite that the integrated semiconductor circuit array comprise memory means <u>for</u> storing digits entered into the calculator, arithmetic means coupled to said memory means <u>for</u> adding, subtracting, multiplying and dividing and <u>for</u> storing the resultant answer in the memory means, and means <u>for</u> selectively transferring numbers to effect the desired arithmetic operation. (CX-10, RX-505, cols. 39-50).

79. Each of dependent claims 2 and 7 in issue specifies the integrated semiconductor array essentially consists of a single semiconductor wafer. (CX-10, RX-505, cols. 39-41).

80. Dependent claim 37 in issue specifies that the integrated semiconductor circuit array includes decoding means responsive to the stored answer for generating signals indicative of the shape in which the stored answer is to be displayed, the display means being coupled to said decoding means. (CX-10, RX-505, col. 46, ls. 40-46).

81. Dependent claim 41 in issue specifies that the integrated semiconductor circuit array comprises a semiconductor substrate having a large

plurality of similar functional units adjacent one surface thereof interconnected by multilevels of insulators and conductors on said one surface. (CX-10, RX-505, col. 46 ls. 59-64).

82. The '921 patent specification discloses that in the preferred embodiment the integrated semiconductor circuit array comprises the control and arithmetic sections of the calculator for performing the arithmetic operations of the numbers entered into the calculator and generating the control and timing signals for appropriately carrying out the arithmetic operations, the printout of the entry data and answers and the advancement of the tape. The integrated semiconductor circuit array is said to be mounted parallel with a keyboard encoder 6 so that they occupy generally parallel planes one above the other in a manner that the entry encoding and control and arithmetic operations of the calculators are accomplished in a very small compact space. It is said in this preferred embodiment the various key entries are made, electrically encoded by the keyboard encoder 6 and transmitted to the integrated semiconductor circuit array where the various arithmetic calculations are made and control signals generated for appropriately commanding a thermal printer and tape advance system. In the FIG. 14 preferred embodiment an integrated semiconductor circuit array comprises four integrated semiconductor circuits placed in areas designated 72-75, three integrated semiconductor shift registers SR1, SR2 and SR3 and two resistors 69, 70 all interconnected and arranged on an insulating substrate identified as 7'. (CX-10, RX-505, col. 9, l. 51- col. 10, l. 10).

83. Integrated semi-conductor shift register circuits SR1, SR2 and SR3 in the preferred embodiment of the '921 patent are identical to one another. (CX-10, RX-505, col. 16, ls. 3-8).

84. The circuitry of the shift registers SR1, SR2 and SR3 is illustrated in FIG. 21 of the '921 patent specification. A detailed description of the shift register circuit of FIG. 21 is found in U.S. Pat. No. 3,573,754 ('754 patent) filed by Jerry D. Merryman and entitled "Information Transfer System. The patent is assigned to TI. The disclosure of the '754 patent is incorporated by reference in the '921 patent. (CX-10, RX-505, col. 15, ls. 1-2, 45-54).

85. In the '921 patent specification, FIG. 15-18 are said to illustrate the logic circuitry of the integrated semiconductor circuit array of the FIG. 14 preferred embodiment. FIG. 15 illustrates a logic diagram having 151 functional unit NAND gates interconnected in the manner illustrated and embodied in the integrated semiconductor circuit whose substrate is mounted in the area designated 75 in FIG. 14. FIG. 16 to illustrates a logic diagram having 132 functional unit NAND gates interconnected in the manner illustrated and embodied in an integrated semiconductor circuit whose substrate is mounted in the area designated 74 in FIG. 14. FIG. 17 to illustrates a logic diagram having 135 functional unit NAND gates interconnected in the manner whose substrate is mounted in the area designated 72 in FIG. 14. FIG. 18 to illustrates a logic diagram having 116 functional unit NAND gates interconnected in the manner illustrated and embodied in an integrated semiconductor circuit whose substrate is mounted in the area designated 73 in FIG. 14. (CX-10, RX-505, col. 1, ls. 1-2, col. 10, ls. 10-26).

86. The term "array" had an everyday meaning in the said sixties at TI. Thus the term "array" was used to refer to the array of gates on one of the quadrants shown in FIGS. 15, 16, 17, and 18 of the '921 patent and the names array "A", "B", "C" and "D" were used to stand for the circuits that are

at FIGS. 15, 16, 17, 18. Array "A" had 151 gates in its array. It was not an array until the gates were interconnected. (Merryman, Tr. p. 508, ls. 5-24; Tr. p. 511, ls. 7-10).

87. In the '921 patent specification each integrated semiconductor circuit embodying the logic circuits of FIGS. 15-18 in the preferrred embodiment of the disclosed calculator is said to be formed in the surface of a silicon substrate of P-type conductivity of the desired resistivity utilizing the planar process in which a silicon oxide film is thermally grown on the silicon substrate by placing it in a furnace at an elevated temperature and passing an oxidizing agent over it. (CX-10, RX-505, col. 10, ls. 61-68).

88. The '921 patent specification discloses that a detailed description of the processes of forming the interconnected functional unit NAND gates at a first level of interconnection and interconnecting the NAND gates in the desired logic configuration at a higher level of interconnection is found in U.S. Pat. No. 3,643,232 ('232 patent) filed by Jack S. Kilby and entitled "Large Scale Integration of Electronic Systems in Microminiature Form". The '232 patent was based on an abandoned application filed June 5, 1967 which was a continuation of an application filed December 21, 1964. The patent is assigned to TI. The disclosure of the '232 patent is incorporated by reference in the '921 patent. (CX-10, RX-505, col. 12, ls. 38-51; CX-54). TI admits that the logic circuits in this detailed description are discretionarily wired. (CPFFR, p. 5).

89. Mr. Kilby, an inventor on the '921 patent, discloses in his '232 patent that "semiconductor integrated circuits" have been widely accepted for electronic systems of the type used in missile and space equipment where size, weight, power consumption, and reliability are critical factors. These integrated circuit devices ordinarily are said to comprise "minute wafers or

bars of semiconductor material having a large number of circuit components formed therein", with the components being interconnected by metal film to provide the desired circuit function. Such devices are said to be described in Kilby's U.S. Pat. No. 3,138,743, issued June 23, 1964. Each integrated device usually contains "one circuit function, such as a flip-flop, a logic gate, or the like". The semiconductor wafers in these devices are said to be ordinarily encapsulated in small, flat, hermetically sealed packages, as illustrated in his U.S. Pat. 3,072,000, issued Jan. 8, 1963 said to be a number of such packages being mounted on a circuit board to provide a subsystem. (CX-54, col. 1, ls. 7-24).

90. Inventor Kilby in his '232 patent states that in electronic equipment employing integrated circuitry the point has been reached, or is fast approaching, where reliability and cost are primarily determined by the connecting structures rather than by the semiconductor wafers. Wires, it is said, must be bonded from the wafers to tabs leading out of the hermetically sealed packages, then these tabs must be welded or soldered to conductors on a circuit board, and the circuit boards interconnected with one another with plugboard arrangements. Each such connection ordinarily is said to involve hand operations, to use expensive materials, and to introduce breakage in manufacture. The interconnections on the semiconductor wafer itself are said to be made by photographic techniques which require no individual hand operations, use infinitesimally small amounts of material, involve no violent mechanical operations, such as welding or pressure bonding during manufacture, and hence are vastly cheaper and more reliable than external connections.

91. Based on reliability and cost considerations as well as the continued goals of reducing size and weight and increasing operating frequencies or speeds, Mr. Kilby states in his '232 patent that it is

desirable to increase the number of components in each integrated circuit wafer, and that this increases the number of electronic functions in each package, reducing the packages per system; that it then was possible to produce monocrystalline silicon slices of perhaps 1 inch in diameter having a hundred or more circuit functions therein, with each circuit function containing perhaps 20 or more circuit components so that the slice includes thousands of components i.e., transistors, resistors, etc.; that unfortunately, the manufacturing yield of good components or good circuit functions on a given slice is less than 100 percent, and that this fact prevents immediate utilization of the advantages of incorporating vast quantities of circuitry in single semiconductor units. (CX-54, col. 1, ls. 25-64).

92. Mr. Kilby in his '232 patent states that data taken on recent production of semiconductor integrated circuits indicate that the yield of good circuit functions per slice is fairly high, significantly above 50 percent, and that this is quite economical when the slice is broken up into wafers which contain only one circuit function; that a slice with all good units thereon is virtually never found. Thus, Mr. Kilby concludes manufacture of semiconductor devices containing complex systems or subsystems on a single semiconductor body would be prohibitively expensive, if not impossible, using "present" techniques. (CX-54, col. 1, ls. 65-75).

93. Inventor Kilby states that in accordance with his invention in the '232 patent an electronic system or subsystem containing many circuits or functional elements or cells is made by first forming a large number of circuit components in a semiconductor body, these being in excess of the number necessary to produce the desired functions, then testing the components or functional units, and finally generating on the semiconductor body a unique

interconnection pattern based on the results of the testing. This pattern is preferably created by photographic techniques using a mask made by conventional manual operations, by electron beam exposure of photoresist directly upon the semiconductor body. It is said that the entire operations of testing and generation of the unique mask may be carried out by electromechanical data processing equipment; that using this invention, a complex electronic system containing hundreds of circuit functions and thousands of circuit components may be formed on a single semiconductor wafer, even using "present-day" process or manufacturing technology, because yields of much less than 100 percent good circuit functions per slice or wafer are acceptable. (CX-54, col. 2, ls. 8-30).

94. Inventor Kilby describes FIG. 1 of the '232 patent as a plan view, greatly enlarged, of a semiconductor wafer containing a plurality of functional elements and adapted for use in practicing the invention. (CX-54, col, 2, ls. 38-40). FIG. 10 is said to be a plan view of the semiconductor wafer of FIG. 1 with a unique wiring pattern. FIG. 11 is said to be a sectional view of the wafer of FIG. 10 showing the multiple layers of interconnections. As described in the '232 patent, the testing and discretionary interconnection is done on the basis of functional elements each of which includes the parts seen in FIGS. 2-4. Inventor Kilby discloses that it will be understood that this discretionary interconnection step could be done on a lower level of complexity, such as on the basis of the individual gates and inverters in the logic system, or on higher levels of complexity; that furthermore, several such discretionary interconnection steps could be utilized, starting with selection of good components, then good circuits, then functional elements then logic subsystems; that several levels of interconnecting patterns might be required, in which case the principles of

FIG. 11 could be continued, adding a layer of insulating material and a layer of conductive strips for each interconnection level. (CX-54, col. 2, ls. 37-39, 59-65, col. 6, ls. 28-42).

95. The '921 patent specification discloses that a detailed description of a molybdenum-gold-molybdenum multi-level contact system for interconnecting circuit elements of an integrated semiconductor circuit is found in U.S. Pat No. 3,581,161 ('161 patent) filed by Clark et al and entitled "Molybdenum-Gold-Molybdenum Interconnection System for Integrated Circuits". The patent is assigned to TI. The disclosure of the '161 patent is incorporated by reference in the '921 patent (CX-10, RX-505, col. 12, ls. 52-64; CX-55).

96. Referring to FIG. 14, the '921 patent specification discloses that the integrated semiconductor circuit array comprises an insulating substrate 7' having printed conductors on its top and bottom surface in order to effect the desired interconnections between the integrated semiconductor circuits. Four insulating plates 76, 77, 78 and 79 are said to be mounted side by side on the insulating substrate 7' over some of the printed conductors on the top surface of the insulating substrate 7'. The insulating plates 76, 77, 78 and 79 have respective apertures therein 80, 81, 82 and 83 for respectively accommodating the integrated semiconductor circuits embodying the logic circuits of FIG. 17, 18, 16 and 15. Patterned conductors 84, 85, 86 are said to be applied onto the top surface of the insulating plates 76, 77, 78 and 79 and overhang into the apertures 80, 81, 82 and 83 and onto the top surface of the insulating substrate 7'. (CX-10, RX-505, col. 13, ls. 7-24).

97. The '921 patent specification discloses that a detailed description of an assembly and mounting of an insulating plate 76, its overhanging patterned conductors and associated integrated semiconductor

circuit is found in U.S. Pat. No. 3,484,534 ('534 patent) filed by Jack S. Kilby et al. and entitled "Multilead Package for a Multilead Electrical Device". The patent is assigned to TI. The disclosure of the '534 patent is incorporated by reference in the '921 patent. (CX-10, RX-505, col. 14, ls. 39-50; CX-56).

98. The '534 patent is based on an application filed July 29, 1966. The abstract of the disclosure is to a method of packaging multilead semiconductor devices and the resulting product. (CX-56, col. 1. ls. 15-16).

98(a). Kilby in the '534 patent states that a semiconductor device 24 may be an entire semiconductor slice, which is nominally about one and one-eighth inches in diameter and about 0.010 inch thick on which an array of many logic circuits may be formed. The large number of components such as diodes, transistors, resistors, and capacitors formed in the semiconductor slice are said to be interconnected into circuits and arrays of circuits by one or more layers of conductors fabricated using conventional thin film technique. (CX-56, col. 4, ls. 45-61).

99. The '534 patent specification discloses that in accordance with another important aspect of the invention, a slice of semiconductor material having circuit arrays formed on both faces, in accordance with a referenced patent application, may be packaged using methods illustrated in FIGS. 11 and 12. (CX-56, col. 6, ls. 54-58).

100. The '921 patent specification discloses that alternatively, the planar integrated semiconductor circuit array may comprise a large integral semiconductor wafer smaller than the insulating substrate 7' comprising quadrants respectively embodying the logic circuits of FIGS. 15-18. It is said that the closely grouped circuit elements comprising each functional unit NAND gate at the surface of the integral semiconductor wafer may be

interconnected at a first level of interconnections to form the NAND gate, the NAND gates in each quadrant may be interconnected at multi-levels of interconnections to respectively embody the logic circuits of FIGS. 15-18 and the logic circuits of the quadrants may be interconnected at another level of interconnections using RF sputtered silicon oxide, photolithographic techniques and metal deposition techniques as discussed and remaining interconnections effected by printed conductors on the top or bottom surface of the insulating substrate 7'. Moreover, it is said that the integral semiconductor wafer may be larger so that the shift registers SR 1, SR 2, and SR 3 and the two resistors 69-70 may be incorporated into the surface of the larger integral semiconductor wafer with their interconnections being effected at multi-levels of interconnections and remaining interconnections being effected by printed conductors on the insulating substrate 7'. (CX-10, RX-505, col. 17, ls. 34-59).

101. Inventor Kilby, with respect to quadrants illustrated in FIGS. 15, 16, 17 and 18 and the alternative embodiment starting at col. 17, l. 34 of the '921 patent testified:

Q Is there anything else in this patent that suggests to you that you could change the shape of the quadrants?

A I don't think we felt it necessary to elaborate on that point. Each of those quadrants is made up of a multiplicity of integrated circuit nand gates, and when you put these all on one wafer it would be very logical to form these in a continuum.

Q On the other hand, -- well, let me put it this way. In column 17, beginning on line 34, it certainly doesn't tell you to do that, does it?

A It doesn't say you have to.

Q It in fact tells you that you could put each of these quadrants of Figures 15 through 18 on a single wafer and interconnect these quadrants, doesn't it?

A It does.

Q And it tells you you could also put the shift registers on a and interconnect them the same way, right?

A You add it in the same way, and I don't know whether it is that explicit or not.

Q Well, I think if you will look at lines 54 plus, you will be able to confirm that. But you tell me.

A The wording is not identical, but it is certainly similar.

Q It is very similar. It talks about the multi-level interconnections, right?

A Right, that is correct.

Q Now, if you follow that teaching what you end up with then is a single wafer that has the same four quadrants that you had from Figure 14, the same three shift registers that you had from Figure 14, but now, instead of being on separate substrates, they are all on the same substrate and they are interconnected by multi-level interconnections, right?

A Yes.

(Kilby, Tr. 171, l. 8- p. 172, l. 18).

102. The '921 patent specification discloses that to reduce further the size of the calculator, the insulating substrate of the keyboard encoder 6 may be integrated with the insulating substrate 7' of the integrated semiconductor circuit array such that the conductors 32 of the keyboard encoder 6 occupy one plane surface of a common insulating substrate and the integrated semiconductor circuit array occupies the opposite parallel plane surface of the common insulating substrate with interconnections being effected by conductive feed throughs extending vertically through the common insulating substrate between the parallel planes, the keyboard encoder effecting the mechanical to electrical conversion of the key entries which in turn are transmitted to the integrated semiconductor circuit array for the arithmetic calculations and the control signals. (CX-10, RX-505, col. 17, l. 60- col. 18, l. 8).

103. The semiconductor circuitry disclosed in the '921 patent is specifically directed to bypolar type circuitry. (Merryman, Tr., p. 528, ls. 5-12; CPFFR p. 6).

104. Bypolar technology was chosen for the embodiments of the '921 patent specification because bypolar technology was the technology that was applicable to discretionary wiring "at the moment" which was inventor Kilby's method of achieving the desired level of integration. (Merryman, Tr. p. 1204, ls. 16-24; CPFFR pp. 6-7).

Integrated Semiconductor Circuit Array

105. Inventor Kilby when asked whether the term "integrated semiconductor circuit array" in the '921 patent means integrated semiconductor circuit array of logic functions, testified "Correct" (Kilby, Tr. p. 318, ls. 18-20). When asked the basis in the '921 patent for that meaning he referred to the specific language in the '921 patent at col. 9 around l. 48 (Kilby, Tr. p. 319, ls. 2-5); col. 10, ls. 3-26. (Kilby, Tr. p. 320, ls. 11-20); col. 17, l. 34- col. 18, l. 8 (Kilby, Tr. p. 320, l. 22-p. 331, l. 9); and the recitations of "integrated semiconductor circuit array" in claims 41, 57 and 58 (Kilby, Tr. p. 321, ls. 11-20). The referenced language of the '921 patent is in the following findings:

col. 9, l. 48- col. 10, l. 10	FF 82
col. 10, ls. 3-26	FF 82, 85
col. 17, l. 34- col. 18, l. 8	FF 100
claim 41	FF 65

Claim 57 of the '921 patent reads:

57. A miniature electronic calculator comprising:
a. input means for entering digits of numbers

and arithmetic commands into said calculator and generating unique signals corresponding to said digits and said commands;

b. electronic means responsive to said unique signals for performing arithmetic calculations on the numbers entered into the calculator and for generating control signals, said electronic means comprising an integrated semiconductor circuit array located in substantially one plane, said integrated semiconductor substrate having a large plurality of similar functional units adjacent one surface thereof interconnected by multilevels of insulators and conductors overlying said one surface, said interconnected functional units comprising:
   i. a clocking means for generating timing signals in response to said unique signals, and
   ii. gating means responsive to said timing signals for generating said control signals; and

c. means coupled to said integrated semiconductor circuit array and responsive to said control signals for recording the answer of said arithmetic calculations.

Claim 58 of the '921 patent reads:

58. A miniature electronic calculator comprising:

a. keyboard input means for entering digits of decimal numbers and arithmetic commands into said calculator and generating unique coded signals corresponding to said digits and said commands;

b. electronic means responsive to said unique signals for performing arithmetic calculations on said numbers entered into the calculator and for generating control signals, said electronic means substantially comprising an integrated semiconductor circuit array located in substantially one plane;

c.

said integrated semiconductor circuit array comprising:
   i. memory means for storing the digits of the numbers entered into the calculator, and
   ii. arithmetic means coupled to said memory means for adding, subtracting, multiplying and dividing said numbers and storing the resulting answer,

d. said integrated semiconductor circuit array further comprising a semiconductor substrate having a large plurality of similar functional units adjacent one surface thereof interconnected by multilevels of insulators and conductors overlying said one surface; and

e. recording means coupled to said integrated semiconductor circuit array and responsive to said control signals for permanently recording said answer.

(CX-10, RX-505, cols. 51, 52).

106. Claim 42 of the '921 patent reads:

42. An electronic calculator according to claim 41 wherein said integrated semiconductor circuit array further comprises:

a. an insulating substrate having printed conductors thereon;

b. a plurality of said semiconductor substrates mounted on one surface of said insulating substrate;

c. conductive leads overlying said semiconductor substrates interconnecting functional units of one semiconductor substrate with functional units of another semiconductor substrate; and

d. conductive leads interconnecting functional units and said printed conductors on said insulating substrate.

(CX-10, RX-505, cols. 46, 47).

107. In referring to the circuits in FIGS. 15, 16, 17 and 18 and the nand gates therein Kilby testified that array to him implies that interconnectons are present; that it is correct that gate array means something in which the interconnections are present. (Kilby, Tr. p. 197, ls. 9-19).

108. In the '921 patent the word "chip" does not appear nor was the term in common usage when the '921 patent was filed for (Kilby, CX-1A, p. 10).

109. Kilby testified that in 1967 the term "wafer" was used to mean something larger than the very small substrates of the day, which were usually less than 0.050 inches square. The meaning of the term wafer today is said to be equally imprecise, meaning a substrate larger than those in common use, up to the full size of the slice. (Kilby, CX-1A, p. 10).

110. While inventor Merryman corrected the statement at the hearing in his direct testimony from:

> "The term 'array' is used in the description of the ['921] patent and refers to an array of logic elements in a single wafer or chip" to: "The term 'array' is used in the description of the ['921] patent and refers to an array of logic elements"

he considered both definitions to be correct. (CX-2, p. 7; Merryman Tr., p. 581, ls. 25-55).

111. Mr. Merryman has used the word "array" to refer to a plurality of gates. He testified that the common everyday meaning of "array", that was used on the CAl-Tech project which led to the filing of '921 patent, was distinct from the way the word "array" is used in the '921 patent. He also testified that a plurality of gates did not become an array until the gates were interconnected. (Merryman, Tr. p. 508, ls. 9-24; Tr. 580, ls. 5-11).

112. Atherton testified that for the Cal-Tech calculator the maximum number of gates needed for one array was 151. (Atherton, Tr. p. 1320 ls. 18-20; CX-216).

113. The integrated semiconductor circuit array comprising the primary electronics illustrated in the FIG. 14 preferred embodiment of the '921 patent had more than one wafer within it. This integrated semiconductor circuit array had seven circuits. (Kilby, Tr. p. 165, ls. 9-18).

114. When inventor Kilby was asked whether at the time that the '921 patent was filed, he had an understanding of the the term "integrated semiconductor circuit" or whether the term was ever used in 1967 when the '921 patent application was filed, Mr. Kilby stated "No, it would not have been"and that he had no understanding of the term because there was a degree of redunancy since "semiconductor circuit" meant "integrated circuit" then (Kilby, Tr. p. 357,, l. 4, p. 358, l. 11). However when the '921 application was filed on September 29, 1971 by inventor Kilby, Merryman and Van Tassel, it stated in part:

> The integrated semiconductor circuit array is illustrated in FIG. 14 and comprises four integrated semiconductor circuits placed in the areas designated 73-75, three integrated semiconductor shift registers SR 1, SR 2, and SR 3 and two resistors 69, 70 all interconnected and arranged on the insulating substrate 7' in the manner to be described.
>
> FIG. 15 illustrates a logic diagram having 151 functional unit NAND gates interconnected in the manner illustrates and embodied in the integrated semiconductor circuit whose substrate is mounted in the area designated 75 in FIG. 14. FIG. 16 illustrates a logic diagram having 132 functional unit NAND gates interconnected in the manner illustrated and embodied in an integrated semiconductor circuit whose substrate is mounted in the area designated 74 in FIG. 14, FIG. 17 illustrates a logic diagram having 135 functional unit NAND gates interconnected in the manner whose substrate is mounted in the area designated 72 in FIG. 14 FIG. 18 illustrates a logic diagram having 116 functional unit NAND gates insterconnected in the manner illustrated and embodied in an integrated semiconductor circuit whose substrate is mounted in the area designated 73 in FIG. 14.
>
> ***
>
> Each integrated semiconductor circuit embodying the logic circuits of FIGS. 15-18 is formed in the surface of a silicon substrate of P-type conductivity of the desired resistivity utilizing the planar process in which a silicon oxide film is thermally grown on the silcon substrate by placing it in a furnace at an elevated temperature and passing an oxiding agent over it. The resulting silicon oxide film acts a a masking medium against the impurities

which are later diffused into the substrate. Holes are produced in the oxide film to allow subsequent diffusion processes to form the transistors, resistors, and PN junction isolating functions. These holes which are patterns of the desired circuit elements and PN junction isolating regions are produced by photolithographic techniques. Contacts and interconnections between the circuit elements are made by similar photolithographic techniques using for example a molybodenum-gold molybdenum s Mo-Au-Mo) contact system over the oxide film to form a metallic pattern connecting the circuit elements together in the circuit configuration of FIG. 20, thereby forming the NAND gates which are to be interconnected in the logic circuits of FIGS. 15-18. The metallic pattern comprises conductive strips on the oxide film extending onto openings in the oxide film for connecting the circuit elements into the circuit configuration of FIG. 20 and comprises contact areas which are to be interconnected to result in the logic circuits of FIGS. 15-18. (CX-10, RX-505, col. 10, ls. 3-26, l. 62 - col. 11, l. 21). [Emphasis added].

Display Means

115. Each of independent claims 1, 6, 30 and 53 recite a means <u>for</u> providing a visual display coupled to said integrated semiconductor circuit array and responsive to said control signals for indicating said answer. Thus the display means for the claimed calculator is defined in functional language. (CX-10, RX-505, claims 1, 6, 30 and 53).

116. The display means disclosed in the '921 patent specification is a thermal printer. The thermal printer is said to comprise a 3 x 5 "array" of integrated semiconductor heater elements located in thermal communication with a tape 14 which is a thermally sensitive material that changes color upon the application of heat thereto. FIG. 6 is said to illustrate a 3 x 5 "array" of means located within the window 50 in a semiconductor wafer 48. Each heater element of the 3 x 5 array is said to comprise a monocrystalline semiconductor body in a mesa shape and contains a heater element formed

therein at the side of the mesa adjacent the larger insulating support 49 so that when the heater element is energized a "hot spot" is said to form at the surface of mesa to provide a localized dot on the thermally sensitive material 14. A group of selectively energized heater elements is said to form a group of dots on the thermally sensitive material 14 thereby defining a numeric character 0-9 or symbols C, E, P, ., +, X, -, + which is printed on the thermally sensitive material 14. The mesas comprising the heater element array are air-isolated from each other and joined by a metallic connecting pattern located between the mesas and the insulating support 49 which pattern interconnects the heater elements in the mesas in the desired circuit configuration. A drive matrix for selectively energizing the heater elements and supplying the desired power to them is located in the semiconductor wafer 48 in an area generally designated 51. The circuit elements forming the drive matrix are said to be integral within the semiconductor wafer 48. PN junction isolated from one another and interconnected in the desired configuration by a metallic connecting pattern between the semiconductor wafer 48 and the insulating support 49. The heating element array and the drive matrix are also interconnected in the desired circuit configuration by the metallic connecting pattern between the semiconductor wafer 48 and the insulating support 49. The surface of the printer 4 is said to be illustrated in FIG. 6 and to correspond to the bottom surface of the printer 4 illustrated in FIG. 3. (CX-10, RX-505, col. 5, l. 40 col. 6, l. 15).

117. FIG. 7 of the '921 specification is said to illustrate the semiconductor wafer 48 in an intermediate stage of its manufacture to show the layout of circuit elements formed in the semiconductor wafer 45 by utilizing the planar process which circuit elements comprise the heater element array and the drive matrix therefor. (CX-10, RX-505, col. 6, ls. 34-39).

118. Referring to FIG. 7, a 3 x 5 array of transistor-resistor pairs is said to be formed on the surface of the P-type semiconductor wafer 48 in the area designated 50 which corresponds to the area of the window 50 in FIG. 6. The heater element array is said to comprise the diffused transistor-resistors pairs, i.e. triple diffused NPN transistors T1 through T15 and their respective N-type diffused resistors R 1 through R 15. Each resistor R 1 through R 15 is said to have one of its ends integral with the collector of its respective transistor in the manner that the resistor is obmically connected to the collector of its corresponding transistor internally of the semiconductor material. The drive matrix for the heater element array is said to comprise 15 triple diffused NPN transistors T 16 through T 30 and their respective diffused N-type collector resistors R_{C14} through R_{C20} having one of their ends integral with the collectors and obmically connected therewith internally of the semiconductor material. The drive matrix also is said to include 15 diffused P-type base resistors and 15 diffused P-type emitter resistors associated with the 15 transistors T 16 through T 30. Each P-type base and emitter resistor is surrounded by an N type isolating region whereby the insulating PN junctions isolate it from the other circuit elements and from one another. Diffused N-type conductive tunnels are said to be provided in the surface of the semiconductor wafer 48 to allow interconnection between the base electrodes of the transistors T 1 through T 15 and the emitter electrodes of the transistors T 16 through T 36. (CX-10, RX-505, col. 6, l. 40, col. 7, l. 1).

119. The '921 specification discloses that a detailed description of the thermal printer is found in U.S. Pat. No. 3,501,615 ('615 patent) entitled "Integrated Heater Element Array and Drive Matrix" filed by inventor Jerry D. Merryman. The '615 patent is assigned to TI and is incorporated by reference in the '921 patent specification. (CX-10, RX-505, col. 5, ls. 46-55).

120. The '615 patent states that the disclosed invention relates to thermal displays of the type having an array of heater elements selectively energized to provide an information display on thermally sensitive material. (CX-52, col. 1, ls. 36-40).

121. In the thermal print of the '921 patent, it was advantageous to put the drivers on the thermal print head to make a better printer head and hence they were not part of the logic array. (Merryman, Tr. 566, ls. 17-21).

122. The thermal printer eliminated heat from the drive electronics, which heat was a nuisance, by integrating it with the print head. (Kilby, Tr. p. 242, l. 19, p. 243, l. 6).

123. FIG. 15 of the '921 patent illustrates logic circuitry of the integrated semiconductor circuit array of FIG. 14 of the '921 patent. (CX-10, col. 2, ls. 1-2). Kilby testified that he could not tell from FIG. 15 whether it represents an MOS or bipolar device; that from FIG. 15, he cannot tell whether discrete technology is used; that FIG. 15 does not teach one to build the disclosed circuit in MOS technology any more than it teaches one to build circuitry of FIG. 15 in discrete technology; that he has never seen the circuit of FIG. 15 built in MOS technology; that he has only seen the FIG. 15 circuit built in the circuitry Cal-Tech calculator. (Kilby, Tr. p. 472, ls. 1-25; TR. p. 473, ls. 1-12).

124. In building the Cal-Tech prototype (CPX-202) which is representative of the preferred embodiment of the '921 patent (Merryman, Tr. p. 502, ls. 3-5) the conventional integrated circuits then in existence were not only too large, but used far too much power for portable battery operation. (Merryman, CX-3, p. 2).

125. CX-54 discribes the discretationary wiring technique used to build the Cal-Tech calculator. This nand gates are connected through discretionary wiring. (Kilby Tr. p. 206 ls. 16-24; Tr. p. 210, ls. 5-10).

126. Inventor Kilby conceded that the main thrust of integrated circuit development almost from the day it started was to take advantage of having things within a single plane and to work from one plane. (Kilby, Tr. p. 151, ls. 4-9).

V. BACKGROUND OF THE '921 INVENTION

127. Jack S. Kilby, an inventor on the '921 patent, is self employed as an engineering consultant and independent inventor. By training he is an electrical engineer. Mr. Kilby graduated from the University of Illinois with a BSEE in 1947 and from the University of Wisconsin with a MSEE in 1950. (Kilby, CX-1, p. 1).

128. Mr. Kilby, upon graduation was employed by the Centralab Division of Globe-Union, Inc. in Milwaukee, Wisconsin. Centralab is now a part of North American Phillips. He was assigned to work on the design and development of what would now be called thick film circuits. These circuits were electronic circuits with the conductors, resistors and some of the capacitors formed by silk screening of inks on ceramic substrates. When Mr. Kilby left Centralab in 1958, Centralab was producing complete transistor circuit assemblies, primarily for hearing aids. This area of electronics was then called microminiaturization. (Kilby, CX-1, p. 1).

129. In 1958, Mr. Kilby began to work at TI. Although he was hired to work in the general field of microminiaturization, the approach to be used was not specified. Mr. Kilby felt that none of the existing approaches, including that of Centralab, was completely satisfactory. After several months of thought Mr. Kilby conceived the idea of fabricating all of the required components within a semiconductor wafer. A patent application on the

approach was filed on February 6, 1959 and U.S. Patent 3,138,743 ('743 patent) issued therefrom on June 23, 1964. This patent is in the semiconductor integrated circuit field. (Kilby, CX-1, p. 1; ALJ, Ex. 2).

130. In accordance with the principles of the '743 patent invention, circuit miniaturization is attained using only one material for all circuit elements and a limited number of compatible process steps for the production thereof. (ALJ, Ex. 2, col. 2, ls. 2-6).

131. In a more specific conception of the '743 patent invention, all components of an electronic circuit are formed in or near one surface of a relatively thin semi-conductor wafer characterized by a diffused p-n junction or junctions. The invention contemplated the use of component designs for the various circuit elements or components which can be integrated into or which constitute parts of the body of semiconductor material. Gold wires or a silicon dioxide evaoration technique may be used to make electrical circuit connections on the wafer. (AJJ, Exh. 2, col. 2, ls. 20-23, col. 3, ls. 70-74, col. 6, ls. 56-63).

132. An article in Science 85, Jan. Feb. '85, Vol. 6, No. 1 pp. 34-41 entitled "The Chip" by T.R. Reid stated:

> "For some time now," wrote J.A. Morton, a vice president of Bell Labs, in a 1958 article celebrating the 10th anniversary of the transistor, "...electronic man has known how in principle to extend greatly his visual, tactile, and mental abilities through the digital transmission and processing of all kinds of information. However, all these functions suffer from what has been called 'the tyranny of numbers.' Such systems, because of their complex digital nature, require hundreds, thousands, and sometimes tens of thousands of electron devices." And each of these devices, Morton noted in a later article, "must be made, tested, packed, shipped, unpacked, retested, and interconnected one-at-a-time to produce a whole system. Each element and its connections must operate reliably if the system is to function as a whole." The consequence? "The tyranny of large systems," he said, "sets up a numbers barrier to future advances if we must rely on individual dicrete components for producing larger systems." (CX-36, p. 35).

133. An electric circuit has to be a complete, unbroken path along which current can flow. That means that all the components of the circuit must be connected in a continuous loop; resistors wired to diodes, diodes to transistors, transistors to other resistors, and so on. Each component can have two, 10, even 20 interconnections with other parts of the circuit. Making the connections--wiring the parts together--was almost entirely hand labor: It was expensive, time-consuming, and inherently unreliable. A circuit with 100,000 components could easily require 1,000,000 different soldered connections linking the components. (CX-36, p. 36).

134. In 1958 Texas Instruments was just beginning to make a mark in the electronics business. In 1952, when transistors were still exotic, unreliable devices costing $15 or more each, Patrick Haggerty, then TI's president, gave engineer Mark Shepherd, Jr., an assignment: Develop a reliable mass-production transistor that would sell for $2.50. Shepherd did it. In 1954, Haggerty put the cheap, reliable transistors into a consumer product--the pocket radio. (CX-36, p. 36).

135. When inventor Kilby arrived at TI in May of 1958, one of many ideas being pursued was the Micro-Module. Because of its record in getting silicon to behave, TI had landed a small research contract from RCA, which had come up with the inspiration for the Micro-Module. The theory was that all the components of a circuit could be made in one uniform size and shape, with wiring built right in. These identical modules could then be snapped together to make instant circuits. (CX-36, p. 37).

136. Kilby disliked the Micro-Module from the start. The Micro-Module did nothing to reduce the huge quantities of individual components in sophisticated circuits. (CX-36, p. 37).

137. In 1958, TI had invested millions of dollars in equipment and techniques to purify silicon and manufacture transistors with it. "If Texas Instruments was going to do something," Mr. Kilby explained later, "it probably had to involve silicon." This conclusion gave Kilby the focus he needed. He began to think hard about silicon. What could you do with silicon? Kilby's answer to that question has come to be known as the Monolithic Idea. (CX-36, p. 38).

138. It was known in 1958 that the standard semiconductor devices, diodes and transistors, could be made of silicon, if the silicon was "doped" with the proper impurities to make it conduct electric charges. (CX-36, p. 38).

139. In 1958 Mr. Kilby thought that by taking advantage of the peculiarities of the junction between differently doped regions of a piece of silicon, a capacitor could be made i.e., if one could make any component from one material, one could put the components of an entire circuit in a monolithic block of that material. If all the parts were integrated on a single slice of silicon, it was thought one wouldn't have to wire anything together. Connections could be laid down internally within the semiconductor chip; no matter how complex the circuit was. Nobody would have to solder anything together. The numbers barrier would disappear and without wiring or connections, an awful lot of components could be squeezed into a small chip. On July 24, 1958, Kilby opened his lab notebook and wrote down the Monolithic Idea: 'The following circuit elements could be made on a single slice: resistors, capacitor, distributed capacitor, transistor." He made rough sketches of how each of the components could be realized by proper arrangements of semiconductor material. (CX-36, p. 38).

140. In 1958, the design that Kilby chose for his idea of fabricating all of the required components within a semiconductor wafer was a phase-shift oscillator which incorporated resistors, capacitors, and transistors--the three most important circuit elements. An oscillator turns a steady flow of direct current into alternating current, electricity that constantly changes direction, surging back and forth. The transformation from DC to AC shows up on an oscilloscope, a piece of test equipment with a screen much like a small TV set. (CX-36 p. 38).

141. On September 12, 1958, Kilby's oscillator-on-a-chip, less than half an inch long and narrower than a toothpick, was ready for viewing. Kilby then showed that the integrated circuit worked. (CX-36, p. 39).

142. Although Mr. Kilby had the semiconductor material silicon in mind for future chips, he used germanium for the first crude integrated circuit. The germanium on which the circuit is built was a thin rectangle. No bigger than a piece of toothpick, the wafer is glued to a larger rectangle of glass, which is glued to yet another piece of glass. The circuit, a phase-shift oscillator, has five electrical components: A transistor is at the center of the germanium; a capacitor is at the left side; and the germanium bar provides the functional equivalent of three resistors. Kilby made some of the connections on the chip with tiny gold wires rather than depositing metallic circuit paths. Its "inelegant design" has been said to contrast sharply with the internal workings of a modern chip. As made by Motorola, a modern chip is a microprocessor--the heart of a computer--with 200,00 transistors on one piece of silicon. (CX-36, p. 39).

143. As a result of Mr. Kilby's work in the semiconductor integrated circuit field he received a number of honors from professional societies, as well as the National Medal of Science, presented by then President Nixon for

Kilby's invention of the integrated circuit in 1958. In 1981 he was inducted into the National Inventors Hall of Fame at the U.S. Patent Office. Additionally, in 1980 he received the award of the Consumer Electronics Society of the IEEE for the invention of a hand held calculator. (Kilby, CX-1, p. 1; CX-146, p. 3).

144. After the invention of '743 patent, Mr. Kilby continued to work at TI. Although he held a number of job titles, basically he was responsible for the integrated circuit development work of the company. In 1968 he was elected an Assistant Vice President of TI, and Director of Engineering for TI's Semiconductor Division. About sixty U.S. Patents have been issued in Kilby's name. (Kilby, CX-1, pp. 1-2).

145. In 1970 Mr. Kilby took a leave of absence to work as an independent inventor. In 1983 he retired from TI, but has continued to work as an engineering consultant and as an independent inventor to this date. (Kilby, CX-1, p. 2).

146. Jerry Dale Merryman, an inventor on the '921 patent, has been employed by TI for over 21 years and has about 25 U.S. patents. (Merryman, CX-2, p. 1).

147. In the years 1949-1952 and 1957-1959, Mr. Merryman studied electrical engineering at Texas A & M University. From 1952 to 1954, he was chief engineer of a radio broadcast station. From 1954 to 1959, he was employed by the Oceanography and Meteorology Department of Texas A & M, where his duties were of three types: (1) he was responsible for maintenance of equipment and data recording at off-shore installations in the Gulf of Mexico during hurricane periods for the purpose of direct measurement of hurricane induced wave forces; (2) he participated heavily in the design and construction of mobile micrometeorological measurement stations; and (3) he

was responsible for concept, design, and fabrication of some of the first meteorological computers, under the sponsorship of the U.S. Air Force and the U.S. Signal Corps. These computers dealt with the micrometeorological variables of the frictional boundary layer, as well as Richardson's equations for the general atmosphere. He has published some of his work in the "Journal of the American Meteorological Society". (Merryman, CX-2, p. 1).

148. In 1959, he joined a small Arkansas electronics firm where he was responsible for the design and execution of projects that typically involved one-of-a-kind special purpose electronic systems. Example of equipments and customers were: (1) telemetry and range equipment for General Electric Space and Missiles Division, Philadelphia; (2) time-code generators for the National Bureau of Standards, Boulder, Colorado; and (3) a moderate-sized analog computer for the Boeing Aircraft Company. (Merryman, CX-2, p. 1).

149. Returning to Dallas in 1961, Mr. Merryman worked as a systems analyst for Alpha Corporation, a subsidiary of Collins Radio. He performed mathematical analysis on, for example, satellite communications systems, and noise analysis of monopulse radar receivers. Later, at another Dallas company, he worked on the development of electrochemical active elements. He was issued a patent on a liquid-state DC amplifier. (Merryman, CX-2, p. 1).

150. Joining TI in 1963, his first assignment was to design an integrated circuit that was to be a high-gain, wide-band linear amplifier to be used with the memory circuits of the "Monica C System". The resulting integrated circuit was featured on the cover of the company's annual report for that year. (Merryman, CX-2, p. 1).

151. For the remainder of 1963 and through 1964, Mr. Merryman designed a few integrated circuits that exploited internal optical and thermal effects. (Merryman, CX-2, pp. 1-2).

152. In 1964 Mr. Kilby was travelling to New York on business for TI. On the plane he met Patrick E. Haggerty, who was then President of TI and its Chief Executive Officer. They sat together, and began to talk. Haggerty said that he felt that the integrated circuit could provide a number of interesting new electronic products and opportunities for the TI. He mentioned three. One was a lipstick sized dictation machine, the second a small calculator, and the third Mr. Kilby no longer remember. Haggerty felt that the calculator should be small - perhaps using a slide rule as a size reference. (Kilby, CX-1, p. 2).

153. Upon Mr. Kilby's return from the New York trip he began to consider the suggestions of Mr. Haggerty. Mr. Kilby did consider the dictation machine. Although some work was being done on memories, a few calculations showed that the dictation machine could not be built with any reasonable extrapolation of the existing technology, and in fact has not been realized to date. (Kilby, CX-1, p. 2).

154. The calculator suggested by Mr. Haggerty received more serious consideration. Mr. Kilby throught about it for several months, and began to define the requirements for a design. The calculator should provide the basic arithmetic functions of addition, subtraction, multiplication and division and be battery operated for portability. Although a calculator the size of a slide rule seemed difficult, Kilby thought it might be possible to build one the size of a paperbacked book, which could still be carried in a pocket. Finally to be successful Mr. Kilby thought that the calculator should retail for less than $100, which meant that the factory cost should be less than $40. He rather arbitrarily assigned cost goals of $10 each to the major

components which would be required, viz. the logic, the display, the keyboard, and the power supply. (Kilby, CX-1, p. 2; CX-210).

155. Although Mr. Kilby was giving serious consideration to a calculator none of the required elements for said calculator existed in suitable form. Integrated circuits of the type than being made cost more than $10 each, and several hundred would be needed. Keyboards existed, but were bulky and expensive. No suitable displays were available, although several new approaches appeared to be worth investigation. Batteries could be used for the power supply, but substantial efforts would be required to reduce the power requirements of the display and the logic if the cost and size goals were to be met. (Kilby, CX-10, p. 3).

156. In 1964-1965 Mr. Kilby was Deputy Director of the Semiconductor Research and Development Laboratory of TI. That group was responsible for all semiconductor development. Although Mr. Kilby early in 1965 did not have an exact figure, it is likely that about 150 professionals and 150 technicians reported to him. The laboratory was organized into about eight groups, none of which were suited for work on the calculator project. To start the work Mr. Kilby chose Jerry Dale Merryman, and asked him to think about how to make a simple, low power a shift register, which Kilby knew would eventually be required for the calculator project. At the time Mr. Merryman was not told of the reason for the request. (Kilby, CX-1, p. 3; Merryman, CX-2, pp. 1-2).

157. In September 1965, meetings on the calculator project were held in the office of Mr. Kilby with a number of the senior engineers at TI, including Mr. Merryman. As a result of these meetings, Mr. Kilby felt that the project was feasible. He asked Mr. Merryman to head the project. Work on the project began in late September 1965. Mr. Merryman was asked to report to Dean Toombs, head of the Thin Film Memory project. Jim Van Tassel, the third

inventor on the '921 patent, was already a member of Toomb's group. The name "Cal-Tech" was chosen for the calculator project to assure secrecy. Other projects within TI then were named after universities. (Kilby, CX-1, p. 4; Merryman, CX-2, pp. 2-3; CX-216).

158. In 1965, it was the feeling of Mr. Kilby that the best chance of realizing the logic required, at a cost of $10, lay in rising much higher levels of integration than those in use at the time. A group working on complex large scale integrated circuits was asked to fabricate the logic circuits required for the Cal-Tech project. (Kilby, CX-1, pp. 4-5).

159. The display represented a problem. Although another group under Mr. Kilby's direction was involved with light emitting diodes, calculations of the day showed that the efficiency was so low that prohibitively large amounts of power would be required. The costs of light emitting diodes also would have been a serious problem initially. Accordingly Mr. Merryman designed a novel form of thermal printer suitable for Cal-Tech in which the drive transistors were integrated with the printhead, with a considerable saving in cost and power. (Kilby, CX-1 p. 5).

160. All of the logic design was done under the direction of Mr. Merryman. It was necessary for him to choose a simple form of architecture which could be realized with a minimum number of gates, to develop circuitry which could operate within the power budget, and to develop the interfaces between the logic and the printer. (Kilby, CX-1, p. 5).

161. Existing keyboards were too bulky and expensive. To simplify the design and to minimize the cost, inventors' Van Tassel and Kilby came up with a design in which the contacts were formed by conductors on a single printed circuit board. They also did the first level of encoding at the switch contacts to save logic. (Kilby, CX-1, p. 5).

162. Inventors Van Tassel and Kilby also devised the method of mounting and packaging the integrated circuit arrays. Inventors Kilby, Merryman and Van Tassel choose initially to build the design shown in Figure 14 of the '921 patent. (Kilby, CX-1, p. 5).

163. All of the components for the Cal-Tech project influenced the final size. Functionally it was felt that the size of the finished unit should be determined by the size of the keyboard, and all decisions were made with this in mind. (Kilby, CX-1, p. 6).

164. It was recognized at the outset of the Cal-Tech project that a number of new technologies would be required to achieve this objective. The size of the calculator was to be set by the size required for a keyboard with keys of familiar size. A keyboard with a single set of digits would assist in reducing the keyboard area. By restricting the logic to a single plane no larger than the Keyboard, the overall dimensions were maintained. (Kilby, CX-1, p. 6).

165. A TI Monthly Report for the period October 1-31, 1965 under the heading "Summary" stated:

> D. CAL TECH
>
> The logic design of the computer is nearly complete. It is presently being refined. The pass at defining array size has started. Mechanical subassemblies such as the keyboard and tape driver were fabricated and will be tested in November.

and under the heading "Cal Tech Project - J. Merryman-535" stated:

> 1. Electronics - J. Merryman - 535
>
> The activities of this project, whose object is to design and fabricate a small electronic desk calculator, were transferred to the Memory Systems Branch during this month. Rough system design and logic diagrams have been accomplished.
>
> One phase of the project, detailed design of a shift register, is in a relatively advanced state. Fabrication of a first run of shift

registers were completed during the month, but yield for the relatively complex device was low. None of the registers would operate through all 20 stages. Design and layout were completed, and diffusions started, for a second type shift register. This design should be more suitable for low-cost applications.

2. Mechanical - J. Merryman - 535

A number of Mylar diaphragm keys have been fabricated using both Hg coated and Au plated contacts. Some mechanical testing of the keys has been done. The Au plated version has yielded the best results to date. A full keyboard has been designed and is being fabricated. Testing will start in November. The tape drive mechanism has been designed and is being constructed. Tests on this will be conducted in November.

(CX-218, pp. 2, 6, 7 of 10/65 monthly report).

166. A TI memorandum dated December 15, 1965 and on the subject "Monthly Report - Cal Tech Project" stated:

CAL TECH PROJECT - J. Merryman - 1484

1. Shift Register

A bipolar shift register having 22 serial bits on a bar 70 x 180 mils has been successfully tested. Operation was from 0 - 500 KC with approximately 36 mw of power dissipation. The project requires 24 bits in four six bit sequence. Masks are completed and diffusions have been started.

2. NAND Gate

The electical design has been completed on a 6 input NAND gate. A DTL circuit operating from 3v was selected for simplicity and low power. Measurements and computations show worst case noise margin of 270 mv from -10°C to +60°C. The gate dissipates 0.9 mw of power and has a propagation time of approximately 500 ns.

3. Gate Array

The center to center spacing for the gates in an array has not yet been determined. This spacing depends more on the density of logic wiring than on the size of the gate components. The discretionary wiring computer program is being used on a 147 gate test problem to determine the spacing required to successfully fabricate arrays of this size.

4. Thermal Print Head

Design has been started on a 3 x 5 thermal print head having 15 hot spots each 12 x 16 mils with a center to center spacing of 16 x 20 mils. Characters printed by such a head are of satisfactory appearance.

5. Mechanical Fabrication

The case and battery holder are being fabricated.

(CX-218).

167. A TI memorandum dated January 18, 1966 and on the subject "Monthly Report - Cal Tech Project" stated:

CAL TECH PROJECT - J. Merryman - 1484

1. Shift Register

Diffusions were completed on the new 24 bit shift register, which provides four six-bit sequences on a bar 85 x 160 mils. Five working bars were obtained from the first run of ten slices. Three bars are required per machine.

2. NAND Gate Array

Photomasks were received for the 6 input NAND gate. Diffusions will start the first week in January. The gate size is 32.5 x 50 mils, giving 384 gates per slice. The "channel-routing" computer program will be used to provide discretionary wiring masks for these slices, wiring up to 150 gates per one-slice-array. Three or four such arrays are required per machine.

The large gate size of the above approach is due to the inefficient "maze-running" program will allow the gate size to be reduced entire machine. The new program requires more work to be entirely operational. A new gate layout suitable for this approach will be started in January. A possible disadvantage of the new program is longer running time on the computer.

3. Keyboard

Etched - circuit boards containing the keyboard coding have been produced, and one has been attached to the mechanical keyboard assembly for testing.

(CX-218).

168. A TI memorandum dated February 8, 1966 and on the subject "Monthly Report - Cal Tech Project" stated in part:

CAL TECH PROJECT - J. Merryman - 1484

1. NAND GATES

The first run of eight slices of diffused material were received from Jim Lewis. Six slices were metallized with the lead pattern of the primary design. Two slices were metallized with an alternate pattern to test a slightly different gate (higher noise immunity) intended as a backup. It is not expected that the alternate gate will have to be used in the progam.

Each of the six slices has had all 384 gates funtionally tested. Two slices showed the yields to be 95%. The other four showed 51% to 77%. Most of the failures on the lower yield slices were obvious and systematic defects in metallization (discontinous leads). There is one gate location that is consistently bad, due to a fault in a master mask.

2. ARRAY LOGIC DESIGN

The machine logic diagram of 533 gates was partitioned into four arrays of 113 to 151 gates each. These diagrams were delivered to Joe Monica to have him prepare the Engineers' List and other preliminary computer input data required for discretionary wiring....

Approximately 50% of the machine logic has been electrically breadboarded, and no errors in logical design have been detected. It is virtually certain that Array A (151 gates) is free from error, so that a computer run can begin whenever sufficient material has been probe mapped. It is expected that the machine will have been 100% breadboard tested by the time it is necessary to freeze the other array designs. In addition, Simtran simulation will be accomplished.

3. ARRAY SLICE MOUNTING

Preliminary testing of a method of ultrasonically bonding array slices to etched circuit board metallization has yielded encouraging results.

(CX-218).

169. A TI memorandum dated May 1, 1966 and on the subject "Cal Tech Monthly Report" stated in part:

CAL TECH PROJECT - J. Merryman - 1484

1. NAND Gate Diffusions

Run 7, of ten slices, was received, eight having satisfactory yield. Run 8 has yielded only two useful slices so far. Some rework is indicated because of bad metalization. Slice assignments for Arrays C and D have been made. Array C, 135 gates required, has been assigned to 16 slices. Array D, 116 gates required, has been assigned to 13 slices.

2. Logic Design

Slight redesign and gate exchange was performed on Arrays B and D, which saved three gates, and effected a considerable reduction in interconnect wiring. Logic design is now complete, and drafting has commenced on the final schematic diagrams.

3. Discretionary Wiring

Last month's claim of success for the computer routing program was premature. The program which successfully routed Array A failed on Array C. When several attempts to debug the program failed to yield satisfactory results, this program was abandoned in favor of a newer routing program that had just been completed. The new program has required practically the entire month for debugging, but it now appears, at month's end, that a successful routing of Array C has been accomplished. The new program is faster and more convenient to use.

4. Array Multilevel Processing

About eight slices for Array A are now at various stages of multilevel processing with careful inspection after each process step. Results are similar to MINT experience, in that a finite number of shorts, opens, and leakages are detected after each step. Projections indicate about 5 to 10 bonds will be required to repair the perhaps 2 out of 10 slices that are suitable.

(CX-206).

170. A TI memorandum dated June 1, 1966 and on the subject "Cal Tech Monthly Report" stated in part:

CAL TECH PROJECT - J. Merryman - 1484

1. NAND Gate Diffusions

Runs 9, 10, and 11, totaling 32 slices were probed, and only 12 slices were found usable. The major problems were bad contracts, metal "blobs", and mask misalignment. The misalignment problem is apparently due to faulty photomask copies ordered lately. Some of the masters had to be remade because wear, and small stepping-errors occurred in some of them.... Run 12 should be ready for probe about June 3.

2. <u>Array Multilevel Processing</u>

All 14 slices of the Array "A" material have been processed through second level metal, and five of these have completed third level metal. Of the five, three slices are potential successful units (2 to 6 bonds required for repair), one slice is dead, and one undetermined. Of the slices remaining at the second level step, two are possible candidates for additional processing; all others are dead. Processing difficulties appear about equally divided between metalization problems, and cracking of the insulation layers.

Array C material will be processed next; masks are in preparation.

(CX-206).

171. A TI memorandum dated February 1, 1967 and on the subject "Cal Tech Monthly Report" stated in part:

CAL TECH MONTHLY REPORT FOR OCTOBER, 1966 J. Merryman - 1484

Array Testing

All of the A and C material has been functionally tested, and the B material started. At month's end, the inventory of correctly functioning arrays is as follows: A, 3 slices; C, 8 slices; B, 3 slices ...

(CX-218).

172. A TI memorandum dated February 1, 1967 and on the subject "Cal Tech Monthly Report" stated in part:

CAL TECH MONTHLY REPORT FOR NOVEMBER & DECEMBER, 1966 J. Merryman - 1484

Array Processing and Testing

...[T]he remaining B material was processed and tested, yielding seven good arrays. D processing was started after remaking some defective masks, and at years' end, one D slice has reached the completion stage, but is not yet fully tested. Known good arrays: A-3, B-7, C-8 and D-0.

Array Packaging

Tune-up and practice has continued on the ultrasonic bonding technique, and package fabrication. Difficulty due to brittleness of the metal has apparently been eliminated by vacuum-annealing the copper sheet before use. The adhesive process continues to be critical, but satisfactory packages are being made on a yield basis. The first attempt to mount working arrays will be made in early January.

Shift Registers

Some old shift register chips were sorted, mounted, and tested, yielding seven additional 24 bit units.

Printer and Tape Drive

In November, the first two thermal printers complete with drivers were received. This is the type printer that is required for the battery-operated prototype. No attempt will be made to fabricate additional units of this (Silicon Carbide Process) type; future efforts will be concentrated on Ed Ruggiero's new processes.

(CX-218).

173. A TI memorandum dated February 1, 1967 and in the subject "Cal Tech Monthly Report" stated in part:

CAL TECH MONTHLY REPORT FOR JANUARY, 1967 J. Merryman - 2484

Array Fabrication

Testing of the D arrays was begun this month, and progress was fairly rapid; the quality of the AZ and metal films in this array is noticably higher than that observed at the beginning of the program.

Also started was the mounting and encapsulation of the finished slices. Results were fairly encouraging, with the following score at month's end: Array D, 4 attempts, 4 successess; Array B, 4 attempts, 3 successes; Array C, 2 attempts, no success; Array A no attempts yet. The D and B material was most successful because of the relatively good quality metal on the slices. All the C material has peeling metal, and a slightly different package will be used for these slices. (CX-218).

(CX-218).

174. In a memorandum dated February 20, 1967 to inventor Mr. Merryman from inventor Van Tassel, regarding Van Tassel's contribution to the Cal-Tech project that led to the patent in suit, Van Tassel stated under the subheading "Package".

> The base material is glass based epoxy, G-10. In the current applications 1/32 inch material was used. It can be purchased as sheets with one face sanded. Because of the limited application for this material we etched off the copper from standard 1/32 single sided board purchased from Westinghouse Micarta thru Altair Co. of Richardson. For good bonding it is necessary that the surface of the material be rough as with the sanded material.
>
> The most satisfactory copper material used has been 2 oz. rolled material. It is cleaned in Bright Dip prior to use. Satisfactory packages have been made with 1 oz. copper and 1 mil Kovar. The 1 oz. copper tended to crack from grain boundry stresses during ultrasonic bonding. This was eliminated by vacuum annealing the material.
>
> One of the real problems in this project was in finding an adhesive that would provide adequate bond strength, stand up through all the plating operations and present a decent appearance. The most satisfactory solution has been to use a low flow B-stage prepreg. which is similar to those used in conventional multilayer boards. It is necessasry to use the minimum of fill on the B-stage to prevent extrusion of epoxy during pressing. If this happens, the copper cannot be etched or plated for bonding. Two satisfactory materials are Westinghouse Micarta 2H017 Binder sheet o.0025" thick and New England Laminate NELCO 3260 with 113 glass-low flow. [CX-205].

175. U.S. Patent No. 3,484, 534 incorporated by reference into the '921 patent and which is directed to a multilevel electrical device states:

> The process of the present invention can best be understood in connectin with FIGURES 1, 2, and 3. The starting material is a dielectric sheet 10 having surfaces 12 and 14. The dielectric sheet 10 may be formed from substantially any material commonly used for printed circuits, such as epoxy impregnated fiber glass fabric, phemolic printed circuit board, etc. or, of desired, may be a metal sheet with an insulated costing thereon. A cavity is formed in the surface 12 of the dielectric sheet 10 for receiving an integrated circuit device which will presently be described. The cavity is preferably formed by an opening 16 which extends completely through the sheet 10 and which may be formed by punching or any other suitable process.

Next, a continuous conductive sheet 18 is bonded to the surface 12 and extends over the opening 16. The conductive sheet 18 may be any suitable metal, such as copper, and may be bonded to the dielectric sheet 10 using any conventional process such as, for example, the process as used to fabricate printed circuit board stock. (CX-56, col. 4 ls. 1-20).

176. Inventor Merryman testified:

Q Now, in the 505 ['921] patent in suit is this problem [real problem referred to in Van Tassel Feb. 20, 1967 memo (CX-205)] or its solution disclosed in any way?

A Well, I believe it says that conventional printed circuitboard techniques can be used, and it is my understanding that these problems described here are still present day problems of conventional printed circuitboard manufacture.

Q Mr. Merryman, in your patent is it disclosed anywhere that it is necessary to use the minimum of fill on the B stage to prevent extrusion of epoxy during pressing, because if this happens, the copper cannot be etched or plated for bonding?

A It is disclosed that conventional integrated circuit techniques are used, which implies that.

Q Implies what?

A Implies that you must control the amount of B stage that you use. I believe that is still a modern problem. It would be known to those who build circuit boards. It would not be considered an unusual statement or an unusual problem. (Merryman, Tr. p. 1223, ls. 2-21).

176(a). A TI memorandum dated February 28, 1967 and on the subject "Cal Tech Monthly Report" stated:

CAL TECH PROJECT - J. Merryman - 2484

A modified array package design allowed mounting of some of the C arrays which had very poor metal. This resulted in a complete set of mounted arrays, and the first complete electronic assembly board having four arrays was finished on the 13th. The date for a completely finished prototype is estimated as the first week in March. The interim time being consumed in final mechanical details of the case, keys, and paper drive.

The possibility exists of completing the electronics for two more machines within a few weeks. Delivery of these machines will be considerably slowed by the availibility of mechanical parts, however.

A new set of Silver-Zinc batteries was received.

(CX-218).

177. A TI memorandum dated April 1, 1967 and on the subject "Cal Tech Monthly Report - March 1967" stated:

> <u>CAL TECH PROJECT - J. Merryman - 2484</u>
>
> The first working prototype was completed early in the month. The unit proved adequately operable from the Silver-zinc batteries, although one additional cell had to be added because of off-tolerance resistors in the presently available print-heads. These batteries will be replaced eventually with Nikel-Cadinum cells.
>
> Due to a logic design error only very recently detected, this first prototype failed to place the decimal point correctly on certain problems. The second complete set of electronics does not have this error, and the sets have now been interchanged (only one case and set of mechanial parts is presently available) so that a working model is now on hand that is perfect in every respect. Mechanization activity has been stepped up so as to rather quickly provide cases and mechanical parts for the several machines that will eventually exist.

(CX-218).

178. Parts of two other Cal-Tech prototypes were completed and were assembled in March 1967. One of the prototypes was delivered to Ti's then President Patrick Haggerty. That unit is now in the possession of the Smithsonian Institution. A second prototype is now in inventor Kilby's possession. The third prototype has been retained by the TI Patent Department. The Cal-Tech prototype operated four hours between charging. (Kilby, CX-1, p. 7; Merryman, CX-2, p. 2).

179. Each of the three Cal-Tech prototypes was made according to the FIG. 14 preferred embodiment of the '921 patent. One of the prototypes was in the hearing room. The inside of the prototype resembled FIG. 14 of the '921 patent. All of the integrated semiconductor circuitry is contained on the board inside the prototype. There are seven semiconductor substrates or seven

wafers on the board. Four are slices, three are not. The term "wafer" is not a precise term. A semiconductor substrate of almost any size up to, including the full size of the silicon, as it is cut from a boule, may be a slice. (Kilby, Tr. p. 176, l. 21, p. 177, l. 5; CPX-202).

180. The shift registers (three substrates or wafers) appear along one boarder or along the lower edge of the board on the open lid of the Cal-Tech prototype that was in the hearing room. These shift registers correspond to SR-1, SR-2 and SR-3 of FIG. 14 of the '921 patent. The substrates, that these shift registers are on, are smaller than a fingernail. (Kilby, Tr. p. 180, l. 21, p. 181, l. 20; CPX-202).

181. The larger four substrates on slices inside the working Cal-Tech prototype in the hearing room corresponded to the quadrants of FIGS. 15, 16, 17 and 18 of the FIG. 14 preferred embodiment of the '921 patent. (Kilby, Tr. 183, pp. 1-13; CPX-202).

182. In the working Cal-Tech prototype in the hearing room the biggest slice or quadrant was a little over an inch in diameter, perhaps an inch in length. (Kilby, Tr. p. 189, pp. 5-14; CPX-202).

183. The working Cal-Tech prototype in the hearing room used a rechargeable battery. (Kilby, Tr. p. 214., ls. 22-25).

184. The Cal-Tech prototype in the hearing room was built using a discretionary wiring technique. The '921 patent teaches making the integrated semiconductor circuit array only by the discretionary technique. (Kilby, Tr. p. 218, ls. 8-23).

185. The Cal-Tech prototype in the hearing room used discretionary elements in the four large quadrants each of which had mixtures of interconnected elements of several different kinds of gates and flipflops diffused into the same wafer. There were some redundant elements present.

The shift registers did not involve the discretionary technique. (Kilby, Tr. p. 19,, ls. 6-24; Tr. p. 440, ls. 20-24).

186. The four large wafers in each of the three Cal-Tech working prototypes, one of which was in the hearing room, had a different selection of gates in the mix available from wafer to wafer. They had some bad non-functional gates. (Kilby, Tr. p. 383, ls. 16-21; Tr. p. 384, ls. 7-13.

187. The three '921 Cal-Type prototypes, one of which was in the hearing room, used bypolar technology. (Kilby, Tr. p. 441, ls. 11-17).

188. The '921 Cal-Tech prototype in the hearing room was approximately 6 inches in length and 4 inches in width. Its average height was approximately 1 3/4 inches. It has 18 keys in four rows. Looking from left to right and from top to bottom the first row had keys designated "C 7 8 9 +", the second row keys designated "e 4 5 6 -", the third row keys designated "P 1 2 3 X" and the fourth row keep designated ". 0 ". The calculators could be held in one hand and weighed approximately two pounds thirteen one-half ounces. (CPX-202).

189. In October 1969 TI and Canon Inc. entered into a license and technical assistance agreement involving binary-coded electronic calculators, the parts of which are adapted electrically and mechanically in relation to each other so as to result in miniature portable calcultors of small dimensions having a volume of less than 100 cubic inches and a weight of less than 80 ounces. Under the license TI granted to Cannon a world-wide nonexclusive license under TI patents to make, use, sell or otherwise dispose of miniature protable binary-coded electronic calculators. The agreement was not limited to rights only in the '921 patent. Moreover TI granted Canon nonexclusive licenses and rights to use trade and industrial secrets and other technical information of TI with respect to said calculators. (CX-305).

190. A first Canon Pocketronic calculator was announced in June 1970. Canon sold several hundred thousand of these units and other manufactures such as Sharp also entered the market. (Kilby, CX-1, p. 7; CPX-224).

191. Engineers at TI took advantage of two important TI semiconductor innovations in the design of the Pocketronic electronic calculator, developed jointly by TI and Canon Inc. The portable calculator was said to be the first to thave all-electronic printout, and to have all its calculations performed by three MOS/LSI arrays. The two "new" TI concepts, incorporated in the design of the calculator, were said to be monolithic electrothermal, printing and programmable logic arrays (PLA). (RX-537, p. 1).

192. A noticeable feature of the Pocktronic calculator was that it did not have a readout display. Instead it had a strip printer that worked electronically. The heart of the electronic printer was a semiconductor thermal printhead developed by TI and described in a TI U.S. patent which issued in Febrary 1970. (RX-537, p. 1).

193. Circuitry in the Pocketronic calculator was partitioned into three blocks, each of which occupied a single MOS/LSI chip. One chip provided timing and character generation for the printer, the second chip included key encoders, registers and an accumulator, while the third chip provided various control circuits. For the control-logic chip, TI used the new PLA technology which allowed logic functions to be defined on the chip merely by programming the connection on a single mask -- the final oxide-removal mask. With this approach, selected MOS devices on the substrate had their gate oxide etched to a thin layer then, when metal is deposited over the oxide, the metal simultaneously acted as a gate electrode and provided the necessary interconnections. (RX-537, pp. 2-3).

194. While the Pocketronic calculator used MOS logic circuitry, the Cal-Tech calculator of the '921 patent used bipolar logic circuitry. (Kilby, Tr. p. 379, ls. 8-13).

195. The Cal-Tech calculator had four wafers of logic and three shift registers. The Pocketronic had its primary logic in three chips. (Kilby, Tr. p. 379, l. 14 , p. 380, l. 7).

196. While one of the chips in the Pocketronic was a programmable logic array, the Cal-Tech calculator had no such programmable logic array. (Kilby, Tr. p. 381, ls. 3-11).

197. In the Pocketronic calculator, the programmable logic array used a single mask to define the logic functions; the Cal-Tech calculator did not use a single mask. (Kilby, Tr. p. 381, ls. 12-22).

198. Each one of the three chips in the Pocketronic calculator was a duplicate of each other. The four wafers in the Cal-Tech calculators were not identical to each other. (Kilby, Tr. p. 382, l. 14, p. 387, l. 2).

199. No discretionary wiring was used in the Pocketronic calculator. (Kilby, Tr. 387, ls. 18-20).

200. Inventor Kilby testified that the Pocketronic calculator was a commercial implementation of the Cal-Tech technology and that decision was made by TI, with Kilby's concurrened in 1969; that the decision was reached to make the Pocketronic calculator with MOS technology. When Kilby was asked whether he felt it was the best way of doing it, he answered "Probably yes." (Kilby, Tr. p. 396, o. 18 , p. 3397, l. 8).

201. A lawsuit was file by TI against Casio Computer Co. Ltd. (Casio), a Japanese corporation on February 19, 1981 alleging infringement of the '921 patent. On July 9, 1981, Casio sought a declaratory judgement that certain TI patents were invalid. The law suits were settled and Casio took a

patent license which admitted to validity of certain Ti patents including the '921 patent. The settlement agreement and license were not restricted to the '921 patent. They included other TI U.S. and foreign patents. (CX-309; CX-310; Donaldson, Tr. p. 1169, ls. 22-25).

202. Order Nos. 57 and 58 issued December 31, 1984 terminated this investigation as to respondents FLX and RJP on the basis of settlement agreements. These agreements were not restricted to the '921 patent but included other patents (foreign and U.S.). (CX-315, CX-316).

203. A license agreement between Hewlett-Packard and TI involved the '921 patent. However it also involved a number of other TI patents (foreign and U.S.) and a number of Hewlett-Packard patents. TI agreed to pay Hewlett-Packard $976,000. (CX-306).

204. A 1977 license agreement between National Semiconductor Corporation and Ti involved the '921 patent. The agreement involved a number of other TI foreign and U.S. patents and a number of National Semiconductor Corporation patents. (CX-307).

205. A 1979 license agreement between Sanyo Electric Co. Ltd. (Sanyo), a Japanese corporations, and TI involved the '921 patent. The agreement involved a number of other TI foreign and U.S. patents and also patents of Sanyo. Monetary payments were made by both Sanyo and TI. 9CX-308).

206. A 1983 license agreement between Cal-Comp Electronics Inc., a Taiwanese company and TI involved the '921 patent. The agreement involved a number of other TI foreign and U.S. patents. (CX-601).

207. A 1984 license agreement between Inventa Electronics Co. Ltd., a Taiwanese company, and TI involved the '921 patent. The agreement involved a number of other TI foreign and U.S. patents. (CX-602).

208. License agreements have been reached between TI and each of Sharp Corporation (a Japanese Corporation) (CX-365), and Matshushita Electric Industrial Co. ltd. (a Japanese Corporation). (CX-366). While these agreements involve the '921 patent, they also involve other TI foreign and U.S. patents and patents of the two Japanese corporations. When TI has received money from a contrasting party, the contracting parts has never designated in writing that the money with respect to the '921 patent, the foreign counterpart or some other calculator patent that was the subject of the license. (Donaldson, Tr. p. 1090, ls. 11-18).

209. There is no written allocation of monies as to a particular patent in any Ti license or contrast, when the '921 patent is the subject of a license with other patents, although some of the licenses call for summary royalty payments. (Donaldson, TR. p. 1092, ls. 17-21; p. 1094; ls. 1-7).

210. TI has approximately 150 patents, exclusive of the '921 patent, related to and covering various aspects of portable calculators. (Heye, CX-5, p. 33; CX-321).

211. In every TI license or contract where the '921 patent is the subject of a license or release, there are additional TI patents that are also the subject of a license or release. (Donaldson, Tr. p. 1086, ls. 2-7).

212. None of the TI license or contracts that involve the '921 patent call for or recite payments specifically under the '921 patent. (Donaldson, Tr. p. 1086, ls. 8-12).

213. Every TI contract or license which involves the '91 patent also involves foreign counterparts of the '921 patent. (Donaldsn, Tr. p. 1090 ls. 1-5).

214. A publication is Southwest Business January 1976 offered by TI read in part:

> The world's first miniature electronic calculator, the forerunner of more than 100 million now in use, has been accepted by the Smithsonian Institution for its permanent collection in the nation's capital....Measuring about 4 x 6 inches, and less than 2 inches thick, the working prototype minicalculator had a high degree of computational power found only at the time in much larger machines. It was a milestone in the development of the calculator industry.
>
> Also presented to the museum was a collection of integrated circuits, the working "heart" of electronics calculators performing all mathematical and memory functions. Included in the collection was the first "calculator-on a-chip". It packed the equivalent of more than 6000 transistors on a tiny piece of silicon about one quarter-inch square. The complex chip, introduced by Texas Instruments in 1971, made it possible to produce electronic calculators at prices more generally affordable and sparked an explosive market growth. It heralded the age of the low-cost consumer hand-held calculator.
>
> An even more complex integrated circuit in the collection is the world's first general purpose "computer on a chip," introducted by TI in 1974. The mini-computer contains both logic and memory funtions -- the equivalent of 8000 transistors in a chip two-tenths of an inch square. Ten years ago 500 integrated circuits would have been required to equal its data processing capability.
>
> The technological breakthrough that made the miniature electronic calculator possible - as well as many other modern electronic developments -- was the invention of the integrated circuit by Jack Kilby at Texas Instruments in 1958....(CX-146).

214(a). When the Cal-Tech project began at least one electronic calculator was on the market. It was the "Anita", made in Great Britain. Mr. Kilby purchased one for examination, and found that it was designed using a unique type of logic with neon tube elements arranged as decade counters. No integrated circuits were used. The display was a set of "Nixie" tubes. Physically it was quite large, probably about 20 inches wide, 12 inches high and about 16 inches deep. The weight was probably of the order of 25 pounds. (Kilby, CX-1, p. 3).

215. Some time after the Cal-Tech project began, Frieden announced its first electronic calculator. The Frieden display was a cathode ray tube, making the unit physically somewhat larger and heavier than the "Anita". Several thousand discrete transistors provided the logic. No integrated circuits were used. Both the Frieden and the "Anita" sold for $2,000 or more in the United States at that time. Both were considered desk machines, and both took more space on a desk than would have been desirable even for the desk mode of operation. (Kilby, CX-1, p. 3).

VII. PROSECUTION OF THE '921 PATENT

Patent Application Ser. No. 671,777

216. The initial patent application (Serial No. 671,777) for the '921 patent was filed on September 29, 1967 with thirty-six claims. Illustrative original claims 1-9, 11, 12, 13, 14, 15, 16, 30 and 35 read:

> 1. An electronic calculator comprising: means for entering digits of numbers and commands into said calculator and generating unique signals corresponding to said digits and said commands, electronic means responsive to said unique signals for performing arithmetic calculations the numbers entered into the calculator and for generating control signals, said electronic means comprising an integrated semicoductor circuit array located in substantially one plane, said integrated semiconductor circuit array comprising memory means for storing the digits of the numbers entered into the calculator and means coupled to said memory means for arithmetically combining said digits and storing the resulting answers and means coupled to said integrated semiconductor circuit array and responsive to said control signals for displaying said answers.
>
> 2. An electronic calculator according to Claim 1, wherein said memory means comprises an integrated semiconductor shift register.
>
> 3. An electronic calculator according to Claim 1, wherein said memory means comprises a plurality of interconnected integrated semiconductor shift registers forming an operand register and an accumulator register.

4. An electronic calculator according to Claim 3, wherein said means for arithmetically combining said digits and storing the resulting answers comprises a serial adder coupled to said operand and accumulator registers and gating means coupled between said serial adder and said accumulator register for storing the resulting answers in said, accumulator register.

5. An electronic calculator according to Claim 1, wherein said integrated semiconductor circuit array comprises clocking means responsive to said unique signals for generating said control signals.

6. An electronic calculator according to Claim 5, wherein said clocking means comprises a clock flip flop and a counter coupled thereto.

7. An electronic calculator according to Claim 1, wherein said means for arithmetically combining said digits comprises means for adding, subtracting, multiplying and dividing said numbers.

8. An electronic calculator according to Claim 1, wherein said integrated semiconductor circuit array comprises decoding means responsive to the stored answers for generating electrical signals indicative of the shape in which the stored answers are to be displayed, the display means being coupled to said decoding means.

9. An electronic calculator according to Claim 1, wherein said display means comprises a temperature sensitive tape and a thermal printer thermally coupled with said tape.

11. An electronic calculator according to Claim 1, wherein said means for entering digits of numbers and commands into said calculator and generating unique signals corresponding to said digits and said commands comprises encoding means located in substantially one plane including an insulating substrate and groups of conductors disposed upon one surface of said insulating substrate and movable conductive means for respectively, selectively, electrically short-circuiting the conductor within said groups of conductors for generating said unique signals.

12. An electronic calculator according to Claim 11, wherein said encoding means is mounted parallel to said integrated semiconductor circuit array.

13. An electronic calculator according to Claim 12, wherein said means for displaying said answers comprises a temperature sensitive tape and an integrated semiconductor heater element array thermally coupled with said tape.

14. An electronic calculator according to Claim 9, comprising tape advance means responsive to said control signals for advancing said tape a predetermined distance after a character is printed on said tape.

15. An electronic calculator according to Claim 1, wherein said integrated semiconductor substrate having a large plurality of similar functional units adjacent one surface thereof interconnected by multilevels of insulators and conductors on said one surface.

16. An electronic calculator according to Claim 15, wherein said integrated semiconductor circuit array comprises an insulating substrate having printed conductors thereon, a plurality of said semiconductor substrate mounted on one surface of said insulating substrate conductive leads overlying said semiconductor substrates interconnecting functional units of one semiconductor substrate with functional units of another semiconductor substrate and conductive leads interconnecting functional units and said printed conductors on said insulating substrate.

30. A miniature electronic calculator comprising: means for entering digits of numbers and authnetic commands into said calculator and generating unique signals corresponding to said digits and said commands, electronic means responsive to said unique signals for performing arithmetic calculations on the numbers entered into the calculator and for generating control signals said electronic means substantially comprising an integrated semiconductor circuit array located in substantially one plane, said integrated semiconductor circuit array comprising memory means for ring the digits of the numbers entered into the calculator and means coupled to said memory means for adding, subtracting, multiplying and dividing said numbers and storing the resulting answers, and means coupled to said integrated semiconductor circuit array and responsive to said control signals for recording said answer.

35. A miniature electronic calculator comprising means for entering digits of numbers and arithmetic command into said calculator and generating unique signals corresponding to said digits and said commands, electronic means responsive to said unique signals for performing arithmetic calculations in the members entered into the calculating means generating control signals, said electronic means comprising an integrated semiconductor circuit array located in substantialy one plane, said integrated semiconductor circuit array comprising a semiconductor substrate having a large plurality of similar functional units adjacent one surface thereof interconnected by multilevels of insulators and conductors overlying said one surface, said interconnected functional units comprising a clocking means for generating timing signals in response to said unique signals and means responsive to said timing signals for generating said control signals and means coupled to said integrated semiconductors circuit array and responding to said control signals for recording the answers of said arithmetic calculations. [CX-48, pp. 68-80].

217. In a Patent Office action dated December 10, 1969, the Examiner rejected claims 1-8, 15, 16, 30, 35 and 36 as clearly anticipated by Bohm U.S. Pat. No. 3,315,069 under 35 U.S.C. 102. Bohm was said to disclose an input means, means for performing calculations and for generating control signals, and means for displaying the answers to the calculations. In addition Bohm was said to show a clock control means composed of a pulse generator and a counter. No patentable significance was given to the fact that the claimed

invention utilized integrated circuits. It was said that the miniaturization of a conventional circuit using integrated circuit techniques is a routine operation which would be obvious to one of average skill in the art; that the miniaturized circuit performs electrically identically with it nonminiaturized counterpart and is therefor not patentably distinct. (CX-48, pp. 87-88).

218. In the Patent Office action dated December 10, 1969 claims 9, 10, 17-20, and 31 were rejected as unpatentable over Bohm in view of Sakurai et al U.S. Pat. No. 3,354,817 under 35 U.S.C. 103. It was said that Bohm discloses the same calculator as claimed with the exception that the applicants recite a thermal printing device used to display and record the output. Sakuurai et al was said to disclose a thermal printer of the type claimed. The Examiner considered it obvious to substitute the printer of the Sakurai et al reference for the printer shown in the Bohm reference to produce the applicants' claimed invention. (CX-48, p. 87).

219. The Examiner rejected claims 11, 12, 21-25, 32 and 33 in the Office action of December 10, 1969 as unpatentable over Bohm in view of Chow et al U.S. Pat. No. 3,430,226 under 35 U.S.C. 103. Bohm was said to disclose the basic system as claimed with the exception that the Bohm reference shows a keyboard but does not disclose the keyboard in detail. The keyboard shown in the Chow et al reference was said to be of the type recited in the claims. It was considered obvious to combine the input means disclosed by Chow et al with the calculator disclosed by Bohm to produce the applicants' claimed invention. (CX-48, p. 87).

220. In the Patent Office action dated December 10, 1969, claims 13, 26-29, and 34 were rejected as unpatentable over Bohm in view of Chow et al and Sakurai et al. The Examiner considered it obvious to one of average skill in the art to combine the calculator of the Bohm reference with the input

means of the Chow et al reference and the thermal printer of the Sakurai et al reference to produce applicants' claimed invention. He further rejected claim 14 as unpatentable over Bohm in view of Sakurai et al and Fitch U.S. Pat. No. 3, 140, 031. Bohm was said to disclose the basic calculator but without showing the specific design of the "PRINTER 22" of Figure 1. The Sakurai et al reference was said to disclose a thermal matrix printer and the Fitch reference to show an apparatus for incrementally advancing a printing tape after each character is printed. The Examiner considered it obvious to one of average skill in the art to use the Sakurai et al printer to record the output of the Bohm calculator and to use the tape advance system of Fitch to control the pressure of the printing tape over the thermal matrix printer of Sakurai et al. The Examiner cited, as of interest, a Kinzie et al U.S Pat. No. 3,331,954 which was said to disclose a serial arithmetic unit. No claims were rejected on Kinzie. (CX-48, pp. 87-88).

221. In an amendment dated June 8, 1970, it was argued that applicants' invention relates to a miniature binary coded decimal electronic calculator capable of adding, subtracting, multiplying and dividing. The decimal units were said to be serially printed out one at a time at a speed compatible with the calculator operations. The parts of the calculator were said to be so adapted electronically and mechanically in relation to each other to result in a miniature portable calculator of extremely small dimensions. For example, it was said that the calculator of the invention may be manufactured with outside case dimensions of approximately 4 1/2 x 4 1/8 x 1 3/4 inches. Within this small size, it was said it has a comparable small weight of approximately 45 ounces. It was argued that a significant aspect of the calculator is that the primary electronics are embodied in an integrated semiconductor circuit array located in a first substantially planar unit; that

the integrated semiconductor circuit array provides all of the arithmetic functions and generates control signals for producing a readable decimal output. It was said that also located in substantially a single plane parallel to the plane of the integrated circuit array is a keyboard encoder structure providing the data input to the calculator. A semiconductor thermal printer was said to provide for the data output which printer is compatible with the speed of operation of the calculator and the voltage supply thereof. (CX-48, p. 96).

222. In the amendment dated June 8, 1970, referring to the rejection of claims 1-8, 15, 16, 30, 35 and 36 as anticipated by Bohm under 35 U.S.C. 102, it was argued that this rejection fails to give consideration to the specific recitation of the claims which provides "an integrated semiconductor circuit array located in substantially one plane"; that there is no suggestion in Bohm of such a structure nor is there any suggestion in Bohm of the use of integrated circuits at all; that while one might agree with the present state of the art in integrated circuits that it is desirable to use integrated circuits to save power in the operation of computers or calculators, there is no suggestion in Bohm of a miniature electronic calculator of applicants' concept. (CX-48, p. 96).

223. In the amendment dated June 8, 1970, referring to the rejection of claims 9, 10, 17-20 and 31 as unpatentable over Bohm in view of Sakurai et al under 35 U.S.C. 103, in addition to the asserted deficiencies outlined with respect to the rejection of claims 1-8, 15, 16, 30, 35 and 36, it was argued that the Sakurai et al thermal printer is directed to printing apparatus "capable of printing out information from computers at a relatively high rate of speed"; that thus, it is clear that the suggestion of Sakurai et al relates entirely to a printer unit as a part of a computer peripheral equipment; that

there is no suggestion in Sakurai et al of the incorporation of a thermal printer in a patentable miniature calculator as specified in applicants' claims. (CX-48, p. 96).

224. In the admendment dated June 8, 1970, referring to the rejection of claims 11, 12, 21-25, 32 and 33 as unpatentable over Bohm in view of show et al under 35 U.S.C. 103, it was pointed out that Bohm does not "disclose the basic system"; that in addition, it is to be specifically noted that these claims call for the keyboard to "selectively, electrically short circuit the conductors"; that insofar as can be determined from the Chow et al disclosure, the keyboard therein suggests closing a circuit to provide the encoding of the information. (CX-48, p. 96).

225. In the amendment dated June 8, 1970 it was further argued that applicants' invention provides a novel co-action of parts which provides for a new and novel sub-miniature calculator; that this miniature calculator has a calculating capability which was previously obtainable only in units with much larger dimensions and weight. (CX-48, last page of amendment).

226. In an Office action dated October 22, 1970, the Examiner rejected claims 1-8, 15, 16, 30, 35, and 36 as unpatentable over Bohm under 35 U.S.C. 103. It was again said that, Bohm discloses an input means, means for performing calculations and for generating control signals, and means for displaying the results of the calculations; that in addition Bohm shows a clock control means composed of a pulse generator and a counter; that as stated in the office action mailed December 10, 1969, no patentable significance is given to the fact that the claimed invention utilizes integrated circuits; that miniaturization of a conventional circuit using integrated circuit techniques is a routine operation which would be obvious to

one of ordinary skill in the art to which the invention pertains; that miniaturized circuit performs identically electrically with its non-miniaturized counterpart and is therefor not patentably distinct. Referring to applicants' argument that the claims distinguish over the art in that they call for an arithmetic unit "located in substantially one plane," it was said that this argument is not persuasive; that the location of components and their arrangement in the calculator case is considered to be merely a routine design choice. (CX-48).

227. In the Office action dated October 22, 1970, the Examiner again rejected claims 9, 10, 17-20 and 31 as unpatentable over Bohm in view of Sakurai et al under 35 U.S.C. 103. As in the December 10, 1969 rejection, it was said that Bohm discloses the same calculator as claimed with the exception that applicants recite a thermal printing device used to display and record the output; that Sakurai et al disclose a thermal printer of the type claimed. It was pointed out that the Bohm reference is, in effect, a teaching reference in that it shows the connections of the general elements of the system; that it is obvious that the Sakurai et al printer could be substituted for the printer shown in the Bohm reference. (CX-48).

228. In the Office action dated October 22, 1970, the Examiner again rejected claims 11, 12, 21-25, 32, and 33 as unpatentable over Bohm in view of Chow et al under 35 U.S.C. 103. As stated in the December 10, 1969 rejection Bohm was said to disclose the basic system as claimed with the exception that the Bohm reference shows a keyboard but does not disclose the keyboard in detail. The keyboard shown in the Chow et al reference was said to be of the type recited in the claims. It was considered obvious to combine the input means disclosed by Chow et al with the calculator disclosed by Bohm to produce applicants' claimed invention. The substitution of one keyboard for another in a calculator was deemed to be an obvious step. (CX-48).

229. In the Office action dated October 22, 1970, the Examiner again rejected claims 13, 16-29, and 34 as unpatentable over Bohm in view of Chow et al and Sakurai et al. The Examiner repeated his December 10, 1969 rejection of those claims, viz. that it was considered obvious to one of average skill in the art to combine the calculator of the Bohm reference with the input means of the Chow reference and the thermal printer of the Sakurai et al reference to produce applicants' claimed invention. Claim 14 was again rejected as unpatentable over Bohm in view of Sakurai et al and Fitch. It was said that Bohm discloses the basic calculator but without showing the specific design of the "PRINTER 22" of Figure 1; that the Sakurai et al reference discloses a thermal matrix printer and the Fitch reference shows an apparatus for incrementally advancing a printing tape after each character is printed. It was considered obvious to one of average skill in the art to use the Sakurai et al printer to record the output of the Bohm calculator and to use the tape advance system of Fitch to control the passage of the printing tape over the thermal matrix printer of Sakurai et al. The Examiner cited as of interest Wang et al U.S.C. Pat. No. 3,509,329, which was said to disclose a calculator. No claims were rejected on Wang et al. (CX-48).

Patent Application Ser. No. 143,192

230. On May 13, 1971 applicants filed a "streamlined continuation" patent application Ser. No. 143,192 of Ser. No. 671,777. Thereafter Ser. No. 671,777 was abandoned. (CX-48, CX-49).

231. On February 16, 1972, the Examiner rejected claims 30-37, 41, 42, 53, 57 and 58, under 35 U.S.C. 103, on Bohm. He also rejected claims 1-4, 6-11, 15-19, 23-25, 28, 29, 38, 39, 43, 44 and 54, under 35 U.S.C. 103, on

Bohm and Sakurai et al. Claims 5, 12, 14, 20-22, 26, 27, 50-52 were rejected, under 35 U.S.C. 103, on Bohm, Sakurai et al and Stiefel et al U.S. Pat. No. 2,932,826. The Examiner rejected claim 40, under 35 U.S.C. 103, on Bohm, Sakuari et al and Fitch. Claims 45-49, 55 and 56 were rejected by the Examiner, under 35 U.S.C. 103, on Bohm and Stiefel et al. (CX-49, pp. 125-126).

232. In the rejection dated February 16, 1972, the Examiner stated that the claims were drawn to the combination of keyboard, an arithmetic unit including a memory, control circuitry and output circuitry; that this combination is shown to be old by the patent to Bohm which discloses broadly the same elements functionally interrelated in the same manner to produce substantially the same results; that this combination differs from that shown in Bohm in the specific construction of the keyboard and the printer; that therefore, the claims are rejected because it is believed that the improvement over the prior art is not in the combination which is old but in the specific keyboard and printer. Attention was called to the patents to Sakurai et al and to Stiefel et al which were said to indicate that thermal printers and keyboards have been recognized as being separate subjects of invention, cabable of independent use, and as having a distinct status of their own. Referring to claim 40, the Examiner considered it obvious to use the tape advance of Fitch and the printer of Sakurai et al in the device of Bohm. (CX-49, pp. 125-127).

233. In the Patent Office action dated February 16, 1972, the Examiner took the position that Bohm discloses the basic device claimed; that the limitations regarding integrated circuitry were not regarded as distinguishing over the prior art since it was well known that circuitry may be implemented in this manner. (CX-49, p. 125).

234. In the rejection dated February 16, 1972, cited, as of interest, were Kimura et al U.S. Patent No. 3,548,179, Kinzie et al U.S. Pat. No. 3,331, 954, Hernandez U.S. Pat. No. 3,553,445, Wang et al U.S. Pat. No. 3,509,329 and Chow et al U.S. Pat. No. 3,430,226. The first four of those patents were said to be directed to calculators; the last to a keyboard. The claims were not rejected on those five patents. (CX-49, pp. 126, 127).

235. In an amendment filed June 12, 1972, applicants replaced certain claims. Illustrative replaced claims 1, 8, 30 and 53 read:

1. (amended) An electronic calculator for printing and permanently recording selected information in a first coded format during a selected printing cycle, comprising in combination:
(a) keyboard input means for entering said selected information in said first coded format into said calculator [;], the keyboard input means including one set of decimal number keys for entering plural digit decimal numbers and a plurality of operand keys for entering functional commands;
(b) signal generating means coupled to said input means for generating control signals indicative of the entry of said selected information and for generating unique signals in a second coded format representing said selected information;
(c) memory means coupled to said signal generating means for storing said second coded signals;
(d) display means coupled to said memory means for displaying said second coded signals in said first coded format, said display means including:
(i) a printing medium for permanently recording said selected information in said first coded format,
(ii) an electronic printhead for printing said information in said first coded format on said printing medium, and
(iii) drive means for advancing said printing medium, a predetermined distance after each printing cycle; and
(e) control means coupled to said signal generating means; and to said electronic printhead and said drive means, said control means being responsive to said control signals for producing first delayed control signals tooperate said electronic printhead and then producing second delayed control signals to activate said drive means for advancing said printing medium.

8. (amended) An electronic calculator comprising:
(a) keyboard input means for entering digits of numbers and commands into said calculator [;] , the keyboard input mans including one set of decimal number keys for entering digits of decimal numbers in sequence and a plurality of operand keys for entering functional commands;

(b) signal generating means for generating unique signals representing each of said entered digits and commands;

(c) electronic means coupled to said signal generating means for storing and arithmetically combining said entered digits including:

(i) arithmetic means for serially arithmetically combining said entered digits in accordance with said command signals and for generating digits of a resulting answer.

(ii) [shift] register means including a plurality of separate registers coupled to said arithmetic means for serially storing said entered digits and serially storing digits of said resulting answer, the contents of the different registers being transferred to the arithmetic means depending upon the particular command signals, and

(iii) control means for generating a control signal indicative of the generation and storage of said resulting answer;

(d) display means coupled to said electronic means for displaying each digit of said resulting answer, said display means including:

(i) a printing medium for permanently recording the digits of said resulting answer,

(ii) an electronic printhead for printing the digits of said resulting answer on said printing medium, and

(iii) drive means for advancing said printing medium a predetermined distance after the printing of each digit of said resulting answer; and

(e) control means coupled to said signal generating means and to aid electronic printhead and said drive means, said control means being responsive to said control signals for producing first delayed control signals to operate said electronic printhead and then producing second delayed control signals to activate said drive means for advancing said printing medium.

30. (amended) [An] A miniature electronic calculator comprising:

(a) keyboard input means for entering digits of numbers and commands into said calculator and generating unique coded signals corresponding to said digits and said commands [;] , the keyboard input including only one set of ten decimal number keys for entering plural digits of decimal numbers in sequence, and including a plurality of command keys;

(b) electronic means coupled to said input means and being responsive to said unique signals for performing arithmetic calculations on the numbers entered into the calculator and for generating control signals, said electronic means comprising an integrated semiconductor circuit array located in substantially one plane;

(c) said integrated semiconductor circuit array comprising:

(i) memory means including a plurality of registers for storing the digits of the numbers entered into the calculator [,] and the coded commands, and

(ii) arithmetic means coupled to said memory means for arithmetically combining said digits and storing the resulting answer [;] , the numbers being transferred from registers in the memory means to the arithmetic means and back to the memory

means in a selectable manner depending upon the commands; and
(d) display means coupled to said integrated semiconductor circuit array and responsive to said control signals for displaying said resulting answer.

53. (amended) A miniature electronic calculator comprising:
(a) keyboard input means for entering digits of numbers and arithmetic commands into said calculator and generating unique signals corresponding to said digits and said commands [;] , the keyboard input means including only one set of decimal number keys for for entering plural digits of decimal numbers in sequence and a plurality of command keys;
(b) electronic means responsive to said unique signals for performing arithmetic calculators on the numbers entered into the calculator and for generating control signals, and electronic means substantially comprising an integrated semiconductor circuit array located in substantialy one plane, said integrated semiconductor circuit array comprising:
(i) memory means including a plurality of registers for storing the digits of the numbers and the commands entered into the calculator, [and]

(ii) arithmetic means coupled to said memory means for adding, subtracting multiplying and dividing said numbers and storing the resulting answer [;] , and

(iii) variable means for selectively transferring numbers serially from the registers through the arithmetic means and back to the registersin a manner dependent upon the commands to effect the desired arithmetic operation; and
(c) [recording] means for providing a visual display coupled to said integrated semiconductor circuit array and resposive to said control signals for indicating [recording] said answer. (CX-49, pp. 129-136).

236. In the amendment filed June 12, 1972 it was argued that Bohm shows a computer system wherein "...the basic feature... is to fixedly connect the four registers in accordance with the ... arithmetic instruction and to select one of the arithmetic functions...solely by the fact that the figures to be calculated arrive at the correct registers..."; that in contrast, applicants show the use of variable connections between the registers and the arithmetic unit, instead of fixed connections. It was stated that this is an advantage for small calculators; that applicants use only two registers instead of four as Bohm shows, yet the same functions are permitted; that even if four registers were used, variable programmed connections would permit a

much greater variety of functions than Bohm permits. Further, it was argued that Bohm does not describe keyboard encoding, nor that both numbers and commands are entered by the same keyboard, nor that encoded commands are entered into memory; that the latter could not be done with Bohm, because all four registers have specific assignments for numbers, not for commands; the manner of controlling the operation of the calculator is said to be not even disclosed in any detail in Bohm; that accordingly claims 30, 31-37, 41 and 42, as well as claims 53, 57 and 58 as amended are distinguishable over Bohm for reasons other than the limitations regarding integrated circuitry; that further, no reference has been cited regarding an array in one plane in a miniature calculator. (CX-49, pp. 139-140).

237. In the amendment filed June 12, 1972, it was further argued that Sakurai et al merely show a thermal printer; that the claims as amended, are distinguished from Bohm for reasons apart from the thermal printer, and hence the issue of whether or not the printer of Sakurai could be used with Bohm to meet the limitations of the claims need not be considered; that in any event, features such as the control means of claim 54, or bias storage means of claim 28, are not shown in Bohm or Sakurai et al. It was argued that Stiefel et al show a keyboard transmitter for sending decimal numbers and an add or subtract indication; that this keyboard uses a separate set of ten keys for each decade rather than being of the "ten-key" type as required by the amended claims; that, a unique code is not generated by each key; that instead, a given key in each decade will produce the same code as the same keys in other decades; that, the function keys do not produce a code but instead merely make electrical connections; that clearly, the keyboard transmitter of Stiefel et al could not be used in a miniature calculator as

applicants claim. It was also argued that the keyboard of Stiefel et al differs from the keyboard of the claimed invention, and further that the claimed details of the integrated circuits are not disclosed in the reference. (CX-49, pp. 140-141).

238. In the amendment filed June 12, 1972, responding to a rejection on February 16, 1972 that all the claims were unpatentable under 35 U.S.C. 112 for failing to particularly point out and distinctly claim what the applicant regards as his invention, it was argued that that rejection is believed to be improper because the claims are distinct from Bohm due to features other than the keyboard and printer, i.e., the way the registers are connected to the arithmetic unit and the way commands and numbers are encoded and entered, as well as the construction of the miniature calculator using an array of integrated functions in a common plane. (CX-49, p. 141).

239. A Patent Office notice dated September 7, 1972 stated changes and/or additions to the application Ser. No. 143,192 record made by the Examiner upon allowance. (CX-49, p. 142).

240. A notice of allowance of application Ser. No. 143,192 is dated September 21, 1972. (CX-49, p. 167).

241. A Patent Office notice dated April 5, 1973 showed that application Ser. No. 143,192 is abandoned because the base issue fee had not been received. (CX-49, p. 144).

Patent Application Ser. No. 317,493

242. On December 21, 1972, applicants filed continuation application Ser. No. 317,493. (CX-50).

243. In prelimanary comments dated June 25, 1973, in Ser. No. 317,493 claims 16-59 were said to be exact copies of allowed claims 16-59 in

Ser. No. 143,192, but with editorial changes in claim 16. Claim 12 of Ser. No. 317,493 was said to correspond to claim 8 of the Ser. No. 143,192, with the exception that limitations had been added regarding the semiconductor circuit array. It was said since claim 8 was previously allowed, claim 12 should be likewise found allowable with the additional limitations. Dependent claim 13 was said to correspond to claim 9, claim 14 to claim 10, and claim 15 to claim 12,, respectively, in Ser. No. 143,192 and that these claims should therefore be found allowable for the same reasons. Claims 1 and 6 were said to be new independent claims, these claims being drafted along the lines of previously allowed claim 53. Claims 2-5 were said to depend on claim 1, and claims 7-11 depend on claim 6. The new claims were said to have added limitations regarding the size of the semiconductor circuit array and claim 1 was said to recite that the calculator is "miniature, portable, battery operated", and that "the entire calculator including keyboard, electronic means, means for providing a visual display, and battery being contained within a 'pocket-sized' housing". In addition, it was said the new independent claims 1 and 6 contain changes regarding entry of coded signals and the registers. (CX-50).

244. In the preliminary comments, a "Claim Correspondence" chart noted that claims 1 and 6 were "Similar to 53" of Ser. No. 143,192. (CX-50, "Preliminary Comments" p. 3).

245. In the preliminary comments it was said that, to facilitate the Examiner's consideration, a prior art search had been made on the subject of Ser. No. 317,493 and that the art cited by the searcher was as follows:

Number	Inventor	Effective Filing Date
2,459,862	Avery	October 16, 1943
3,053,449	Hoberg et al	March 4, 1955
3,129,418	Tour	August 4, 1960
3,161,765	Hoberg et al	March 4, 1944
3,209,131	Harper	July 11, 1960

3,265,875	Richards	November 19, 1962
3,270,187	Fomenko	December 30, 1963
3,300,017	Yazejian et al	April 30, 1965
3,328,763	Rathbun et al	October 1, 1963
3,330,946	Scuitto	October 7, 1963
3,375,355	Asada et al	October 27, 1964
3,391,391	Simpson	September 25, 2965
3,402,285	Wang	September 22, 1964
3,405,392	Milne et al	April 30, 1965
3,447,136	Bogert et al	October 18, 1966
3,453,601	Bogert et al	October 18, 1966
3,474,238	Ragen et al	October 28, 1963
3,518,629	Frankel	February 6, 1964
3,523,282	Ragen	October 28, 1963
3,546,676	Ragen	October 29, 1963
3,634,666	Ragen	October 29, 1963
3,641,501	Lloyd	March 27, 1967
3,534,404	Hanson	
3,492,658	Klett	
3,467,946	Stephanik	
3,428,950	Chang	
3,428,793	Scuitto	
3,405,392	Milne	
3,380,031	Clayton	
3,375,498	Scuitto	
3,372,381	Raspanti	
3,364,473	Reitz	
3,330,946	Scuitto	
3,291,276	Milne	
3,273,122	Chandler	
3,270,318	Stawbridge	
3,267,429	Strohmeyer	
3,249,745	Burkhart	
3,159,740	Broel	
3,141,963	Zuhisdorf	
3,099,742	Bryne	
3,047,228	Bauer	
3,031,139	Spingies	
3,028,086	Sierra	
3,022,950	Dirks	
2,966,303	Isserstedt	
2,962,211	Ghertman	
2,661,899	Chromy	

Compared to the references cited in the file history of Ser. Nos. 671,777 and 143, 192, with the exception of Milne et al U.S. Pat. No. 3,405,392 and two Japanese publications, it was the opinion of applicants' attorney that none of the other items listed above was any more pertinent. (CX-50, "Preliminary Comments" pp. 3-5).

246. In the preliminary comments, the two Japanese publications were referred to as a periodical of Matsushita Electric Industril Co., Ltd., "National Technical Report", Vol. 12, No. 2, 1966, pp. 129-137, and a Japanese magazine "Electronics", Vol. 12, No. 1, 1967, pp. 55-58. The effective dates of these two items were said to be not known precisely, although it was said that applicants' counsel had been advised that the items "were received at the National Diet Library (Japan) on May 20, 1966 and December 26, 1966, respectively , which dates are the testifiab'e public days available in Japan." It was said that the second Japanese item seemed to be merely a condensed version of the first; that these items, are believed to be subsequent to applicants' date of conception or invention, but would be treated as references at this time as they can be distinguished. (CX-50, "Preliminary Comments" p. 5).

247. It was stated in the preliminary comments that claims 12-59 were previously allowed in the parent case. These claims were said to have been allowed after having been initially rejected in view of Bohm, Sakurai et al, Stiefel et al, and Fitch; that the features which distinguish the claimed invention from these references include the basic concept of implementing all of the primary electronics of the calculator system in a single integrated semiconductor array located in substantially one plane; that the cited references not only do not show or suggest this concept, but also do not show systems that could be implemented in this manner for reasons such as the use of magnetorestrictive delay line or magnetic core memories, etc. (CX-50, "Preliminary Comments", p. 6).

248. The preliminary comments stated that Milne et al U.S. Pat. No. 3,405,392 shows a desk type calculator which has a ten key input and printer for an output; that the face of the Milne calculator being about seven times as wide as the "ten key" keyboard group and five times as deep, and that at its thickest point the calculator was over three times as thick as the length of the keyboard; that in contrast, applicants' calculator is not much larger than the keyboard with the keyboard limiting the size of the applicants' device; that the keyboard must be of a certain size so that it is convenient to use by hand, It was said that applicants' entire calculator is about one "keyboard" wide, two long and one-half keyboard in thickness; that using keyboard size as a figure of merit or unit of size, the Milne et al calculator is roughly 7 x 5 x 3 or 105 units, while applicants is 1 x 2 x 1/2 or 1 unit; that the principal reason that the Milne et al calculator is roughly one hundred times as large (in "Keyboard units") as applicants' calculator is that the primary electronics of the calculator system, i.e., the registers, adder, controls, etc. are implemented in a large number of electronic components which are comparatively large in size and not readily miniaturized. It was said that miniaturization of Milne et al's calculator would require a complete redesign and the use of entirely different components. (CX-50, "Prelimanary Comments", pp. 6-7).

249. The preliminary comments dated June 25, 1973 stated that the Japanese reference "National Technical Report" shows a desk-top calculator of rather large dimensions; that using the keyboard size as a unit, the calculator shown in a photograph is five and one-half units wide, at least four units deep and at least three units thick, so the total volume is 5 1/2 x 4 x 3 or 66 units; that the calculator seems to be at least about 66 times bigger than applicants' calculator; that the reason for this difference in

size is that the calculator described in the Japanese reference is constructed using nine hundred and fifty integrated circuits, each of which is a Motorola MECL series logic circuit and each of which is packaged in a TO-5 or flat pack having ten pins, plus 160 transistors and 600 diodes; that these are mounted on 5 x 6 inch multilayer printed circuit boards, each of which will hold about 90 pieces, so at least twelve of these would be needed. It was said that the concept is basically different from applicants, concept of constituing the entire primary electronics as one integrated special purpose unit, rather than building it up from a plurality of general purpose components; that, in applicants' invention, a semiconductor array is provided that, as its sole function, provides the registers, adder, controls, etc. for a calculator i.e., to add, subtract, multiply, divide numbers which are entered by the keyboard. It was stated that instead of a unique purpose integrated array, the designers of the Japanese reference constructed their system from individual components or functions, such as I/C flip-flops gates, transistors, diodes, etc; that the result was a calculator 66 times as big as applicants' calculator and which operated on 100V AC supply at 130 watts, instead of tiny batteries; that thus, it is apparent that applicants have achieved a new order of miniaturization through the use of large scale integrated circuitry, resulting in a completely new and different product, i.e., the miniature, pocket-sized electronic calculator, which was unknown and unavailable prior to applicants' invention. (CX-50, "Preliminary Comments" p. 7, 8).

250. The preliminary comments noted that Wang et al, 3,509,329, shows a calculator implemented in two separate units, a desk-top keyboard console which "weighs less than six pounds and measures approximately 10 1/4 x 8 x 4 1/2", and an electronic package which "weigh less than 14 pounds and measures about 16 1/2 x 8 x 5 1/2"; that in keyboard units, this calculator

would be about 70 units in volume; that the Wang et al calculator uses a core memory unit, which at least in part accounts for its large size and also makes it impossible to implement the Wang device in a single integrated semiconductor array. It was said that Kinzie et al, 3,331,954, likewise show a computer which is described in terms of a random access core memory; that this is a "high speed, general purpose digital computer of the type which is particularly adapted for use in airborne vehicles"; that Bohm, 3,315,069, does not show a complete calculator, but instead only a "four function arithmetic unit" which generally "is a structural component of a larger arithmetic system in which still other structural components, such as input keying devices and output printers are provided" and that no mention is made of implementating this unit in an integrated semiconductor array located in one plane. (CX-50, "Preliminary Comments", pp. 8-9).

251. The preliminary comments stated that applicants have produced a completely new and different product, not previously known to the art or available to the public, i.e., the miniature, pocket-sized, electronic calculator with four-function capability; that applicants' calculator is not simply smaller than the prior art calculators, but that it is a totally different device with different uses and an appeal to a wholly different market. A very significant advantage of forming the primary electronics of the applicants' calculator in an integrated semiconductor array was said to be that the assembly or manufacture of the device is greatly simplified; that instead of having to make a dozen multilayer circuit boards, and solder the thousands of connections as "seemingly" required by the Japanese publication, the applicants' integrated array is made mostly by photolithographic techniques where thousands of components are made in the same semiconductor wafer at the same time with very few hand operations, and only one circuit

board need be utilized. It was stated that this results in a calculator selling at a price of perhaps $100 instead of perhaps $1500 or $2500 in the case of the prior art calculators. (CX-50, "preliminary Comments", pp. 9-10).

252. In the preliminary comments, dated June 25, 1973, it was argued that a claim, which corresponds to claim 1 of the '921 patent in issue, is distinguished from the prior art of record by reciting a "miniature, portable, battery operated" electronic calculator, "electronic means...for performing arithmetic calculations...comprising an integrated semiconductor circuit array located in substantially one plane, the area occupied by the integrated semicoductor array being no greater than that of the keyboard, said...array comprising...memory means...arithmetic means...means for selectively transferring..." and "the entire calculator including keyboard, electronic means, means for providing a visual display, and battery being contained within a 'pocket-sized' housing". (CX-50, "Preliminary Comments". p. 10).

253. In the preliminary comments, it was argued that claim 2, which corresponds to dependent claim 2 of the '921 patent in issue, is further distinguished from the prior art of record by reciting that a single semiconductor wafer is used in the array. It was said that the prior art does not suggest a single semiconductor array having as its sole purpose the provision of the primary electronics of a four-function calculator; that instead, Milne et al show magnetostrictive delay lines for memory. Wang et al was said to show cores, and the Japanese art to show 950 I/C's on twelve circuit boards, etc. (CX-50, "Preliminary Comments", p. 10).

254. In the preliminary comments, it was argued that claim 6, which corresponds to claim 6 of the '921 patent in issue, is distinct from the prior art of record by reciting a "miniature" calculator having "electronic means...for performing arithmetic calculations...comprising an integrated

semiconductor circuit array located in substantially one plane...having lateral dimensions at most not substantially greater than that of the keyboard...comprising...memory means...arithmetic means...means for selectively transferring...". (CX-50, "Preliminary Comments", p. 10).

255. In the preliminary comments, it was argued that claims 30 and 53, which correspond to claims 30 and 53 of the '921 patent in issue are distinguished from the prior art by reciting a "miniature electronic calculator", "electronic means...for performing arithmetic calculations..., said electronic means comprising an integrated semiconductor circuit array located in substantially one plane...said integrated semiconductor circuit array comprising...memory means...arithmetic means...". (CX-50, "Preliminary Comments" p. 11).

256. A Patent Office action dated in early 1974 stated that s application Ser. No. 317,493 appears to be in condition for allowance except for formal matters. Prosecution as to the merits was closed. (CX-50).

257. In the Patent Office action in early 1974, the Bohm, Kimura et al, Kinzie et al, Hernandez, Wang et al, Chow, Sakurai et al, Stiefel et al and Fitch patents, cited in the prosecution of Ser. Nos. 671,777 and/or 143,192, were cited as of interest. The first five patents were said to disclose calculators, Chow was said to show a keyboard. Sakurai et al and Stiefel were said to show printers and Fitch to show a tape advance. (CX-50).

258. A notice from the Patent Office dated in February 1974 stated that all the claims were allowable. A notice of allowance issued on March 11, 1974. (CX-50).

Green Machine

259. The position of the hearing respondents is that except for the downsizing features, the entirety of the claimed subject matter is found in such prior art desk calculators as the "Green Machine", the Frieden calculators and the Wang U.S. Pat. No. 3,402,285 calculator. The "missing" downsizing aspects of the Kilby et al claims are said to be taught by a Moore publication and illustrated with a picture of a handheld personal computer. (RPH-20).

260. Thomas E. Osborne, technical expert, of the hearing respondents designed and built, as an independent consultant, in 1964, an electronic desk-top calculator. The first prototype of that calculator which he construted in his home was called the "Green Machine" and is now on display in the Museum of American History, Smithsonian Institution, Washington, D.C. (Osborne, RX-500, p. 1).

261. Mr. Osborne is currently a private consultant in the design of computers and calculators. He is the prinicpal of Logic Design Co., San Francisco, California.

262. Mr. Osborne received his BSEE from the University of Wyoming in 1957 and his MSEE from the University of California at Berkeley in 1961. Mr. Osborne first became involed in the design of small electronic calculators in 1962 and has continued to be active in that field and the computer field. (Osborne, RX-500, p. 1).

263. Mr. Osborne was one of the principal designers of the HP-35, a Hewlett-Packard calculator, which was a shirt pocket calculator and a

"hand-held" scientific calculator. An HP-35 calculator is on display in the Smithsonian Institution. A photograph of the HP-35 is at Exhibit 502. (Osborne, RX-500, p. 2).

264. Mr. Osborne is the author of a number of articles in the calculator field including:

> "Hardware Design of the Model 9100A Calculator", Hewlett-Packard Journal, p. 10-13 (1968),
>
> "The Benefits of Decentralized Computing" Novo Sibirsk, Oct. 1970.
>
> "Personal Thoughts on Personal Computing", Computer, pp. 22-24 (December, 1976).

265. Mr. Osborne is the inventor of a number of inventions in the computer and calculator field for which a number of U.S. Patents have been issued. The following list identifies a representative sample of his patents:

U.S. Patent 3,668,461 - Output Display for use with a Calculator, June 6, 1972

U.S. Patent 3,704,448 - Data Processing Control System, November 28, 1972

U.S. Patent 3,711,690 - Calculator and Tester for Use Therewith, January 16, 1973

U.S. Patent 3,769,621 - Calculator with provision for automatically interposing memory access cycles between otherwise regularly recurring logic cycles, October 30, 1973.

U.S. Patent 3,825,736 - Calculator with provision for eficiently manipulating factors and terms, July 23, 1974.

U.S. Patent 4,037,092 - Calculator having preprogrammed user-definable functions, July 19, 1977.

(Osborne, RX-500, p. 3).

266. The first electronic calculator Mr. Osborne worked on was a desk-top device made by SCM Corp. and called the "Cogito." He assisted in the circuity design of the Cogito in 1962 and 1963. The Cogito was an entirely electronic calculator which measured about 18" x 16" x 8". Cogito was placed on the market sometime in 1965. Mr. Osborne left SCM in 1963. By the end of 1964, he had completed the first prototype of the new calculator design which he called the "Green Machine". (Osborne, RX-500, p. 4).

267. Mr. Osborne confirmed that the machine that was present in the hearing room during a portion of the hearing and was on a table directly in front of the bench was the Green Machine. Photographs of this Green Machine are Exhibits CX-290A through CX-290T. The Green Machine was brought in by the Smithsonian Institution where the machine is on exhibition. Dr. Uta Merzbach as custodian of the machine from the Smithsonian was present during the entire time the machine was in the hearing room. (Osborne, Tr. p. 1873, l. 8 through p. 1874, l. 6).

268. The Green Machine, as present in the hearing room, is contained in two cabinets. One cabinet was green and the other was tan. Both cabinets are required for the machine to operate and in addition, a third piece, the power supply, which fitted inside the tan cabinet, is required. (Osborne, Tr. p. 1882, ll. 20-25; Osborne, RX-500, pp. 4-5). The green cabinet contained the input and the display unit, i.e. the keyboard input or encoder and a display which was provided by a small cathode ray tube. The tan cabinet contained the primary electronics, i.e. the electronics which performed the arithmetic operations in response to key strokes and produced modulating signals to generate a display logic gates are in the circuitry. (Osborne, Tr. p. 1873, ls. 16-13; p. 1881, ls. 2-16; Osborne, RX-500, pp. 4, 5).

269. The dimensions of the green cabinet are approximately sixteen inches deep by eight inches by eight and one-half inches across. (Osborne, Tr. p. 1874, l. 19 - p. 1875, l. 6; Exhibit CX-90H).

270. The weight of the green cabinet is approximately four pounds. (Osborne, Tr. 1875, ls. 7-90).

271. The tan cabinet contained all the primary electronics and it was approximately fourteen inches long by ten inches wide and eight inches high. The power supply which was suppose to be present in the tan box was said to be quite large because "most of the space in the second cabinet was taken up by a direct current power supply" which was larger than it needed to be and which was capable of providing far more than the fifteen to twenty watts required to operate the Green Machine. (Osborne, Tr. pp. 1875, 1876, 1882, 1883; Osborne, RX-500, p. 4).

272. The circuit boards containing the semiconductor logic circuitry of the Green Machine are physically connected together by small angle brackets that connect the sideboards to the baseboard and four "L" brackets that connect all of the sideboards to each other and are located in the sides and bottom of the tan cabinet. Mr. Osborne purchased the angles already bent and in constructing the Green Machine at no time did he have occasion to unbend them. (Osborne, Tr. p. 1876, l. 10, p. 1877, l. 1, Osborne, CX-500, p. 4).

273. The tan cabinet of the Green Machine has many small boards. On these boards are mounted diodes. These boards are mounted perpendicular to the main boards on which they are mounted. There were small boards projecting up from the bottom and ribs projecting in from the sides. (Osborne, Tr. p. 1877, ll. 2-9; Osborne, Tr. p. 1875, l. 18; Osborne, Tr. p. 1926, l. 17-20).

274. At the time the Green Machine was built there were integrated circuit chips that would have allowed Osborne to make the machine "much, such,

much smaller" but at "much, much, much, much more power". The Green Machine was intended to be a vehicle by which Osborne could take a big company's facilities and reduce it into a "much smaller machine". However, Osborne lacked the research and development facilities in his home to do that. (Osborne, Tr. pp. 1926-1927).

275. Osborne estimated that if he were to have implemented the Green Machine in the then existing integrated circuit technology, the machine would have taken a section of table space that was probably six feet wide or six feet square of space. (Osborne, Tr. p. 1927, l. 22 - p. 1928, l. 3).

276. Photographs CX-290 J, L and O, taken in the hearing room on February 5, 1985, show in particular the Cal-Tech calculator to be smaller than either of the components of the Green Machine, viz. the green cabinet and the tan cabinet. (Tr. p. 1878-1879).

277. Photographs CX-290 A, B, C, D, E, O, E and T taken in the hearing room on February 5, 1985 show in particular certain components of the tan cabinet. (Tr. pp. 1878-1879).

278. The memory in the Green Machine is a Ferrite core memory. The approximate size of the memory is five inches by three and one-fourth inches by two inches. The total volume of the memory is 32.5 cubic inches. (Osborne, Tr. p. 11882, ls. 2-7). The memory of the Cal-Tech calculator in contrast is contained on three shift registers (CX-10, RX-505, FIG. 14). The Cal-Tech prototype, built according to the FIG. 14 embodiment, shows the shift registers to measure approximately an area of one-quarter of an inch by one-quarter of an inch having the thickness of much less than 1/32 of an inch. The entire size of the Cal-Tech calculator was about four inches in width by about six inches in length and by about one and three-fourths inches in height so that only one of the two memories of the Green Machine was approximately the same size as the entire Cal-Tech calculator. (CPX-202).

279. The Green Machine is constructed totally from discrete components. There are some solid state parts which are the transistors. All of the transistors are of the bipolar semiconductor type. (Osborne, Tr. p. 1884, ls. 4-8).

280. The magnetic core memory was contained on seven printed circuit boards and there were an additional five circuit boards which comprise the bottom and four sides of the tan cabinent. (Osborne, Tr. p. 1906, ls. 14-21).

281. The remaining "carrier boards" which are made of the same material as the "circuit boards" are organized in the same way as the 12 circuit boards in that they had components mounted thereon to aid in the fabrication process. (Osborne, Tr. p. 1906, l. 22 through p. 1907, l. 9; p. 1908, l. 14 p. 1909, l. 11).

282. In the Green Machine one flip-flop had an area of 1 1/2 inch by 1 1/2 inch on each side and contained four transistors, resistors and interconnects and that was a single flip-flop. (Osborne, Tr. p. 1926, ls. 17-22).

283. The tan cabinet of the Green Machine contained the "guts". The Green Machine required both the tan and green cabinets. It was designed with one-thing in mind, and that was to show people that Osborne had the capability of mapping their devices into workable function, if somebody had some technology that they wanted to move under that. (Osborne, Tr. p. 1934, ls. 7-20). Each cabinet of the Green Machine was larger than the Cal-Tech calculator. (CPX-202).

284. The Green Machine was implemented with discrete transistors rather, than integrated circuits, because in 1964 lower power consumption could be achieved in a calculator system with discrete transistors rather than integrated circuits. (Osborne, CX-500, p. 51).

285. Mr. Osborne sold the invention rights of the Green Machine to Hewlett-Packard. (Osborne, Tr. p. 1938, ls. 3-9).

286. Mr. Osborne collaborated with Hewlett-Packard in the design of a calculator that was eventually marketed as the HP 9100A. The size of the HP 9100A was about 20" x 19" x 9", and it employed a display in the form of an electrostatic cathode ray tube with a face plate measuring 3-1/4" x 4-13/16". The HP 9100A was placed on the market in March of 1968. It was supplanted in the early 1970's by the HP 9800 series of calculators. (Osborne, RX-500, pp. 6-7).

287. The HP 9100 was capable of performing transcendental functions, and it was programmable. In 1968, attention at HP was turned to a practical shirt pocket calculator. HP developed a light emitting diode (LED) display which culminated with the introduction in 1972 of HP's first commercial shirt pocket calculator, the HP 35. The HP 35 calculator is shown at CPX-222. (Osborne, RX-500, pp. 7-8).

288. Osborne was involved in the making of the HP-35 calculator. (CX-236, pp. 8-9).

289. According to a 1972 Hewlett-Packard publication, the HP-35 calculator is a nine-ounce, battery-powered scientific calculator, small enough to fit in a shirt pocket. It has logarithmic, trigonometric and expermential functions and computes ounces to 10 significant digits. The HP-35 contains five MOS/LSI (metal-oxide-semiconductor/large-scale integration) circuits, three read-only-memories (ROMs), an arithmetic and register circuit (A&R) and a control and timing circuit (C & T). The HP-35 is assembled on two printed circuit boards. The upper board contains the display and drivers and the keyboard. The lower and smaller board has all the MOS logic, the clock driver and the power supply. (CX-236, pp. 2, 4).

290. The HP-35 calculator, according to inventor Kilby, is not within the scope of the '921 patent because part of its logic is bipolar and part is MOS so that HP 35 could not be integrated. Kilby also testified that HP-35 did not have an integrated semiconductor circuit logic array mounted in one plane; that it used two boards in different planes each of which had logic elements therein. However this conclusion is on the assumption that all the MOS logic and clock driver of the HP-35 is not on the same board which is inconsistent with the Hewlett-Packard 1972 publication. (CX-236).

291. The HP-35 calculator was a useful and successful product. (Merryman, CR-2A, p. 2).

Frieden Calculator

292. The Frieden calculator was believed by inventor Kilby to come on the market in 1965. That calculator had an input means, including a keyboard, for entering digits of numbers and arithmetic commands into the calculator and for generating signals corresponding to the digits and commands. (Kilby, Tr. p. 99, ls. 9-24; Tr. p. 101, ls. 17-22).

293. The keyboard included only one set of decimal numbered keys for entering plural digits of decimal numbers in sequence and included a plurality of command keys. (Kilby, Tr. p. 99, l. 20; Tr. p. 100, l. 2).

294. The Frieden calculator had electronic means responsive to the signals for performing arithmetic calculations on the entered numbers and for generating control signals. It used discrete transistors for its logic circuitry. (Kilby, Tr. p. 100, ls. 3-6; Kilby, CX-1, p. 3).

295. The electronic means comprised memory means, arithmetic means and means for selectively transferring the numbers. (Kilby, Tr. p. 100, ls. 6-8).

296. The Frieden calculator, including the keyboard, the electronic means, and the digital display means was contained within a very large housing. (Kilby, Tr. p. 100, ll. 12-14).

297. Later "perhaps in 1966" a Frieden second generation machine was "announced". It used several hundred integrated circuits for the logic and was the first in its line to use integrated circuits. Mr. Kilby believed that on electroluminescent display was used. (Kilby, CX-1, p. 3).

298. Both versions were "line operated" desk calculators. The second version was smaller than the first version, probably about eight inches by twelve inches by six inches. (Kilby, CX-1, p. 3).

Wang U.S. Pat. No. 3,402,285

299. Wang U.S. Patent No. 3,402,285 ('285 patent) entitled "Calculating Apparatus" issued on September 17, 1968 on an application filed September 22, 1964. (CX-27).

300. The calculator, constructed in accordance with the Wang patent, included an input register and a log register, each having adder circuitry coupled to it. The calculator also included means for generating logarithmic values by successively multiplying a value in natural number form by selected constants and correspondingly modifying a logarithmic value by the logarithms of the selected constants. It is said that use of such constants enabled each multiplication operation to be performed by a shift and single addition step. Means were provided to sense the size of the natural number as it is varied in the multiplication operation, and in response to each sensing of a predetermined numerical condition, the value of the constant was changed. (CX-27, col. 1, ls. 10-11, l. 67-col. 2, l. 3).

301. FIG. 1 in the Wang patent is a diagrammatic view of the control panel of a desk type calculator in accordance with the Wang patent; and FIG. 2 is a logic block diagram of apparatus employed in that calculator. (CX-27, col. 2, ll. 28-34). There is no indication in Wang of exactly the type of memory employed, whether it is a core memory or discrete components and nowhere is there any mention in Wang of the use of integrated circuits. (Kilby, CX-1A, pp. 2-3).

302. The Wang patent does not disclose what the physical embodiment of the disclosed calculator is. There is no drawing of the overall packages. There is no suggestion of construction details. (Kilby, Tr. p. 119, ls. 17-28).

303. All the elements of sub-paragraph "a" of claim 1 of the '921 patent are included in the calculator of the Wang patent. (Leach, Tr. p. 1673, l. 19-p. 1674, l. 13; Kilby, Tr. p. 111, ls. 9-22; CX-27, FIG. 1).

304. TI admits that the Wang calculator has an electronic means for performing the arithmetic calculations marked on Wang's command keys. (CPFFR, p. 9).

305. Both Mr. Kilby and Mr. Leach confirmed that the Wang patent discloses a means for providing a visual display coupled to the electronic means and responsive to the control signal for indicating the answer. However the testimony was conditioned upon the use of the term "electronic means", rather than the more specific "integrated semiconductor circuit array" required in the language of the '921 patent claims in issue. (Kilby, Tr. p. 117, l. 9 - p. 118, l. 1; Leach, Tr. p. 1696, l. 24 - p. 1697, l. 3).

306. With regard to part (iii) of subparagraph "b" of claim 1 of the '921 patent Mr. Leach's testimony confirmed that the electronic means of Wang included means for selectively transferring numbers from the memory means

through the arithmetic means and back to the memory means in a manner dependent upon the commands to effect the desired arithmetic operation, although, his testimony was predicated on the omission of an "integrated semiconductor circuit array". (Leach, Tr. p. 1692, l. 14 - p. 1695, p. 11).

307. A Loci machine is a commercial version of the Wang calculator of the '285 patent. In the first version of the Loci, the control panel with electronics was in a large cabinet which occupied about half a desk. Later models of the Loci had a separate box for the electronics which was put on the floor. (Kilby, Tr. p. 107, ls. 20-25, Tr. p. 120. ls. 18-25).

308. The Wang reference does not disclose use of an integrated semiconductor circuit array and the Wang calculator does not have an integrated semiconductor circuit array. (Leach, Tr. p. 1695, l. 21 - p. 1696, l, 3).

309. The Wang patent was included in a list of prior art references cited to the Patent Office during prosecution of the '921 patent, and was commented on by applicants in its prosecution of the '921 patent. No rejection was made by the Examiner an the Wang patent. (CX-50, "Preliminary Comments", pp. 4, 8).

Moore Publication

310. Gordan E. Moore, in an article entitled "Cramming more components onto integrated circuits "in Electionics, pp. 114-117 (April 18, 1965) stated that the future of integrated circuits is the future of electronics itself, that the advantages of integration will bring about a porliferation of electronics, pushing this science into many new areas; that integrated circuits will lead to sucn wonders as home computers - automatic

controls for automobiles, and personal portable communications equipment. (RX-518, p. 114).

311. Moore states that with unit cost falling as the number of components per circuit rises, by 1975 economics may dictate squeezing as many as 65,000 components on a single silicon chip. (RX-518, p. 114).

312. Moore states:

> By integrated electonics, I mean all the various tecnologies wich are referred to as microelectronics today as well as any additional ones that result in electronics functions supplied to the user as irreducible units. These technologies were first investigated in the late 1950's. The object was to miniaturize electronics equipment to include increasingly complex electronic functions in limited space with minimum weight. Several approaches evolved, including microassembly techniques for individual components, thin-film structures and semiconductor integrated circuits.
>
> Each approach evolved rapidly and converged so that each borrowed techniques from another. Many researchers believe the way of the future to be a combination of the various approaches.
>
> The advances of semiconductor integrated circuitry are already using the improved characteristics of thin-film resistors by applying such films directly to an active semiconductor substrate. Those advocating a technology based upon films are developing sophisticated techniques for the attachment of active semiconductor devices to the passive film arrays.
>
> Both approaches have worked well and are being used in equipment today.

(RX-518, p. 114).

313. Moore further states:

> The complexity for minimum component costs has increased at a rate of roughly a factor of two per year.... Certainly over the short term this rate can be expected to continue, if not to increase. Over the longer term, the rate of increase is a bit more uncertain, although there is no reason to believe it will not remain nearly constant for at least 10 years. That means by 1975, the number of components per integrated circuit for minimum cost will be 65,000.
>
> I believe that such a large circuit can be built on a single wafer.

(RX-518, p. 115).

314. Moore also states:

> With the dimensional tolerances already being employed in integrated circuits, isolated high-performance transistors can be built on centers

two thousandths of an inch apart. Such a two-mill square can also contain several kilohms of resistance or a few diodes. This allows at least 500 components per linear inch or a quarter million per square inch. Thus, 65,000 components need occupy only about one-fourth a square inch.

On the silicon wafer currently used, usually an inch or more in diameter, there is ample room for such a structure if the components can be closely packed with no space wasted for interconnection patterns. This is realistic, since efforts to achieve a level of complexity above the presently available integrated circuits are already underway using multilayer metalization patterns separated by dielectric films. Such a density of components can be achieved by present optical techniques and does not require the more exotic techniques, such as electron beam operations, which are being studied to make even smaller structures.

Increasing the yield

There is no fundamental obstacle to achieving device yields of 100%. At present, packaging costs so far exceed the cost of the semiconductor structure itself that there is no incentive to improve yields, but they can be raised as high as s economically justified. No barrier exists comparable to the thermodynamic equilibrium considerations that often limit yields in chemical reactions; it is not even necessary to do any fundamental research or to replace present processes. Only the engineering effort is needed.

In the early days of integrated circuitry, when yields were extremely low, there was such incentive. Today ordinary integrated circuits are made with yields comparable with those obtained for individual semiconductor devices. The same pattern will make larger arrays economical, if other considerations make such arrays desirable.

(RX-518, pp. 115-116).

315. Moore states under the heading "Heat problem":

Will it be possible to remove the heat generated by tens of thousands of components in a single silicon chip?

If we could shrink the volume of a standard high-speed digital computer to that required for the components themselves, we would expect it to glow brightly with present power disipation. But it won't happen with integrated circuits. Since integrated electronic structures are two-dimensional, they have a surface available for cooling close to each center of heat generation. In addition, power is needed primarily to drive the various lines and capacitances associated with the system. As long as a function is confined to a small area on a wafer, the amount of capacitance which must be given is distinctly limited. In fact, shrinking dimensions on an integrated structure makes it possible to operate the structure at higher speed for the same power per unit area.

(RX-518, p. 116).

316. There is an illustration in the Moore article which shows a booth with the sign "Happy Home Computers" wherein a man is holding a device which has a plug attached thereto. (RX-518, p. 116).

317. Moore teaches nothing about how integrated circuits might be used in a calculator. Moore does not suggest equiping any calculator with an integrated semiconductor circuit array with the attendant aspects of "memory means", "arithmetic means" and "means for selectively transferring numbers" in the context of a miniature electronic calculator. (Leach, CX-3A, p. 7).

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IX. ACCUSED CALCULATORS

318. It is admitted that the accused calculators of respondents Nam Tai, IMA and Enterpex are portable handheld calculators. (RPH1).

319. It is further admitted that the accused calculators of respondents Nam Tai, IMA and Enterpex have (a) an input means including a keyboard for presenting an arithmetic problem to the calculator, (b) an electronic means for solving the problem and (c) a display means for presenting the answer in visible form. (RPH 1-2).

320. It is admitted that accused calculators of respondents Nam Tai, IMA and Enterpex have plural logic functions (RPH 4).

321. It is also admitted that accused calculators of respondents Nam Tai, IMA and Enterpex, when they are opened, (1) a single chip will be found inside, (2) that such single chip in smaller than the keyboard and (3) that such single chip contains all the "calculating" circuitry in one plane. (RPHR 6).

322. TI's expert Jerald G. Leach evaluated a number of accused calculators. (Leach, CX-3, pp. 12-24).

323. Mr. Leach's educational background includes a Bachelor of Science in Electrical Engineering in 1976 from Texas A&M University. His experience in integrated circuit design includes over eight years involving logic design, layout, solving circuit problems and circuit design, with four years of specializing in calculator chip circuits, all of which was gained while working at TI where he is now presently employed. He is a "Senior Member" of the Technical Staff of TI and have been for over two (2) years. This status is obtained by selection made by a special board set-up for this

purpose to recognize outstanding achievement in technical areas. The status of Senior Member of the Technical Staff is limited to five percent of all of the technical personnel at TI. (Leach, CX-3, ¶ 2).

324. Mr. Leach is named as an inventor in the following U.S. Patents:

U.S. Patent No.	Issue Date	Title
4,264,963	4/28/81	Static Latches for Storing Display Segment Information
4,338,600	7/6/82	Liquid Crystal Display System Having Temperature Compensation
4,459,565	7/10/84	Low Current Electronic Oscillating System

In addition, he has also been named sole inventor on a U.S. patent application directed to a low-powered inverter circuit which issued as a U.S. patent on January 22, 1985. (Leach, CX-3, ¶¶ 3, 4).

325. Mr. Leach's tasks at TI have been involved in the design of numerous semiconductor circuits for use on calculator chips including the TI-310 which is a CMOS microprocessor chip. This chip provides the primary electronics in a number of different TI calculators including model numbers TI-1001, TI-1010, TI-1030, TI-1031, TI-1040, TI-1040A, TI-1750-III, TI-1850, TI-1880, and Data Cards. He has also been involved in the design of the TI-320 chip, a microprocessor chip which provides the primary electronics for TI professional LCD calculators, the Business Analyst II and the Business Card. Other circuits where he has been involved in designing include the display driver circuit for a chip to be used in the TI-88 calculator and the

TI-920 microprocessor circuit chip which is the primary electronics in a four-function calculator. (Leach, CX-3, ¶ 5).

326. Mr. Leach has been designing circuits for watches including the watch chip TMC349 used in wrist watches as well as a modification in that chip referred to as the TMC550. He also has been involved in designing microprocesser circuit chips including the TI-2220 chip which has a LCD drive and is used in several different products. In the video display field, he has been involved in chips having model numbers 9118, 9128, and 9129, which are eight-bit microprocessors used to generate video displays for computers, and he is working on a design of a microprocessor chip which is a new video display processor chip used to present computer information in video form. (Leach, CX-3, ¶ 6).

327. In designing chips, normally about twelve months are required for the design itself and an additional six months is required to debug the design. Chip design progresses in a number of phases. Initially, the logic circuit design is made where the logic gates and their arrangement in the circuit are determined and a detailed logic diagram or drawing is prepared. Subsequently the circuit design of the logic gates is converted into transistor schematics where the transistors are sized to meet the circuit requirement. The size is related to a number of factors, including speed, power, performance, node sizes, transistor fanout, process variations, coupling, noise, and voltage range. The transistor schematics are then converted into a composite layout which is a drawing of the mask used for making the semiconductor chip and which visually resembles the appearance of the chip when viewed under high magnification. (Leach, CX-3, ¶¶ 7, 8).

328. Once the design of a chip has been completed, it must be debugged. This involves examining and testing a chip which has been processed using the mask, to insure that the manufactured chip operates properly. During this phase, much time is spent probing internal nodes with microprobes. This requires locating logic gates and nodes in the finished chips and applying the microprobes to determine if the electric charge is in the proper place at the proper time as designed. (Leach, CX-3, ¶ 9).

329. Part of Mr. Leach's job responsibility has been to reverse engineer competitive products or chips and determine their operation. This reverse engineering includes visual and electrical examination of the chip in order to draw its structure and understand its operation. Based on previous design experience with calculator chips, he has working knowledge of calculator chip design and architecture which enables him to appreciate, often "quickly" from a visual examination what is encompassed within the chip design. The visual examination can be verified using the probing procedure. In addition to visually inspecting a calculator chip, performing a number of calculator operations can also verify the existence of "certain" elements within the calculator. (Leach, CX-3, ¶ 10).

330. Exhibit CX-192 is a block diagram of a typical calculator circuit. The memory is used to store numbers used in calculations. It is usually either a RAM or shift registers. The ALU is used to add, subtract, multiply, or divide numbers. The transfer logic transfer numbers from the memory to the ALU and back to the memory. The control section generates the instructions necessary to complete operations. It usually contains a ROM as well as random logic, and sometimes a program counter and instruction decode. The keyboard is used to enter numbers into the calculator. The keys are decoded by a PLA (Programmable Logic Array) and the digits transferred into

the memory. The number which will be displayed is tranferred from the memory then decoded by the display PLA. The number is converted from a binary number into bits which show which segments of a digit are on or off. Calculators with LCD displays usually contain a display register with all the segment information decoded. (Leach, CX-3, ¶ 11).

331. Mr. Leach studied and evaluated by reverse engineering a Toshiba Chip No. T6014U from a Compex LC-827 calculator manufactured by Nam Tai. The calculator included a keyboard, an LCD display and contained batteries. (Leach, CX-3, ¶¶ 21, 22).

332. Mr. Leach noted in Exhibit CX-231A, and from inspection of the following NAM TAI calculators, that each uses a Toshiba T6014U chip: LC-837; LC-839; CS-111; CS-839; LC-625; LC-849; LC-859; LC-84; LC-811; RC22; LC-809; LC-615; MC-2808; MC-2605; CS-827 and had the same features he found in the Compex LC-827. (Leach, CX-3, ¶ 34).

333. Mr. Leach studied and evaluated by reverse engineering Toshiba Chip T6853BU. (Leach, CX-3, ¶ 2). The following model numbers used Toshiba Chip T6853BU: SC-50, SC-70, SC90, SC-91 and SC-92. (Leach, CX-3, ¶ 35). These calculators are represented respectively by CPX-92, CPX-81, CPX-91, CPX-90 and CPX-89 and were manufactured by Nam Tai. SC-90 is a solar calculator sold under the brand name COMPEX . (Leach, CX-3, ¶ 31).

334. Mr. Leach studied and evaluated by reverse engineering a Sharp Chip LI-3033M. (Leach, CX-3, ¶21).

335. Sharp Chip No. LI-3033M has a commonality among a number of calculators, specifically:

Producer	Brand Name	Model No.	CPX
General Electronics	IMA	LC-610	20
General Electronics	IMA	LC-620	22, 22.1
Luks	IMA	LC-640	23, 24
General Electronics	RADIO SHACK	EC-2	28

Unknown	SEARS	I.58400	35
RJP	(None)	CALC/RULER	107
Tronica	CALFAX	MB-1100	50
Tronica	NOVA	WC30	55
Tronica	MBO	MC-50	108
Voesa	MOB	TRAV-CARD	110
Voesa	MOB	FORMEL-40	111
Unknown	MOB	MC-40	112
Hua Chang	DIAMOND	LC-333A	114.1
Hua Chang	DIAMOND	LC-783	115
Tronica	SUTRONIC	LC-10	116
Tronica	SUTRONIC	LC-30	117
Dah Sun	D.S.	LCD-199	119
Voesa	VOESA	LC-28	126
	MBO	FORMEL-12	129
Dah Sun	DS	LCD-380	132
Qualitro	COMUS	CCA-3220	160
Qualitro	COMUS	CC-3210	164
Unknown	CALC/CLOCK	6712	
Tronica	(None)	MICRO	64, 171
	SLIMCARD	3112	176
Taiwan	COMUS	CC-741	117
Tronica	VISCOUNT	LC-12	180
Tronica	TRONICA	LC-12	192
Tronica	TRONICA	M-72	195

Respondents so identified here are Dah Sun, General Electronics, Hua Chang, Luks, RJP and Voesa. (Leach, CX-3, ¶ 36).

336. With respect to each of chips LI-3033M, T6014U and T6853BU, Mr. Leach identified the ALU (used to add, subtract, multiply, or divide numbers) the memory means, and the transfer logic. Thus he first identified the memory location. All three (3) chips were said to contain shift registers which can be identified from an 8 x 10 photograph. Shift registers were said to be a common memory means used in calculators. Then, with the use of a microscope, he traced the data paths of the shift register outputs, until he identified two full adders. The full adders were said to be primary logic elements used in bit serial ALU's. The first adder was said to be used to add two numbers together, and the second for binary to decimal correction. He made a photographic montage of the area surrounding the full adder and traced out the

circuitry for further verification that it was the ALU. Truth tables were used to verify the logic. He then traced the output of the ALU back to the shift registers. The transfer logic was said to be the logic which selectively transfers numbers from the shift registers to the ALU and then transfers the output of the ALU back to the shift register. He also marked this logic with boxes. (Leach, CX-3, ¶ 21).

337. By reverse engineering, chips LI-3033M, T6014U and T6835BU Mr. Leach determined, as for each chip, that:

a. The chip is located in substantially one plane;

b. After comparing the area of the chip with the keyboard, the area occupied by the the chip is no greater than that of the keyboard;

c. The chip was said to include:

(1) Memory means in the form of shift registers which store the digits of numbers entered into the calculator. (2) Arithmetic means coupled to the shift registers for adding, subtracting, multiplying and dividing the numbers and storing the resulting answer in the shift registers; and (3) Means for selectively transferring numbers from the memory means (shift registers) through the arithmetic means (ALU) and back to the memory means in a manner dependent upon the commands to effect the desired arithmetic operation (Leach, CX-3, ¶ 23, ¶ 30, ¶ 31).

338. Mr. Leach studied the Compex LC-827 calculator in addition to studying the chip, examined the circuit board circuits which underlie the keyboard and determined that the calculator uses encoding in connection with the keyboard so that the calculator includes input means including a keyboard for entering digits of numbers and arithmetic commands into the calculator and

generates signals corresponding to the digits and commands, and that the keyboard has only one set of decimal number keys for entering plural digits of decimal numbers in sequence and includes a plurality of command keys, the decimal number keys and command keys being visible on the physical calculator noted as (compex LC-827, and the signals being generated corresponding to the digits and the commands are unique signals. (Leach, CX-3, ¶ 24).

339. Mr. Leach found that the Compex LC-827 calculator had electronic means which are responsive to the signals performing arithmetic calculations on the numbers entered into the calculator and for generating control signals, the electronic means comprising an the chip. (Leach, CX-3, ¶ 25).

340. From an inspection of the Compex LC-827 calculator it was said to have a LCD (liquid crystal display) coupled to the the chip and to be responsive to control signals for indicating the answer and that the LCD was a means for providing a visual display coupled to the "integrated semiconductor circuit array (the chip)" and responsive to the control signals for indicating the answer. In displaying the answer, the chip was said to include decoding means responsive to the stored answer for generating electrical signals indicative of the shape in which the stored answer is to be displayed, the display means being coupled to the decoding means for this purpose. (Leach, CX-3, ¶ 26).

341. Mr. Leach inspected the Compex LC-827 calculator and determined that it is a miniature, portable, battery-operated electronic calculator, and that the entire calculator including the keyboard, the electronic means, the visual display and battery are contained within a "pocket-sized" housing. (Leach, CX-3, ¶ 27).

342. Mr. Leach evaluated the Compex LC-827 calculator with regard to its size, and the size was said to fall within the range of a miniature calculator and is "pocket sized". (Leach, CX-3, ¶ 28).

343. The lateral dimensions of the chip of Compex LC-827 were compared by Mr. Leach with that of the keyboard, and he determined that the chip has lateral dimensions which are at most not substantially greater than that of the keyboard. (Leach, CX-3, ¶ 29).

344. Mr. Leach identified a liquid crystal display in Nam Tai's accused COMPEX LC-827 calculator, Solar Calculator SC-90, and its SC-70, SC-92,SC-91, SC-50, LC-839, CS-111,CX-839, LC-625, LC-849, LC-857, LC-859, LC-84, LC-811, RC-22, LC-809, LC-615, MC-2808, MC-2605 and CX-827 calculators (Nam Tai's certain calculators); IMA's LC-610, IMA-620. IMA LC-640 calculators; Radio Shack's EC-2 calculator; Sears' I.58400 calculator; Tronica's MBO MC-50, MOB Trav-Card, Sutronic LC-10 and LC-30, Viscount LC-12, LC-12 and M-72 calculators; Voesa's MOB Trav-Card, MOB Formel-40 and LC-28 calculators; Hua Chang's Diamond LC-333A and LC-783 calculators; Dah Sun D.S. LCD-19 calculator; Qualitro's Comus CCA-3220 calculator; and Taiwan's Calc/clock 6712 and Comus CC-741 calculators and determined that the certain Nam Tai calculators use encoding in connection with the keyboard. (Leach, CX-3, paras. 24, 30, 36).

345. Mr. Leach was given approximately 184 accused calculators listed in Exhibit CX-231. Each calculator was contained in a folder and to identify each calculator evaluated, Mr. Leach initialled each folder upon completion of the evaluation. (Leach, CX-3, ¶ 32).

346. In order to determine whether calculators listed in Exhibit CX-231A contained the memory, arithmetic means and transfer means, Mr. Leach evaluated the various functions such as addition, subtraction, multiplication

and division. Each calculator was said to contain keys for entering plural digits of decimal numbers sequentially. It was concluded that the calculators must have memory means in order to store numbers which have already been entered into the calculator; that the memory means is located in the chip since there is no other component in the calculator capable of storing numbers; that since the calculators can add, subtract, multiply and divide, an arithmetic means must be contained in the calculator; that this arithmetic means must be located in the chip since there is no other component capable of doing these functions; that the resulting answer is displayed on a visual display; that since the number is continuously displayed it must be stored in memory somewhere; that it must be stored in the I.C. (integrated circuit) since it is the only component capable of storing this number; that the numbers being operated on have to be transferred from the memory means to the ALU to do additions, subtractions, multiplications and divisions, and the answer has to be stored in memory that since the integrated circuit is the only component capable of transferring this information, it necessarily contains the transfer logic. (Leach, CX-3, ¶ 33). With the exception of certain calculators of TI, Nam Tai and IMA, the calculators so evaluated are:

Physical Exhibit No.	Reference To Exhibit No.	Producer	Model No.
4	CX-489	APF	1903
18		Luks	LC-650
19	CX-153	General Electronics	130CBW
20	RX-153 RX-158	General Electronics	LC-610
21	RX-153 RX-158	Nam Tai	LC-615
22	RX-153 RX-158	General Electronics	LC-620
22.1	RX-153 RX-158		LC-620
23	CX-552	Luks	LC-640

24	RX-153	Luks	LC-660
27	CX-510	RJP	RC-200
28		General Electronics	EC-2
28.1		General Electronics	EC-271
29		General Electronics	EC-273
30		Luks	EC-273
31		General Electronics	EC-305
32		General Electronics	EX-306
34	CX-521	RJP	2910
35		Unknown	1.58400
36		APF	1.58510
37		APF	1.58530
38		APF	1.58580
40	CX-513	Luks	LC-2601A
41	CX-520	RJP	631 Ruler
42		Taiwan	EC-277
43		Taiwan	EC-204
44		Taiwan	KSC-200
45		TI-USA	TI-35
47	CX-385	Promoters	LC-205
48	RX-153 RX-158	General Electronics	LC-750
49	CX-479	Far East	Calc/Ruler
50		Tronica	MB-1100
53		Unknown	Alarm Calc
54		Unknown	WC-34
55		Tronica	WC-30
58	CX-512	Tronica	Solar Cell
59	CX-450 pp. 22-25 CX-455	Tronica	E-268
59.1	CX-450 pp. 22-25 CX-455	Tronica	E-268
60	CX-450 pp. 25-26 CX-454	Nam Tai	LC-809
60.1	CX-450 pp. 25-26 CX-454	Nam Tai	LC-809
61		Tronica	Check Master
61.1		Tronica	Check Master
63	CX-400 pp. 18-21, 27, 30 CX 567 RX-158	Dah Sun	CLIP
64		Tronica	Micro
65	CX-479	Kin Sung	840
66	CX-552	Unknown	LC-683
68	CX-521	Tronica	218
71		Sam Sung	CL-8500
72		Sam Sung	CL-8100N
75	CX-479	Time Proc.	Wallet
76	CX-525	Taiwan	MC-2820
78	CX-496	Zeny	C-6
107	CX-520	RJP	Calc/Ruler

	RX-158		
108		Tronica	MC-50
110		Voesa	Trav-Card
111		Voesa	Formel-40
112		Unknown	MC-40
113		Nino	Francaise
114	CX-516	Hua Chang	LC-333A
114.1	CX-516	Hua Chang	LC-333A
115	CX-516	Hua Chang	LC-783
116		Tronica	LC-10
117		Tronica	LC-30
118		Integrated	CL-19
119	CX-400 pp. 21, 27, 50 CX-530 pp. 6-10 CX-567 RX-158	Dah Sun	LCD-199
120	RX-158	Unknown	RC-200
121	RX-153	General Electronics	130CBW
122	RX-153	Unknown	LC-625
123	RX-153	Unknown	LC-905
124	RX-153	Unknown	LC-780
125	RX-159	Far EAst	RX-400
126	CX-479	Voesa	LC-28
127			LC-80
128		Integrated	B-28
129			Formel-12
130		Taiwan	Alpha-604
131	CX-521	Tronica	218-SE
132	CX-400 pp. 21-22 27, 30 CX-567	Dah Sun	LCD-380
148	CX-461 pp.15-18 20-21 CX-505	Taiwan	MC855 BL
149	CX-461 pp. 18-19 CX-505	Taiwan	LC835 B
150	CX-461 pp. 24-25 CX-505	Time Proc.	SL 888
151	CX-461 p. 30 CX-505	China	SL803 G
152	CX-461 p. 14	Taiwan	MM845W R
153	CX-461 pp. 27-28 CX-505	Taiwan	SL800
154	CX-461 p. 34 CX-505	Taiwan	RX-80c
155	CX-496	Unknown	TCA-900
156	CX-461 p. 21 CX-505	Unknown	CK12M BE
157	CX-461 pp. 12-13 CX-505	Sentex	CK12M BE
158	CX-461 pp. 21-23 CX-505	Far East	C90

159	CX-496	Far East	CCA-3200C
160	CX-496	Qualitron	CCA-3220
161	CX-496	Sentex	CCA-3230
162	CX-496	Sentex	Cat-3000G
163	CX-479	Sentex	DC80-A
164	CX-496	Qualitro	CC-3210
165	CX-490	Taiwan	6412BY
166	CX-461 p. 34 CX-505	Unknown	RC80R
167	CX-461 p. 34 CX-505	Taiwan	SL5
168	CX-479	Beare/Taiwan	RC-02
169	CX-490	Taiwan	6712
170	CX-479	Nam Tai	LC-7002
171		Tronica	Micro
172	CX-483	Luks	LC-740
173	CX-479	Time Proc.	782
174	CX-490	Qualitron	5222
175	CX-490 CX-479	Qualitron	3122
176	CX-490 CX-479	Qualitron	3112
177	CX-496	Taiwan	3112
178		Nam Tai	CX-91
179	CX-461 pp. 22-25 CX-505	Taiwan	SL805BK
180	CX-450 pp. 22-25 CX-455	Tronica	LC-12
181	CX-450 pp. 22-25 CX-455	Luks	LC-90
182	CX-450 pp. 22-25 CX-455	Luks	LC-92
183	CX-450 pp. 22-25 CX-455	Hong Kong	LC-263N
184	CX-450 pp. 22-25 CX-455	Luks	LC-92
185	CX-450 pp. 26-28	Tronica	288
186	CX-450 pp. 26-28 CX-452	Unknown	LC-8050
187	CX-450 pp. 25-26 CX-454	Unknown	LC-289
188	CX-450 p. 26 CX-453	Luks	300A-1
189	CX-450 pp. 25-26 CX-454	Luks	LC-277
191	CX-450 pp. 25-26 CX-454	Tronica	289
192	CX-450 pp. 25-26 CX-454	Tronica	LC-12
193	CX-450 pp. 25-26 CX-456	Tronica	MC-88
194	CX-450 pp. 26-28 CX 452	Tronica	283
195		Tronica	M-72

(CX-231A). Certain of the above calculators are identifed on CX-231A as bought in Hong Kong.

347. All Nam Tai calculators which Nam Tai has manufactured and which have been imported into the United States which include those Mr. Leach inspected are listed below under "Model No.", the list being the same as Exhibit 4 to Responses of Nam Tai Ltd. to TI's First Set of Interrogatories (Nos. 1-37), CX 527; the drawings each identify the Model No. to which they pertain; the CPX No. show the calculators Mr. Leach evaluated. The particular chip for each Model No. is obtained from actual CPX Nos., Nam Tai Exhibit 4 to CX-527 and Nam Tai's drawings:

MODEL NO.	DRAWINGS	EXHIBIT	CHIP
LC-1001S	CX-166	CPX-52	UPD-1856G
LC-803	CX-167		UPD-1831G
LC-0808S/0818S	CX-168		UPD-1852G/1854G
QC-81	CX-169		UPD-1032G/T-3939
QC-85	CX-170		
EC-1212	CX-112		
LC-807			T6014AS
LC-801	CX-94	CPX-103	
LC-804	CX-94	CPX-87	
MQ-1200	CX-173		
LC-1200	CX-86	CPX-99	
SC-10	CX-114		T6853
LC-819	CX-174		T6014
QC-87	CX-175	CPX-85	T-3939S
LC-809	CX-111 CX-115	CPX-60	T-6014
LC-811	CX-176	CPX-88	T-6014
LC-1002S	CX-113	CPX-39 CPX-51	
LC-829	CX-177	CPX-82	
SC-20	CX-178	CPX-10	T6853
SC-30			T6853
ML-801	CX-172	CPX-84	
QC-99	CX-179		
SC-50	CX-180	CPX-92	T6853
MC-889	CX-89	CPX-9	
LC-827	CX-182	CPX-6	T6014
LC-839	CX-182	CPX-8	T6014
MC-847	CX-90	CPX-94	
LC-837	CX-97	CPX-7	T6014
LC-1004S	CX-91		T6755S
LC-859	CX-183	CPX-97	T6014
LC-817	CX-95		T6014

RC-22	CX-184	CPX-95	T6014
LC-857	CX-185	CPX-98	T6014
RC-33	CX-186	CPX-93	T3939S
SC-70	CX-110	CPX-81	T6853
SM-80	CX-117		T6856S
QC-77	CX-116		
SC-90	CX-101	CPX-91	T6853
SC-91	SX-103	CPX-90	T6853
SC-23	CX-119	CPX-96	T6853
SC-97	CX-99		T6853
SC-92	CX-105	CPX-89	T6853
LC-1229	CX-106		
KC-82	CX-107		T6014
SC-93	CX-102		T6853
SC-94	CX-108	CPX-102	T6853
LC-802			
QC-89	CX-152		
LC-1003S	CX-109		
CR-101			
LC-849	CX-153	CPX-100	T6014
LC-9001S	CX-153	CPX-100	T6014
QC-833	CX-98		
MI-003	CX-151		
QC-916	CX-150		
LC-1005S	CX-140		
MQ-1201			
TC-10			
SC-60S			
QC-88	CX-161		
LC-869	CX-100		T6014
LC-879			T60014
CB-11			
LC-319			T6014
LC-687	CX-155		T6014
LC-1239	CX-156		
LC-1006S			
LC-1007S			
SC-120			
SC-121			
SC-122	CX-157		
SC-812	CX-158		T6853
SC-813	CX-258		T6853
SC-689			T6856
SC-882			T6853
QC-86T	CX-160		
QC-88T	CX-161		
RC-66	CX-162		T6856
RC-68	CX-163		T6853
EC-838	CX-164		T6014
P-201			
CR-104	CX-165		
CR-105			
KS-6021A			

348. IMA is involved in the importation into and/or sale in the United States of the following calculators made by the following manufacturers (Schoenberg Tr., pp. 2258-2260). The CPX number identifies the calculators Mr. Leach evaluated.

Calculator Model	Manufacturer	CPX
IMA LC 610	General Electronics	20
IMA LC 615	Nam Tai	21
IMA LC 620	General Electronics	22,
IMA LC 620		22.1
IMA LC 640	Luks	23
IMA LC 660	Luks	24
IMA LC 670B	Nam Tai	25
IMA LC 680B	Nam Tai	26
IMA RC 200	RJP, Unknown	27, 120
IMA RC 200A	Taiwan	
IMA LC 750	General Electronics	48
IMA LC 683	Unknown	66
IMA LC 672	Nam Tai	67
IMA LC 625	Unknown	122
IMA LC 905	Unknown	123
IMA LC 780	Unknown	124
IMA RC 400	Far East	125
IMA LC 800	FLX	
IMA LC 788	FLX	
IMA LC 785	FLX	
Hanimex LC-650	Luks, General Electronics	19

Etron used by Luks. (Schoenberg, Tr. p. 2267).

(CX-231A).

349. Inventors Kilby and Merryman examined the following miniature portable calculators:

CPX	Producer	Brand	Model
7	Nam Tai	Compex	LC-837
10	Nam Tai	Compex	SC-20
83	Nam Tai	Compex	SM-80
85	Nam Tai	Compex	QC-87
57	Nam Tai	Penquin	SC-300
64	Tronica	Ruby	MICRO
65	Kin Sung	Audel	840

Both Kilby and Merryman placed their initials and the date of their examination within the file jackets pertaining to each of the above-listed physical exhibits. Some used small primary batteries and some used solar batters. They observed that each had a keyboard, a visual display, and a semiconductor circuit chip. The semiconductor chip had an area less than that of the keyboard. From enlarged photographs of the chips, they noted in one instance that the memory means was a RAM structure instead of shift registers. (Kilby, CX-1, pp. 9-10; Merryman, CX-2, p. 8; CX-213A).

350. The item in the accused calculators which is denominated by TI as the "integrated semiconductor circuit array" is the single chip about 150 thousandths of an inch square. (Kilby, Tr. p. 315, l. 4, p. 317, l. 24).

351. Most modern portable calculators (both four-function and professional/scientific) are constructed from 5 elements:

the keyboard and associated printed circuit board,

the liquid crystal display,

the power source (battery or solar cell),

the housing, and

the MOS chip.

Some or all of the elements, except the MOS chip programmed as a calculator, are common to a variety of modern devices such as clocks, garage door openers, elevator control panels, personal computers, two way radios etc. The element that makes the calculator a calculator is the programmed MOS chip. That programmed chip is the heart of the calculator. The single MOS chip and the LCD display pose the greatest technological difficulties in realization of the calculator. The other components as technologically trival by comparison. (Osborne, RX-500, pp. 14-15).

352. Liquid crystal display or LCD is a digital display that consists of two sheets of glass separated by a sealed-in, liquid crystal material. A voltage applied between from and back electrode coatings affects the orderly arrangement of the molecules enough to form visible characters even though no light is generated. (Osborne, RX-500, p. 14).

353. Today the term "chip" is commonly used to identify a fingernail sized piece of semiconductor material which comprises a single integrated circuit. Individual or leads are bonded to the chip to provide connections to the "non-integrated" outside world, such as a copper clad printed circuit board. In manufacture, a thin polished slice of wafer of semiconductor crystal from 1" to 6" in diameter is processed to form spatially and functionally separate electrical structures which may be repeated, in whole, numerous times across the wafer. The wafer is then cut into individual chips, each constituting a single integrated circuit. (Osborne, RX 500, p. 16).

354. Charles G. Sodini, technical expert of Nam Tai, Enterpex and IMA, examined calculator chips marked as Exhibits RPX-9, RPX-10A and 10B, RPX-11 and RPX-12. He was informed that those chips were removed from single chip calculators respectively designated as LC-859, LC-829, SC-92 and LC-1001S and that statement has been challenged by TI. (Sodini, RX-534, p. 1).

355. According to Sodini a chip is not a wafer. A wafer is a substrate on which integrated circuit chips are fabricated. Because of defects which exist in the wafers or which are caused by their subsequent processing, a chip which would take up an entire wafer, according to Sodini, has been impractical. Use of redundancy or restructuring which would be necessary to overcome the defect problems would also be impractical in a low cost environment such as a portable calculator application. (Sodini, RX-534, p. 1).

356. LC-859, LC-829, SC-92 and LC-1001S correspond to Nam Tai calculators identified respectively as CPX-97, CPX-82, CPX-89 and CPX-32. (RX-231A).

357. Charles G. Sodini is currently Assistant Professor at the Massachusetts Institute of Technology in the Department of Engineering and Computer Science. He received a BSEE degree from Purdue University in 1974, and his MSEE and PhD degree from the University of California at Berkeley in 1981 and 1982, respectively. His principal expertise is in integrated circuit design and technology. (Sodini, RX-534, p. 1).

358. Professor Sodini, was employed by Hewlett Packard Labs in 1974 and from January 1975, to Dec. 1982. He was a visiting lecturer at UC Berkely in the fall of 1982. He became an Assistant professor at M.I.T. in January 1983. (Sodini, RX-534, Appendix A).

359. According to Sodini most modern single chip calculators are, in fact, dedicated-purpose microcomputers in which the microprocessor and memory are located on a single chip. He believed the following definitions accurately reflect the current usage in the art of the terms "microprocessor" and "microcomputer":

<u>microprocessor</u>: "A computer central processing unit that is manufactured on a single integrated-circuit chips (or on several chips) by utilizing large-scale integration technology. A microprocessor may be incorporated directly into the instrumentation of an automatic control system or used as the main element of a microcomputer." Marcus, <u>Electronics Dictionary</u> (4the Ed. Mc Graw Hill, 1978)

<u>microcomputer</u>: "A microprocessor combined with input/output interface devices, some type of external memory, and the other elements required to form a working computer system." Marcus, <u>supra</u>.

(Sodini, RX-534, p. 2).

360. According to Sodini, in most modern single chip calculators the dedicated programming is contained in a read only memory or "ROM". The ROM provides flexibility in the type of functions performed and in the algorithms employed to achieve those functions. The ROM provides a programmed data pattern which causes the microprocesser to perform the desired arithmetic or other function. Each of the chips of Exhibits RPX-9, RPX-10A and 10B, RPX-11 and RPX-12 contain ROMs. The chips of Exhibits RPX-10A, and 10B and RPX-12 each employ a random access memory (RAM) as opposed to a shift register memory. Each of the chips of Exhibits RPX-9, RPX-10A and 10B, RPX-11, and RPX-12 are metal-oxide-semiconductor (MOS) chips. They are <u>not</u> based upon bipolar technology. (Sodini, RX-534, pp. 2-3).

361. A bipolar chip is a chip with integrated bipolar transistors. Bipolar transistors employ charge carriers of both polarities (positive and negative), hence the name bipolar. The N and P regions are adjacent and define emitter, base and collector regions in an NPN or PNP configuration. All regions are formed from semiconductor material. Bipolar transistors are formed of semiconductor materials doped with electron donor impurities (N regions) and other regions doped with electron acceptor impurities (P regions). N and P regions are located adjacent to each other to form either an NPN or PNP transistor configuration. (Sodini, RX-534, p. 3).

362. The operation of a bipolar transistor is basically that an emitter-to- collector current is controlled by a much smaller emitter base current (typically in a ratio of 100 to 1). (Sodini, RX-534, p. 4).

363. In required low power applications such as portable calculators, in the implementation of logic functions with bipolar transistor structures, as shown in FIGS. 20 and 31 of the '921 patent there are several major disadvantages: (1) a base current must flow to control the transistor, (2) losses of current during an "off state" are significant in comparison to

an MOS transistor, (3) and bipolar transistors require relatively large silicon area compared to MOS transistors. Sodini testified in essence this meant that the thousands of bipolar transistors which much be employed to construct the logic gates and shift registers needed for the calculator will continuously draw a substantial amount of current which will quickly drain portable batteries and draw far too much power to permit powering of the calculator with shirt pocket sized solar cells. (Sodini, RX-534, pp. 4-5).

364. An MOS chip is a chip employing integrated metal-oxide-semiconductor field effect transistors in which a metallized gate (M) of the transistor is separated from a silicon semiconductor substrate (S) by an insulating layer of oxide (O). MOS chips have substantially different structures and operate substantially differently from bipolar chips. For example, in MOS chips, capacitors are formed from metal areas separated from the substrate by oxide. Memory sections of some dynamic MOS devices rely on stored charges. Unlike bipolar structures, shown in FIG. 20 of the '921 patent, where current must flow in at least one transistor in the "logic" gate at all times so that there is a continuous draw of substantial current, an MOS implementation of that logic function could be accomplished without a continuous draw of current. (Sodini, RX-534, pp. 5-6).

365. Logic functions implemented with bipolar transistors as shown in FIG. 20 of the '921 patent are to be contrasted, to implementation with MOS transistors. MOS transistor implementation draws less current by at least a factor of ten. In addition MOS integrated circuits have a number of operational differences over bipolar integrated circuits, especially, in low power applications as portable calculator, wherein there are size and cost contraints. There are: (1) no gating current flows to control the MOS field effect transistor; (2) current losses during an "off state" are insignificant;

(3) transistors and memory can be more compactly fitted on individual chips. Accordingly, thousands of MOS field effect transistors and capacitors can be fabricated on a single chip, yet require a very small amount of power. In fact, so little power is required that the entire calculator can be powered with a solar cell about one square inch in area. (Sodini, RX-534, p. 7).

366. According to Sodini the making of a practical single MOS chip portable calculator required major advances on a number of technological fronts. Among these were: (1) control of threshold stability, and (2) control of the electrical properties of the silicon/silicon dioxide interface. These advances were made independently of bipolar technology. To Sodini's knowledge no one has ever produced a single chip calculator using the bipolar technology represented in FIGS. 20 and 31 of the '921 patent. To Sodini's knowledge, no one has ever produced a commercial battery powered calculator using only such technology. He concluded such a calculator would involve high power consumption, and would yield only a short operating period before requiring battery replacement. (Sodini, RX-534, pp. 7-8).

367. Integrated injection logic (I^2L) is a bipolar technology which was proposed in the early 70's and which was intended to rival MOS for the implementation of logic functions. In view of the industry today, I^2L has not lived up to its purported low cost expectations. Hence, there is very little use of this technology in present day logic applications. I^2L bipolar circuitry remains substantially different from MOS circuitry in structure and operation. To the extent I^2L structures can achieve comparably low power applications, they do so with a resistor and not with low conductance transistors as in MOS circuits. (Sodini, RX-534, p. 8).

368. According to Sodini a shift register memory is a memory in which data is entered at one end and must be shifted stage by stage through the entire memory before becoming available again. The data can then be either circulated or removed. It is a simplified form of serial memory, adapted to minimize leads and transistors. The data locations cannot be individually addressed to enter or extract data. Data can be withdrawn only in serial fashion at predetermined locations, usually from the last stage in the register. (Sodini, RX-534, p. 8).

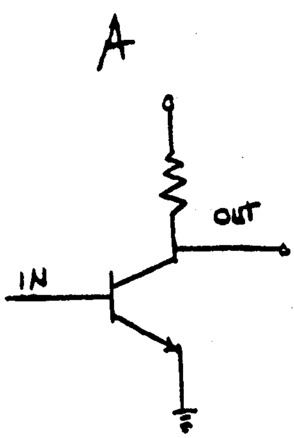
369. According to Sodini, in contrast to a shift register memory, a random-access memory (RAM) is a computer memory in which each storage location is individually addressable for example by X and Y coordinates. Unlike with shift registers, the time required for writing in or reading out data is thus independent of location. RAMs and shift registers are said by Sodini to differ substantially in structure and operation. RAMs may be addressed by a ROM to rapidly extract numbers or portions of stored numbers (such as the exponent of the number) to effect the calculations. With shift register memories, individual bits cannot easily be separately accessed without clocking out the data located in the stages in front of the datum desired to be accessed. As a result, Sodini testified such accessing consumes computation time to clock out the right amount of stored information. Additional hardware is also required to mask undesired data or digits. Accessing a bit in a shift register requires different amounts of time depending on its location. Computation must be slowed down to permit the required shifting. The fastest access time of a shift register is the slowest access time of a RAM. With ROMs, such as in the MOS chips of RPX-9, RPX-10A and 10B, RPX-11, and RPX-12, programming information not intended to be erased can be permanently stored in a small area. The implementation of the '921 patent did not employ such ROMs. (Sodini, RX-534, p. 9).

370. TI's expert Mr. Leach in his rebuttal-testimony was of the opinion that Sodini's claim that MOS operate substantially different from bipolar was incorrect ; that one of ordinary skill in the art could easily substitute MOS for bipolar and bipolar for MOS. To show similarities of bipolar and MOS he relied in his drawing A for an early bipolar inverter, his drawing B for an an early MOS inverter and his drawing C for an improved MOS inverter. (Leach, CX-3A, pp. 8-9). Drawing A was a prior art discrete bipolar inverter; drawing B is an early MOS inverter not used in any of the accused calculators and drawing C is an inverter not used in any of the accused calculators. (Leach, Tr. 1713, p. 8, Tr. 1715, l. 8).

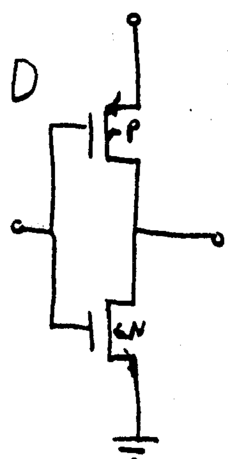
371. The bipolar inverter shown in drawing A is in the '921 Kilby patent. (Leach, Tr. p. 1778, ls. 18-20).

372. The accused calculators that Mr. Leach examined used CMOS technology which is shown in drawing D. Drawing D represents a CMOS inverter. (Leach, Tr.]. 1776, ls. 13-22; Tr. p. 1777, ls. 19-23; RX-540).

373. Drawing A and D are as follows:



(CX-3A, p. 8)



(RX-540)

374. When the device of drawing A is on, there is a DC path from power to ground and power is being consumed. The device would consume more power significantly than a CMOS inverter. (Leach, Tr. p. 1779, l. 15- p. 1780, l. 160).

375. The CMOS inverter (RX-540) shows two field effect transistors, the N cabinet is at the bottom and the P channel is at the top. (Leach, Tr. p. 1780, l. 17- p. 1781, l. 5).

376. In the CMOS inverter, there is only an insignificant leakage of DC current from power to ground. The resistance provided in the device is several orders of magnitude higher than the resistance in the bipolar inverter. (Leach, Tr. p. 1781, l. 19 - p. 1782, l 9, Tr. p. 1784, ls. 5-12).

377. For the same photolithography capability, the structure of drawing A is approximately twice the size of the structure of drawing D. (RX-540). (Leach, Tr. p. 1785, ls. 14-18).

378. George L. Brantingham who has a BSEE degree and MSEE degree, has been employed by TI for over 11 years and holds 16 patents dealing with calculator integrated circuit design, testified that the issues raised by Sodini's power consumption testimony are essentially irrelevant; that the conflict in shift register or ram storage in Sodini's testimony cannot be resolved in favor of one or the other approach; and that he found it hard to believe that anyone "even marginally skilled in the area could not have made the translation from bipolar to MOS or vis-versa". (CX-9). However, when asked whether he had ever seen a commercially distributed hand-held calculator that had bipolar primary electronics, which the Cal-Tech calculator has, his answer was an unequivalant "No.".. (Merryman, Tr. p. 528, ls. 5-12; Brantingham, Tr. 2448, ls. 5-8).

379. Accused calculators do not have a thermal printer which is described as the display means in the '921 patent; while the driver for the display means of the patented '921 calculator is integrated with a thermal print head, the driver in the chip of the accused calculators, where a liquid crystal is the display, is with the rest of the integrated circuitry. (Merryman, Tr. pp. 563, 566).

380. The sole display means disclosed in the '921 patent is a thermal printer. (kilby, Tr. p. 227, ls. 2-4).

381. In a liquid crystal display, glass sheets are separated by a sealed-in liquid crystal material. The application of a voltage between the front and back electrode coatings effect the orderly arrangement of the molecules eonugh to form visible characters, even though no light is generated. (Kilby, Tr. Tr. p. 228, ls. 22-25; Tr. p. 289, ls. 1-6).

382. A thermal printer basically causes a change in the structure of the molcules held in a paper matrix. It changes the color of paper in an invissible way. (Kilby, Tr. p.. 229, l. 23- p. 230, l. 6). The thermal printer used in the '921 patent had a tape advance and produced a hard copy; the liquid crystal display has nothing like a tape advance and it is basically erasible. (Kilby, Tr. p. 230).

383. While there is a continuous input of new paper into a thermal printer display system; there is not a continuous input of liquid crystal material into a calculator that has liquid crystal displays. (Kilby, Tr. p. 231).

384. Kilby has never seen a thermal printer in a thin credit card kind of calculator; it would be a "significant" invention. (Kilby, Tr. p. 231, l. 25- p. 232 l. 11).

385. Kilby has never seen a thermal printer in a solar-powered calculator. (Kilby, Tr. 233, ls. 21-23).

386. When Kilby began to consider the Cal-Tech project and the use of thermal printer displays, there was a power consumption problem. The thermal printer worked better with higher voltage than the logic. Mr. Merryman taught how to integrate the drive electronics within the thermal printer. His solution would not teach how to implement a liquid crystal display into a hand-held calculator. (Kilby, Tr. p. 234). Thus Merryman's approach minimized leads. This problem does not arise with LCDs. (Kilby, Tr. p. 34; Merryman, Tr. p. 564, ls. 3-25).

387. With the thermal printer, a pulse is applied to the printer element to heat it, and that pulse is turned off to avoid getting merely a black spot rather than a discernable numeral. With the LCD, the line segments which produce the visual display are continuously pulsed. (Kilby, Tr. p. 458, ls. 4-13, p. 459, ls. 8-21).

388. The substitution of an LCD in a calculator that already had a thermal printer would be guesswork and inventor Kilby did not know of anyone who performed such a task. (Kilby, Tr. p. 453, l. 7- p. 455, l. 24).

389. The driver for the LCD is maintained with the rest of the integrated circuitry while the drive electronics in the thermal printer is in the printhead. (Merryman, Tr. 564, ls. 3-25).

390. The LCD relies on line segment displays while the thermal printer has a dot element which is not a line segment display. (Merryman, Tr. p. 1189, ls. 3-15).

391. Inventor Kilby admitted that he could not express an opinion on the level of skill involved in implementing an LCD into a calculator. (Kilby, Tr. p. 461, l. 23- p. 462, p. 22).

392. A thermal printer and tape advance, disclosed in the '921 patent would consume too much power to be solar powered. Even at today's

state of the art, a thermal printer requires too much space to be used in the thin calculators now being made. (Osborne, RX-500, p. 45, ls. 1-4).

393. In reaching threshold size, utilization of a circuit in which the main power path travelled from source to ground through only a single transistor was a contribution. (Kilby, Tr. p. 280, l. 22- p. 281, l. 6). Discretionary wiring enabled the reach of a threshold size. (Kilby, Tr. p. 283, ls. 14-18; Tr. p. 284, ls. 16-25; Tr. 285, ls. 20- p. 286, l. 5).

394. In realizing the results of the '921 patented device, the circuitry architecture used a minimum number of gates; Kilby doubts that the accused calculators operate by minimizing the number of gates in the circuitry. (Kilby, Tr. pp. 287-289).

394(a). In the scanning technique used by the accused calculators, the chip scans the keyboard and inferentially determines which key is depressed. After reusing that a key has been depressed, the chip cans the keyboard in a pattern at a very reapid rate to determine by clock intervals, the key which has been depressed. (kilby, Tr. p. 246, l. 18- p. 247, l. 24).

(394(b). In the accused systems, the keyboard does not generate signals corresponding to digits and commands as in the claimed calculator of the '921 patent. (Osborne, RX-500, p. 41).

395. There are significant differences in MOS circuitry and size circuitry in the accused calculators as compared to the bipolar circuitry and size circuitry of the '921 calculator. (Kilby, Tr. p. 290, ls. 5- p. 293, l. 18). Bipolar transistors in the calculators of the '921 patent had a load, linear resistor. A high resistance was desired and hence a large size of resistor was used. (Kilby, Tr. p. 296, ls. 14-19; p. 300, ls. 9-24).

396. In general the accused calculators do not use a linear resistor load. (Kilby, Tr. p. 301, ls. 8-14).

397. Today's MOS circuits occupy significantly less area and consume significantly less power than the bipolar circuits of tne '921 patent. (Kilby, Tr. p. 306, ls. 2-8).

398. The difference in load in MOS load resistors of accused calculators as compared to the load of the '921 patented calculator enable MOS circuits of accused calculators to be much smaller and to consume alot less power than the bipolar circuitry of the '921 patent. (Kilby, Tr. p. 307, l. 23- p. 308, l. 4).

399. The accused calculators are MOS calculators and hence do not use the shift registers circuit of U.S. Pat. No. 3,573,754 that is incorporated into the '921 patent and which is used in FIG. 21 of the '921 patent. (CX-10, RX-505, col. 15, ls. 446-54; Merryman, Tr. p. 517, pp. 4-13).

400. In modern MOS circuits, power consumption is considerably less than the power consumption of the bipolar circuit of the '921 patent and the size is also considerably less than the size of the circuitry of the '921 patent. (Merryman, Tr. p. 528, ls. 5-12).

401. The accused calculators have MOS circuitry. (Merryman, Tr. 530, l. 4).

402. MOS transistors of 1985 are smaller than the bipolar transistors of 1967. (Merryman, Tr. 530, ls. 13-14).

403. MOS circuits of the accused calculators use field effect transistors; the circuit for the Cal-Tech prototype did not use field effect transistors. (Merryman, Tr. p. 550, ls. 13-20).

404. The accused calculators have line segment displays; the thermal printer of the '921 patent has dot element which is not a line segment display. (Merryman, Tr. p. 1189, ls. 3-15).

405. Bipolar technology was used to implement logic design of the Cal-Tech calculator (CPX-202) because MOS was not then reliable. (Merryman, CX-2, p. 4). There is nothing in the '921 patent that teaches the way to make MOS reliable for a calculator application. (Merryman, CX-2, p. 4, para. 7; Tr. p. 1190, ls. 25- p. 1191, l. 15).

406. At the hearing the testimony of inventor Merryman was:

Q Mr. Merryman, isn't it a fact that the decision to use bipolar technology in the Cal-Tech calculator was because bipolar technology was the one applicable to discretionary wiring, which was Mr. Kilby's method of achieving the level of integration that you needed for the project?

A No.

Q Now, on page 87 and 88 [of your deposition] I asked you who decided to use the bipolar technology for the Cal-Tech calculator, and then I asked you why, and on page 88 your answer was, "Well, bipolar technology, for example, was the technology that was appplicable to discretinary wiring at the moment, which was Kilby's method of achieving this level of integration."

Do you recall that question and answer, sir?

A I certainly do.

Q You were under oath at the time then?

A Yes.

Q You were represented by counsel?

A Yes. May I point out that those answers are two different questions, sir.

Q You can try to point it out, Mr. Merryman, but the record will speak for itself.

(Merryman, Tr. pp. 1203-1205).

407. The technique used for the logic circuitry that helped solve the size problem in the Cal-Tech prototype is not the technique for solving the size problem in the accused calculators. (Merryman, Tr. p. 507, ls. 13-18).

408. The Cal-Tech calculator is in fact 4-1/4" x 6-1/8" x 1-3/4". (RX-505, CX-10 col. 3, ls. 43-46). That works out to a volume of 45.5 cubic inches. A typical accused solar credit card calculator (RPX-2, Compex Model SC-92) is 3-3/8" x 2-1/8" x/16" or about .448 cubic inches in volume. From such measurements and calculations, the Cal-Tech calculator is about 100 times larger than a calculator alleged by TI to be equivalent.

X. TI MINIATURE CALCULATORS

409. Jerald Leach evaluated TI Four-Function and Professional calculators and a TI Datamatch calculator. The Four-function calculators include: TI-1031; TI-1040; TI-1788-III; TI-1766; TI-30-SLR; TI35-SLR; TI-1786; TI-1025; TI-1001; TI-1100; TI-1706; TI-1746; TI-1780; and the Time Manager. The professional calculators include: TI-3011; TI-66; TI-30 Galaxy; TI-30-II; TI-35-III; TI-BA-III; TI-BA-35; TI-57-II; and TI-BA-45. These TI calculators were evaluated and were determined by Leach to each have a chip which is an "integrated semiconductor circuit array" located in substantially one plane. Each chip occupied an area no greater than that of the keyboard. He also studied each of these calculators in addition to studying their chips. Thus for each calculator, he examined the circuit board which underlies the keyboard and determined that the calculator uses encoding in connection with the keyboard so that the calculator includes input means inlcudes a keyboard for entering digits of numbers and arithmetic commands into the calculator and generates signals corresponding to the digits and commands, and that the keyboard has only one set of decimal numbers in sequence and including a pluarlity of command keys, the decimal number keys and command keys being visible on the calculator, and the signals generated

corresponding to the digits and the commands being unique signals. For each calculator he found that it has electronic means which are responsive to the signals performing arithmetic calculations on the numbers entered into the calculator and for generating control signals, the electronic means comprising an "integrated semiconduct circuit array" (the chip). Leach CX-3, ¶ 33, ¶ 37).

410. From an inspection of each of the TI calculators identified the preceding finding Mr. Leach found it has a LCD (liquid crystal display) coupled to the "integrated semiconductor circuit array" (the chip) and is responsive to control signals for indicating the answer and that the LCD is a means for providing a visual display coupled to the "integrated semiconductor circuit array" (the chip) and responsive to the control signals for indicating the answer. In displaying the answer, the "integrated semiconductor circuit array" includes decoding means responsive to the stored answer for generating electrical signals indicative of the shape in which the stored answer is to be displayed, the display means being coupled to the decoding means for this purpose. He determined that each of the calculators is a miniature, portable, battery-operated electronic calculator, and that the entire calculator including the keyboard, the electronic means, the visual display and battery is contained within a "pocket-sized" housing. He also evaluated each of the calculators with regard to its size, and found that the size falls within the range of a miniature calculator and is "pocket sized". The lateral dimensions of the chip of each of the calculators were compared with that of the keyboard, and he determined that the chip has lateral dimensions which are at most not substantially greater than that of the keyboard. (Leach, CX-3, ¶ 37).

411. In order to determine whether each of the TI calculators, in the preceding finding contained the memory, arithmetic means and transfer

means, Mr. Leach evaluated the various functions such as addition, subtraction, multiplication and division. Each calculator contains keys for entering plural digits of decimal numbers sequentially. Therefore, he concluded the calculators must have memory means in order to store numbers which have already been entered into the calculator. He concluded that the memory means is located in the integrated semiconductor circuit array since there is no other component in the calculator capable of storing numbers. Since the calculators can add, subtract, multiply and divide, he concluded an arithmetic means must be contained in the calculator which must be located in the semiconductor array since there in no other component capable of doing these functions. The resulting answer was said to be displayed on a visual display. Since the number is continuously displayed he considered it must be stored in memory in the integrated circuit since it is the only component capable of storing this number. Mr. Leach concluded the numbers being operated on have to be transferred from the memory means to the ALU to do additions, subtractions, multiplications and divisions, and the answer has to be stored in memory. Since the integrated circuit is the only component capable of transferring this information, he concluded it necessarily contains the transfer logic. (Leach, CX-3, ¶ 37).

412. With respect to the TI-3011 calculator a block diagram of the TP0456 chip used in this calculator was studied by Mr. Leach and he determined that it shows all the same features as he found with the chips; LI-3033M, T6014V, and T6853BU. In addition, Mr. Leach evaluated the actual TI-3011 calculator and found that the TI-3011 calculator includes a keyboard and LCD display and contained batteries. He also found it had substantially the same elements as the Nam Tai COMPEX LC-827 calculator (Leach, CX-3, ¶¶ 30, 38).

413. The TI calculators identified in the preceding findings correspond to the following physical exhibit numbers:

Model No.	CPX No.
TI-1031	CPX-1
TI-1040	CPX-2
TI-3011	CPX-3, 3.1
TI-35	CPX-45
TI-66	CPX-69
TI-30 Galaxy	CPX--70
TI-1788-III	CPX-73
TI-1766	CPX-79
TI-30-SLR	CPX-104
TI-35-SLR	CPX-105
TI-1786	CPX-106
TI-1025	CPX-133
TI-1001	CPX-134
TI-1100	CPX-135
TI-1706	CPX-136
TI-1746	CPX-137
TI-1780	CPX-138
TI-30-III	CPX-139
TI-35-III	CPX-140
TI-BA-III	CPX-141
TI-BA-35	CPX-142
TIME MANAGER	CPX-144
TI-57-II	CPX-145
TI-5000	CPX-146
TI-BA-45	CPX-147

(CX-231A).

414. Inventors Kilby and Merryman examined TI miniature portable calculators, as listed hereinafter:

CPX	Producer	Brand	Model
1	TI	TI	TI-1031
3	TI	TI	TI-3011
104	TI	TI	TI-30-SLR

Both Kilby and Merryman placed their initials and the date of their examination within the file jackets pertaining to each of the above-listed physical exhibits. Some used small primary batteries and some used solar batteries. The observed that each had a keyboard, a visual display, and a semiconductor circuit chip. The semiconductor chip was concluded by the inventors to be a semiconductor circuit array which had an area less than that of the keyboard. They were shown enlarged photographs of the semiconductor chips. In one instance, they noted that the memory means was an RAM structure instead of shift registers. (Kilby, CX-1, pp. 9-10; Merryman, CX-2, p. 8).

415. Examination of the TI calculators in in the record showed the following patent markings:

CPX #	U.S. Patent Nos.	Model No.
1	3921142; 3855577; 3934233; 3819921; 4005293	TI-1031
2	3921142; 3855577; 3819921; 4005293	TI-1040
3	3819921;3988604 3921142; 3904863; 4005293; 4073006	TI-30II
3.2 (Not listed on CX-231-A; also no CPX-3.1 as listed on CX-231-A)	3819921; 3988604 3921142; 3904863 4005293; 4073006	TI-30-II
45	3819921; 3988604; 3921142; 3904863; 4005293; 4073006	TI-35
69	NONE INDICATED	TI-66
70	NONE INDICATED	TI-30 Galaxy
73	NONE INDICATED	TI-1788-III
	NONE INDICATED	TI-1766
104	NONE INDICATED	TI-30-SLR
105	3819921; 3988604 3921142; 3904863 4005293; 4073006	TI-35-SLR
106	NONE INDICATED	TI-1786

133	3819921; 3932846; 3988604; 3855577; 3934233; 3991305; 3904863; 3955181; 4005293; 3921142; 3987416; 4014013	TI-1025
134	3921142; 3855577 3934233; 3819921; 4005292	TI-1001
135	NONE INDICATED	TI-1100
136	NONE INDICATED	TI-1706-II
137	NONE INDICATED	TI-1746
138	NONE INDICATED	TI-1780II
139	NONE INDICATED	TI-30-III
140	NONE INDICATED	TI-35-III
141	NONE INDICATED	TI-BA-III
142	NONE INDICATED	BA-35
143 (Not listed on CX-231-A)	3819921; 3988604; 3921142; 40730067	
144	3921142; 3855577; 3934233; 3819921; 4005293	Time Manager
145	3819921; 3988604; 3921142; 3904863; 4005293; 4073006	TI-57-II
146	NONE INDICATED	TI-5000
147	NONE INDICATED	BA-45
207	NONE INDICATED	TI-1795

XI. RELEASE AND IMPLIED LICENSE AFFIRMATIVE DEFENSES

416. An agreement dated between TI and contains the following paragraph:

ARTICLE III
GRANT OF LICENSES BY TI

Section 1. TI grants and agrees to grant to

. (RX-3).

417. Article I, Section 20 of the TI- agreement definic as:

Section 20.

:

(RX-3).

418. Article VII of the TI- Agreement provided that the agreement would expire on . The agreement . (RX-3C; Donaldson, CX-610A)

419. TI concluded a license agreement with on which was amended on and expired on .
(RX-106).

420. Article III of the agreement stated:

ARTICLE III
GRANT OF LICENSES BY TI

TI grants and agrees to grant to

. (RX-106).

421. Article I, Section 12 of the agreement defines as:

Section 12. :

,

(RX-106).

422. , and , and all other of TI paid royalties based on the value of the , and not on the value of . A is within the term in the -TI and agreements. (Donaldson, CX-610A, p. 8; Donaldson, Tr. p. 1135).

423. implied a license under the '921 patent. (Donaldson CX-610A, p. 5). In fact, on entered into a separate agreement (RX-46) with TI concerning . Under this agreement, subject to the payment of , TI released from past infringement of any TI . Also released TI from past refringment of any . further granted to TI a

. (RX-46).

424. TI's have numerous applications completely unrelated to calculators. Integrated circuits made under TI's patents have extremely wide applications, including use in stoves, thermostats, and automobiles. As two examples, U.S. Patent No. 3,463,975, for a Schottkey clamp integrated curcuit, and U.S. Patent No. 4,152,779, for a sophisticated dynamic RAM, have never been applied in calculators. (Donaldson, CX-601A, pp. 8-9).

425. Even when TI's are used to produce chips, which may be used in calculators, these chips have various uses other than in portable calculators. Chips which can be used in calculators have a

These functions are not determined by the manufacturer. Rather, the manufacturer has a basic architecture in silicon, and he can program the chip to perform different functions. A customer will approach the manufacturer and request certain functions, typically providing a gate code or the types of results that he wants. This customer-provided information is typically proprietary. (Donaldson, Tr., p. 1166).

426. With respect to releast for past infringement, the agreement between TI and signed on contained the following paragraph:

"2.1

Paragragph 1.1(D) of this Agreement contained the following defintion:

(RX-46).

427. Article III of the TI- agreement of read:

LICENSE GRANTS

3.1

***

3.3

3.4

428. When TI negotiated its license agreement with , the parties identified as a separate issue, not involved in the license under negotiation, which they wished to talk about

later. The parties did continue with negotiations, which took four and a half years to complete. These negotiations led to TI's agreement with . (Donaldson, Tr., p. 1148).

429. According to TI's Donaldson who was involved in the negotiations leading to the the negotiations were delayed because . The parties wished if possible to wait until . (Donaldson, Tr. p. 1143).

430. In TI's negotiations with , leading to the lists of patents that were calculator patents were presented by the parties to be included in the agreement and patents that did not cover a were excluded. (Donaldson, Tr., p. 1147, ls. 5-9).

431. TI has represented that the effective date of the TI- agreement is . (CPHR, p. 22).

432. Nam Tai purchases approximately 95% of its chips from Toshiba Corporation of Japan and the remainder from NEC and Sharp, also of Japan. (Koo, RX-87, p. 1).

433. In general, it takes about 90 days before a chip that is shipped by Toshiba to Nam Tai reaches the United States in one of Nam Tai's calculators. (Koo, RX-87, p. 1).

434. The first year that respondent Nam Tai made calculators was 1980. (Koo, Tr. p. 2061, ls. 9-11).

435. The total quantity of calculators Nam Tai made in 1984 was about . Included those calculators were about calculators that Nam Tai shipped into China. (Koo, Tr. p. 2061, L. 17- p. 2062, l. 5).

436. With respect to the use of chips that have been produced under the of the TI- license agreement of and the license agreement, TI's Donaldson testified that even when the patents covered by such licenses are used to produce chips which may be used in calculators, these chips have various uses in devices other than portable calculators; that these used include plug-in-the-wall calculators, portable clocks, and calculators incorporated into large stationary furniture or devices. (Donaldson, Cx-610, p. 9; Donaldson, Tr. pp. 1125-6).

437. TI's Evans testified that the chips supplied by Nam Tai by and are at the time of sale, not capable of any substantial use other than as the central element of a portable calculator. (Evans, Tr. p. 880; Evans, Dep. CX-393, p. 43). The record however contains no evidence that the chips sold be to Nam Tai were "comprehended" by TI patents, which is the term usedin the TI license agreemtn of and the license agreement to denote the products involved with the licensed patents. (RX-3, RX-106).

438. Chips made under the license such as the TI- license agreement or the agreemtn can be sold to companies who have taken calculator licenses, which may then in turn freely use them in calculators. had a calculator license from , and took a license again in . and took a calculator license in , in , in , in , and and in . These licenses are still in effect. Further, these licensees could, by the terms of their licenses, subcontract calculator assembly. Thus, through the years, chip manufacturers have been able to sell

chips to numerous major purchasers who in turn enjoyed the benefits of calculator licenses from TI. (Donaldson, CX-610, p. 9).

439. continues to sell chips to Nam Tai after the effective release of the TI- agreement and after . (Koo, Tr. pp. 2112-2120; CX-575; CX-574).

440. There is no testimony, or documentary evidence in the record from which shows that at the time of sale by of semicnductor chips to Nam Tai, was fully aware that the chips were to be used by Nam Tai in the manufacture of portable electronic calculators and/or that had knowledge that of Nam Tai's calculators employing chips were exported by Nam Tai to the United States.

XII. IMPORTATION AND SALE

Far East

441. Respondent Far East manufactures portable calculators in Hong Kong. (CX-402, p. 208).

442. Complainants' physical exhibits 49, 125 and 158-159 are portable calculators manufactured by Far East. (CX-231-A).

443. Far East sold calculators in to . (CX-496, letter dated December 17, 1984, p. 3).

444. is a California corporation which acts as an importer selling to wholesalers digital products consisting of time pieces and calculators. (Ruwin, CX-461, p. 3).

445. has purchased calculators from the Conic Group in Hong Kong, of which Far East United Electronics is a subsidiary. (Ruwin, CX-461, pp. 10, 22, 55).

446. began importing calculators into the United States in . (Peress, CX-401, p. 13).

447. has imported one calculator model from Far East United Electronics. (Peress, CX-401, p. 23).

448. purchased calculators from Far East in and (Peress, CX-401, p. 26).

449. Since , has purchased calculators at a value of from Far East United Electronics. (CX-479, p. 4).

Fordstech

450. Fordstech has not produced portable electronic calculators, nor has it exported portable electronic calculators to the United States. (SX-3).

FLX

451. imported units of calculator model LC128L, which was manuactured by FLX in Hong Kong. (Ruwin, CX-461, pp. 10, 11).

452. , has imported calculators into the United States from FLX for under the brand name (Lipper, CX-458, pp. 13, 47).

453. On , located in Maryland, purchased approximately checkbook calculators, model number , directly from for sale to . These calculators were manufactured by FLX. (Fitzpatrick, CX-449, pp. 16, 17).

454. purchased some calculators for a test market in the fall of . These calculators were manufactured by FLX, and opened a letter of credit with FLX with acting as a representative. (Fitzpatrick, CX-449, pp. 17-18).

Hua Chang

455. The October 1984 issue of Asian Sources Electronics magazine, page 252, shows a calculator advertisement for Hua Chang. (Chow, CX-402, pp. 190, 202-203).

456. , has been selling calculators for approximately 18 months. once purchased calculators from Hua Chang Electronics in Hong Kong. (CX-477, pp. 1, 3).

Integrated Display

457. The January 1979 issue of Asian Sources Electronics shows a calculator advertisement for Integrated Display. (CX-570, p. 12).

MBO

458. MBO advertised portable calculators in Asian Sources Electronics in 1978, 1981, 1983 and 1984. (CX-507, p. 4; CX-512, p. 12; CX-516, p. 12; CX-519, p. 5; CX-520, p. 15).

Mino

459. In the 1984 and 1985 issues of Asian Sources Electronics magazine, show calculator advertisments placed by Mino. Mino exhibited its calculators at the 1984 Consumer Electronics Show in Chicago. (Chow, CX-402, pp. 190-192; CX-517, p. 2; CX-518, p. 2; CX-519, p. 2; CX-520, p. 2; CX-521, p. 2; CX-522, p. 2; CX-523, p. 2).

Promoters

460. , has been selling calculators in the United States since 1975. (CX-483, p. 1).

461. has purchased calculators from Promoters in Hong Kong. (CX-483, p. 3).

Success

462. Success produced an LED calculator from November 1978 to December 1979 with chips purchased from TI. (SX-4). Success advertised a portable calculator in Asian Sources Electronics in 1984. (CX-522, p. 15).

Dah Sun

463. Dah Sun has shipped portable electronic calculators to the United States since . (CX-532, Interrogatory No. 59, p. 10).

464. Dah Sun advertised portable calculators in the November, 1984 issue of Asian Sources Electronics and participated in the summer 1984 Consumer Electronics Show in Chicago. (CX-522, p. 22; CX-44, p. 2).

465. is a California corporation which develops premiums for various clients in the United States and acts as a sales representative for the purchase of calculators by its customers. (Susich, CX-462, pp. 5-7).

466. obtained calculators from Dah Sun on . (Susich, CX-462, p. 12).

467. purchased calculators from Dah Sun in . (Peress, CX-401, pp. 14-15).

468. purchased calcultors, model LC-3322, manufactured by Dah, Sun, in . (CX-506).

Luks

469. purchased through the following calculators from Luks:

1981: 2,000 of Model No. 263A,
600 of Model No. 300A-1;
1982: 113,855 of Model No. 263A;
1983: 42,350 of Model No. 263A.
(CX-494, p. 2).

470. purchased calcualtors, Model Nos. LC-3322 and 33-916, manufactured by Luks, in . (CX-506).

471. In January 1983, obtained calculators from Luks designed to look like a Stanley tool or tape meansure. In purchased calculators of a basic, four-function type from Luks. (Susich, Cx-462, pp. 11, 12).

472. has purchased calculators from Luks since . In purchased calculators from Luks at a U. S. dollar value of . (CX-483, p. 4).

RJP

473. Enterprex has purchased 2,000-3,000 calculators, Model No. 2910 from RJP. (Yuan, CX-459, pp. 78-79).

474. purchased calculators from RJP in and calculators from RJP in . These calculators were desktop and credit card models. (CX-477, p. 5).

475. has purchased several models of calculators from RJP --

Sears

475(a). Complainants' physical exhibits CPX-35-38 are Sears brand portable calculators. (CX-231-A).

units of Model SL4; units of Model SL3; and approximately units of Model SL2. (Ruwin, CX-461, pp. 32, 33).

476. RJP advertised portable calculators in <u>Asian Sources Electronics</u> in 1984 and 1985. (CX-522, pp. 5-6; CX-523, pp. 13-14). RJP participated in the 1985 International Winter Consumer Electronics Show. (CX-553, p. 4).

<u>Tronica</u>

477. Tronica sold calculators in and calculators in to . (CX-494).

478. Tronica sold credit card calculators at solar calculators at ; and key chain calculators at to , in . (CX-495, p. 4).

479. Tronica sold credit card calculators at and key chain calculators at in to , in . (CX-495, p. 4).

480. The October 1984 issue of <u>Asian Sources Electronics</u> magazine, page 289, shows a calculator advertisement placed by Tronica, a manufacturer of calculators. Tronica exhibited its calculators at the 1984 Consumer Electronics Show in Chicago. (Koo, CX-402, p. 206).

481. imports calculators into the United States from Tronica under the brand names and "Tronica." (, CX-458, p. 47).

482. , located in , has been selling calculators since 1980. (CX-478, p. 1).

483. Since , has purchased approximately calculators at a dollar value of from Tronica. (CX-478, pp. 4, 12).

484. , located in

, has been selling calculators for . (CX-484, p. 1).

485. In and purchased approximately calculators, Model No. 283, at a dollar value of from Tronica. (CX-484, pp. 4, 7).

Nam Tai

486. Nam Tai sold Model calculators at in 1983 and Model calculators at in 1984 to . (CX-442).

487. Nam Tai manufactured six to seven models of calculators in 1981 that were exported to the United States. Two of these models has scientific functions. (Koo, CX-402, p. 23).

488. In 1984, Nam Tai sold calculators in the United States at a dollar value of . (Koo, RX-87, p. 3).

Voesa

489. The October 1984 issue of Asian Sources Electronics magazine, page 157, shows a calculator advertisment placed by Voesa, a manufacturer of calculators in Hong Kong for over two years. (Chow, CX-402, pp. 198-199).

490. purchased printing calculators from Voesa. (Ruwin, CX-461, pp. 60-61).

General Electronics

491. General Electronics began manufacturing calculators two to three years ago. (Chow, CX-402, p. 210).

492. General Electronics has manufactured calculators distributed by IMA in the United States. (SX-5, Interrogatory No. 11, p. 8).

493. General Electronics advertised portable calculators in Asian Sources Electronics in 1979, 1980 and 1982. (CX-570, p. 9; CX-509, p. 17; CX-510, p. 11; CX-514, p. 6).

APF

494. APF sold calculators with a value of in ; in ; and in to .

(CX-488; CX-489).

495. APF has sold the portable calculator Model No. 1983, made in Hong Kong. (CPX-4).

IMA

496. IMA coordinates the purchase and export of electronic products, including calculators, from Hong Kong to the U.S. (Schoenberg, CX-88, p. 1; Schoenberg, Tr. 2272; CX-552).

497. In its capacity as a liaison office between calculator manufacturers and its clients, IMA has dealt with the following calculator manufacturers, among others, and appears occasionally as the shipper of record

for their products:

. (Sx-5, Interogatory No. 11).

Cosmo

498. Cosmo imports for sale in the United States portable electronic calculators manufactured by Nam Tai. (Response of Cosmo Corporation to Complaint, ¶ 3.29).

Enterprex

499. Enterprex has purchased calculators from and in and from and in . (Yuan, CX-459, pp. 18-20).

500. In 1983, Enterprex purchased approximately calculators from and sold overall approximately calculators in 1983. Through the end of July 1984, Enterprex purchased approximately calculators from and sold overall approximately calculators for the same time period. (Yuan, CX-459, p. 72).

501. Enterprex has purchased approximtely calculators from . (Yuan, CX-459, p. 78).

502. Enterprex representatives attend the Chicago and Las Vegas electronics trade shows every year and the New York trade shows several times a year to promote Enterprex calculators. (Yuan, CX-459, pp. 60-62).

XIII. DOMESTIC INDUSTRY

TI's Consumer Products Division

503. TI's Consumer Products Division currently produces and sells calculators and educational products in the United States. Aside from certain desk top calculators that run off of line current and must therefore plug into the wall, all TI calculators are portable and battery powered, either by a chemical cell or a solar cell. (Heye, CX-5, p. 2).

504. Approximately employees in TI's Consumer Products Division are involved in various aspects of the production and sale of portable calculators for the U.S. market. (CX-320; Heye, CX-5, p. 3).

505. TI employs approximately , all of whom are involved in various aspects of TI's calculator R&D program. The R&D facilities are located in Dallas and Lubbock, Texas. (Heye, CX-5, p. 3).

506. From 1978 through 1984, TI's annual research and development budget for portable calculators averaged approximately . (CX-372).

507. Approximately employees are involved in TI's new product design and development process for portable calculators. These individuals are located in Dallas, Texas and include engineers, technicians and support personnel. (Heye, CX-5, pp. 3-4).

508. TI's Consumer Products Division employs engineers and technicians whose activities principally concern the assembly process. Most of these individuals are located in Lubbock, Texas. These individuals have no responsibility for . (Heye, CX-5, p. 4; Heye, Tr. 998).

509. TI's Quality and Reliability Assurance ("QRA") department is responsible for the comprehensive testing and product qualification of every portable calculator model sold by TI in the United States. The QRA department is located in Lubbock, Texas and employs individuals. The testing equipment and facilities utilized by this department occupy approximately square feet. Employees in the QRA department are also responsible for TI's products. (Heye, CX-5, p. 4; Heye, Tr. 1039).

510. TI's current facilities for assembling portable calculators are located in Lubbock, Texas. In 1984, TI used at the Lubbock plant covering a total area of square feet. During a normal working day, employees are involved with the assembly line, including both labor and supervisory and personnel. (Heye, CX-5, pp. 4-5; Heye, Tr. 1042).

511. In the fall of 1982, TI decided to certain calculator models . (Sick, CX-4, pp. 5-6; Sick, Tr. 968-970).

512. In 1984, TI assembled approximately calculators plus or minus in its Lubbock facilities. Currently, TI is assemblying approximately units per shift each day in the Lubbock facility which is operating at capacity, (Heye, Tr. 1042-1043).

513. In 1984 approximately of the professional calculators sold by TI were assembled at TI's Lubbock facilities. (Heye, CX-390, pp. 11-12).

514. In the first quarter of 1985 TI expects to of its professional calculators during the development of its process in Lubbock. (Heye, CX-390, p.12).

515. TI assembled no four-function calculators for 1984, nor will it in 1985, in its Lubbock facilities. (Heye, Tr. pp. 1000-01; Dolait, Tr. pp. 637-38).

516.

. (Dolait, Tr. 607-608).

517. The following components for all of TI's calculators are procured from suppliers: 1) ; 2) ; 3) ; 4) ; 5) and; 6) . (Evans, Tr. 886-889).

518. All of the calculators offered by TI in the 1984 catalog were . (Dolait, Tr. 602,603). TI the technology for . TI is currently working on the development of a and expects to be able to use it in its calculators sometime in , at which time TI expects to in the United States. (Evans, CX-393, pp. 17-18; Dolait, Tr. 607; Heye, CX-390, p. 64).

519. An additional employees in Lubbock provide purchasing, material handling and accounting services which support the calculator assembly operations. (Heye, CX-5, p.5).

520. The same personnel and facilities can be used for assembling all of the various portable calculator models in the TI line. (Heye, CX-5, p. 5).

521. Calculators sold in the United States and components used in U.S. assembly operations are subject to quality control inspection. TI's quality control department is located in Lubbock, Texas and employs individuals. The testing facilities of the quality control department are separate and distinct from those used by QRA for product qualification, occupy approximately square feet, and represent an additional investment of . (Heye, CX-5, p. 5).

522. Employees in TI's quality control department are responsible for products. (Heye, Tr. 1046).

523. Incoming components for calculators are tested by TI's quality control organization. The number of components tested and the nature of such tests depend upon whether a . (Heye, Tr. 1047).

524. Once the first commercial lot of a calculator model is released, TI thereafter conducts quality control tests upon calculators from . These quality control tests are conducted upon both calculators and calculators . (Jensen, CX-394, pp. 19-20, 24-25, Exhs. 1, 2; Heye, CX-390, pp. 32-33).

525. In-process quality checks are sometimes made by TI personnel during the production of new calculator models in the United States. (Heye, Tr. 1048-49).

526. TI has a group of individuals who prepare, revise and update the manuals and design the packaging for all TI's portable calculators. These individuals are located in both Dallas and Lubbock, Texas. (Heye, CX-5, p. 5).

527. TI's Consumer Products Division maintains a field sales organization, comprised of field salespersons and their clerical staff of about people, located throughout the United States. In addition, another individuals at the Division's Dallas and Lubbock offices are engaged in sales, customer service and marketing related activities. These employees are responsible for both calculator and educational products. (Heye, CX-5, pp. 5-6; Heye, Tr. 1050-51).

528. Although some calculators are packaged in a TI-designed box, TI also maintains a skin-wrapping operation in Lubbock which currently uses

machines, each of which costs . Approximately employees are currently involved in skin-wrapping portable calculators. (Heye, CX-5, p. 6).

529. Approximately of all calculators are skin-wrapped by TI in the United States. (Dolait, Tr. 653).

530. TI maintains a piece-parts warehouse in Lubbock, Texas which handles the components and raw materials for the calculator assembly operation as well as raw materials for the skin-wrapping operation. This warehouse employs people, occupies square feet and costs . (Heye, CX-5, p. 6).

531. All TI calculators sold in the United States are processed through a separate finished goods warehouse in Lubbock, Texas. This facility employs people, covers square feet of space and costs . (Heye, CX-5, p. 6).

532. TI maintains a network of 48 service centers across the country which provide post-sale service for TI consumer products, including portable calculators, educational products and home computers. In addition, there is a repair facility at TI's Lubbock plant which employs engineers, technicians and support personnel who conduct calculator repairs. The Lubbock repair center services all of the different models in the TI line of calculator products. (Heye, CX-5, p. 7; Heye, Tr. 1014).

533. The management of TI's Consumer Products Division as well as the individuals who perform administrative, financial, personnel, and support services are represented by an additional employees located in Lubbock and Dallas, Texas. (Heye, CX-5, p. 7).

Four-Function Calculators - 1984

534. TI has used the term "handheld" calculators to refer to four-function calculators, i.e., calculators which perform addition, subtraction, multiplication, and division, and usually include square root and percent keys. (Dolait, Tr. 728; CX-363 (1984), pp. 18-19, RX-57, ¶ 2.5).

535. In 1984, TI offered the following four-function calculator models for sale in the United States: TI-1706, TI-1766, TI-1780, and TI-1100. (CX-363 (1984), pp. 18-19; Dolait, Tr. 589-590).

536. TI-1706 is a solar-powered portable electronic calculatór featuring 4-key memory, automatic percent key, and square root key. This calculator was for TI in by and in . (CX-363 (1984), p. 18; Dolait, Tr. 590-91).

537. TI-1766 is a solar-powered portable electronic calculator with a 4-key memory, automatic percent key, and square root key. This calculator was for TI in by . (CX-363 (1984), p. 19; Dolait, Tr. 590).

538. TI-1780 is a solar-powered, horizontally-styled portable electronic calculator which features a 4-key memory and an automatic percent key. This calculator was for TI in by and in . (CX-363 (1984), p. 19; Dolait, Tr. 591).

539. TI-1100 is a battery-powered 6-function portable electronic calculator featuring "Automatic Power-down" which prevents accidental battery drain by turning the calculator off after approximately seven minutes of

non-use. This calculator was for TI in by in . (CX-363 (1984), p. 19; Dolait, Tr. 591).

540. TI purchased approximately calculators from and approximately calculators from in . (Dolait, Tr. 628-629).

Professional Calculators - 1984

541. Professional calculators are segmented into two groups, "business" and "scientific" calculators, some of which are programmable. (RX-57, ¶¶ 2.4, 2.6).

542. The terms "slide rule" calculators and "scientific" calculators are synonymous. (Dolait, Tr. 694).

543. In 1984, TI offered the following business calculators for sale in the United States: TI Business Analyst-II, TI Student Business Manager BA-45, and TI Professional Business Analyst BA-55 (CX-363 (1984), pp. 15-17).

544. Most of TI's business calculators were assembled in the United States in 1984. A few units were assembled for TI in by in . (Dolait, Tr. 602).

545. In 1984, TI offered the following scientific calculators for sale in the United States: TI-30-III, TI-30 SLR, TI-35 Student Math Kit, TI-45 Micro Scientific Printer/Display, and TI-55-II. (CX-363 (1984), pp. 12-13).

546. TI-30-III is a battery-powered portable electronic calculator containing the following functions: roots, reciprocals, powers, common and natural logarithms, and trigonometry. This calculator was for TI in

by and in . (CX-363 (1984), p. 12; Dolait, Tr. 592).

547. TI-30 SLR is a solar-powered version of TI-30-III. This calculator was for TI in by . (CX-363 (1984), p. 12; Dolait, Tr. 597).

548. TI-35 is a 54-function portable electronic calculator which performs most slide rule functions as well as pi, factorial, and statistics. Approximately 85-90% of these calculators were assembled by TI in Lubbock, Texas in 1984. Some TI-35 units were also for TI in by in . (CX-363 (1984), p. 13; Dolait, Tr. 598, 600-01).

549. TI-55-II is an advanced LCD slide rule calculator with programming, metric conversions, and integration capability. This calculator was assembled in 1984 by TI in Lubbock, Texas. A few units were ; these are presently in inventory in the United States. (CX-363 (1984), p. 13; Dolait, Tr. 601).

550. In 1984, approximately of TI's scientific calculators were . (Dolait, Tr. 609-611).

551. In 1984, TI offered the following programmable calculators for sale in the United States: TI-57 Programmable LCD, TI-66 Programmable, and TI-LCD Programmer. (CX-363 (1984), pp. 10-11).

Four-Function Calculators - 1985

552. In 1985, TI changed its terminology from "handheld" calculators to "general purpose" calculators. (CX-363 (1984), p. 18; CX-363 (1985), p. 26; Dolait, Tr. 729).

553. TI currently offers the following models of "general purpose" calculators for sale in the United States: TI-1100-II, TI-1706-II, TI-1746, TI-1766, TI Card TI-1786, TI-1795, and TI Checkwriter TI-2200. (CX-363 (1985), pp. 27-33).

554. TI-1100-II is an upgraded version of the TI-1100 calculator and is for TI by . (Dolait, Tr. 605).

555. TI-1706-II is an upgraded version of the TI-1706 calculator and is for TI by . (Dolait, Tr. 604-05).

556. TI-1746 is a solar-powered 6-function calculator newly introduced by TI by 1985. This calculator is for TI by . (CX-363 (1985), p. 29; Dolait, Tr. 605).

557. TI-1766 will in 1985. TI received approximately units from in January 1985. All 1985 sales of this calculator will be made from . (Dolait, Tr. 605, 766).

558. TI-1786 is a solar-powered credit card calculator. This calculator is for TI by . (CX-363 (1985), p. 31; Dolait, Tr. 606-07).

559. TI-1795 is a solar-powered general purpose calculator, also known as the "mini-desktop" calculator. This calculator is for TI by . (CX-363 (1985), p. 32; CPX-207; Dolait, Tr. 607, 731).

560. TI-2200 is a portable electronic calculator which is featured with a vinyl wallet designed to hold the calculator and a standard-sized checkbook. This calculator is for TI by . (CX-363 (1985), p. 33; Dolait, Tr. 607).

Professional Calculators - 1985

561. TI currently offers the following models of scientific/programmable calculators for sale in the United States: TI-30-III, TI-30 SLR, TI-35-II Student Math Kit, TI-35 Solar Student Math Kit, TI-35 Galaxy Solar Student Math Kit, TI-45 Micro Scientific Printer, TI-55-II, and TI-66 Programmable. (CX-363 (1985), pp. 18-25).

562. TI-30-III is currently for TI . TI plans to make all units of this calculator in the United States in . (Dolait, Tr. 603-04).

563. TI-30 SLR is for TI and will continue to be so in . (Dolait, Tr. 604).

564. Ninety-five percent of TI-35-II units are assembled in Lubbock, Texas. Approximately 5% of TI-35-II units are . (Dolait, Tr. 604, 765, 766).

565. TI-35 Solar Student Math Kit is for TI in and will continue to be so throughout . (Dolait, Tr. 605).

566. Ninety-five percent of TI-55-II units will be assembled in the United States in 1985. (Dolait, Tr. 766).

567. TI-66 Programmable calculators are for TI in . (Dolait, Tr. 733).

568. In the first quarter of 1985, approximately of TI's scientific calculators will be . (Dolait, Tr. 611, 612).

569. TI currently offers the following models of business/financial calculators for sale in the United States: TI Business Analyst-II, TI Student Business Analyst BA-35, Micro Business Manager BA-45, and TI Professional

Business Analyst BA-55. Ninety-five percent of all business calculators are assembled by TI in Lubbock, Texas. (CX-363 (1985), pp. 13-16; Dolait, Tr. 734)

570. TI is now implementing a plan to the Lubbock assembly lines. Construction is underway and completion is expected by the . The line will occupy approximately square feet and will have a capacity of approximately calculators per shift. TI expects to run no less than per day. Production of professional calculator models on a low volume basis is expected to begin in and it is expected that all professional calculator models will be assembled in Lubbock by the end . (Heye, CX-5, pp. 9-10; Heye, Tr. 1044-45).

571. The process will be capable of making both professional and four-function calculator models. TI expects to begin assembly of its four-function calculators on its line in Lubbock in . (Heye, Tr. 1078; Heye, CX--390, pp.65-66).

<u>TI Portable Electronic Calculators Alleged To Be Under The '921 Patent</u>

572. Of the foregoing portable electronic four-function calculators offered for sale by TI in the United States in 1984 and 1985 (as reflected in TI's 1984 and 1985 catalogs, CX-363), the following models were evaluated and determined by TI to be covered by the claims of the '921 patent: TI-1706, TI-1766, TI-1780, TI-1100, TI-BA-45, TI-30-III, TI-30 SLR, TI-35, TI-35-II, TI-57-I, TI-66, TI-1746, TI-1766, TI-1786, TI-1795, TI-30-III, TI-35, TI-BA-35 and TI-BA-45. (Leach, CX-3, pp. 22-23; see Dolait, Tr. 767).

TI's Calculator Product Cycle

Calculator Development And Qualification

573. As part of its R & D efforts, TI is continually engaged in new product design and development. As the current models in its line of calculator products lose their consumer appeal, new models are developed to replace them. (Heye, CX-5, p. 14).

574. TI personnel are constantly redesigning the portable calculator models to add new functions, change styling, or otherwise enhance marketability. At present, TI redesigns more than   of the portable lculator models in its product line each year. (Heye, CX-5, pp. 14, 15).

575. The following table represents the TI line of portable four-function and professional calculators for the years 1979, 1981, 1983, and 1985, as reflected in catalogs contained in CX-363:

1979	1981	1983	1985
1010			
1025			
1030			
1750	1750-II		
DataChron			
DataCard			
BA-II	BA-II	BA-II	BA-II
MBA	MBA		
Bus. Card			
Programmer	Programmer	Programmer	
30	30-II	30-II	30-III
25			
35	35	35	35-II
50			
55	55-II	55-II	55-II
57	57	57	
58C	58C		
59	59		
	1001	1001	
	1031	1031	

1755	—	
1766	1766	1766
Time M.		
Check W.		Check W.
1850	1850	
Converter	Converter	
40		
54	54	
Invest A.		
	1006	
	1776	
	30-SLR	30-SLR
	Student BA	Student BA
	Prof. BA	Prof. BA
	E.T.	1100-II
		1706-II
		66
		45
		Micro BA
		1746
		1786
		1795
		Galaxy

(CX-363 (1979, 1981, 1983, 1985)).

576. In 1985 and 1986 TI will introduce   new calculator models, respectively. (Heye, CX-5, p. 15; CX-360, pp. 015728, 015732).

577. TI conducts ongoing research regarding calculator components, and in particular the   . Chip design is extremely complicated, typically taking several engineers   to complete their work. TI engineers write the software that directs the sequence of events by which the chip's circuitry performs each computation or operation. (Heye, CX-5, pp. 13).

578. Once a new model is conceived, TI prepares detailed product specifications of all components, including chip, power source, keyboard layout, display and housing. The goal of the design process is to provide a low cost calculator which is durable and of pleasing appearance, and which reliably performs the required functions. (Heye, CX-5, p. 15).

579. Some calculator components may not be commercially available and must be developed by TI. For example, TI developed the Clexon keyboard in response to a need for a low cost, reliable keyboard. (Heye, CX-5, p. 15; Heye, Tr. 1067).

580. Through the efforts of TI's new product design employes, working jointly with TI's research and development staff, TI controls the layout, design and product specifications of every portable calculator sold in the U.S., including models . (Heye, CX-5, pp. 3-4; Heye, CX-390, p. 64; Jensen, CX-394, p. 9; Sick, CX-392, pp. 33-34, 43-45; Dunn, CX-389, pp. 50-52, 98-101).

581. With respect to its calculators TI will, at times, qualify an already existing model of calculator. In such instances the calculator must qualify by meeting TI specifications. (Jensen, CX-394, pp. 10-12; Dolait, Tr. pp. 633-635).

582. Three of the four four-function calculators offered by TI in its 1984 catalog are of calculators by . (Evans, CX-393, pp. 17-18).

583. TI evaluates the designs of all of its calculators, develops test requirements to qualify each of its calculators, engages in qualification testing, evaluation of test results and determines what design changes, if any, are required. All of these processes apply to each of TI's calculator models, . (Jensen, CX-394, pp. 6-9).

584. The following is an example of qualifying work done by TI with respect to . TI went to the

. In these instances, TI specified external styling changes relating to the location of keys and the color pattern. It also required the following internal design changes: the printed circuit board had to be relaid; a had to be added; the packaging had to be changed to meet TI transportation tests; the methods of attaching internal components had to be changed and; material used in the assembly of the two units had to be changed in order to pass TI temperature tests. (Jensen, CX-394, pp. 12-13).

585. After the design of a particular model has been completed, the next steps are to arrange for necessary tooling and molds and to begin prototype assembly. (Heye, CX-5, p. 15).

586. The major components of a calculator are: a top case; a bottom case, usually plastic; a printed circuit board or a piece of flexible film; a semiconductor device, commonly referred to as a MOS; a display, such as a liquid crystal display; a battery or solar cell; a keyboard, usually made of an elastomeric material; a key set or individual keys of the calculator. (Evans, Tr. 882-83).

587. PCC Tooling is the initial start-up cost for tooling a new product. A PCC is a profit control center which is responsible for the initial design and testing of the new product. (Reed, CX-391, pp. 29-30).

588. With respect to calculators, TI may develop "pcc tooling" in the

.

The current trend is to

for the cost of the tooling. (Reed, CX-391, p. 30).

589. Designing a for can cost TI as much as . (Dolait, Tr. 669).

590. PCC tooling includes the cost of developing the box and owner's manual for calculators. (Dolait, Tr. 669).

591. For calculators is responsible for the development of the tooling or the metal mold for the top case based upon TI's design, and for the insides of the product. (Evans, Tr. 883).

592. Once the design of a particular model has been completed, and the necessary tooling and molds developed, a prototype is assembled. TI's Quality and Reliability Assurance "QRA" Department in Lubbock is responsible for comprehensive component and prototype testing an qualification of every portable calculator model to be sold in the U.S. (Heye, CX-5C, pp. 14-15). To meet this responsibility, TI's QRA Department has developed QRA criteria that are applied to all TI calculator products, both those in the U.S. and those . (Jensen, CX-394, pp. 15-16, Dunn, CX-389, p. 96).

593. Each of the component parts proposed to be used in the assembly of any new calculator model is separately tested and must be approved by TI's QRA Division before it can be used in production, regardless of whether will occur in the U.S. . Such QRA tests are conducted at TI's testing laboratories in Lubbock, Texas, on each part proposed to be used in the calculator, such as electronic devices, LCD's, keyboards, printed circuit boards, plastics and clips. (Jensen, CX-349, p. 9; CX-388, pp. 2-3; e.g., CX-376 (electronic devices); CX-377 (LCDs); CX-378 (button type cell batteries).

594. Once the component parts receive QRA approval, a prototype batch of the new model must still pass TI's QRA procedures and be certified by

the QRA group prior to approval for commercial production. TI's QRA procedures are designed to expose and remedy any operating weaknesses in the new calculator models by simulating of actual use of calculator units. (CX-388, p. 3; Heye, CX-5, p. 15).

595. One complete set of QRA tests requires a minimum of to complete, but the actual qualifying time for a model may be as long as , as defects are identified, corrective measures researched and developed, suggested changes incorporated into the product, and QRA procedures again run on the modified calculators. (CX-388, p. 3; Heye, CX-5, pp. 15-16; Dolait, Tr. 625-626, 634-635).

596. Approximately calculators are required to be submitted from the same assembly line which will be used for the full-scale commercial assembly. The calculators are spilt into six groups (A-F) of calculators each, with group E including at least survivors from each of groups A-D and group F having at least survivors of all prior tests. (CX-388 pp. 3-4); Heye, CX-5, p. 15).

597. All calculators are required to be functional before, during and after testing. If even one calculator fails to operate after any of the tests, the model is considered defective and an investigation is undertaken to determine necessary changes to correct the problems. New models are then assembled and subjected again to the qualification tests. (CX-388 p. 4; Heye, CX-5, p. 15).

598. The Group A calculators are subjected to tests, tests, tests, tests, tests and tests. Group B is subjected to tests from for required periods of time. Group C is subjected to

and for days and required to operate continuously. Group D is required to operate for at a temperature of ; the calculators are also tested at and required to operate for . Group E is a comprehensive test using calculators from the prior groups. Calculators in Group F are provided from passing calculators in prior groups, and are subjected to tests and testing . (CX-388, p. 4; Heye, CX-5, p. 15; CX-379).

599. As the initial round of QRA tests is completed, the QRA division prepares a detailed report for each test failure. These results are transmitted to the TI design team for the model, which examines the results, researches the problem, develops changes necessary to correct any identified problem, and requires that these changes be incorporated into the calculator model. The process of reviewing QRA test results involves representatives from several disciplines at TI, including electrical and design engineers, QRA staff and marketing personnel, who consult to address any problems/defects identified by the QRA procedures. (CX-388, pp. 4-5; Heye. CX-5, pp. 15-16; Jensen, CX-394, p. 16).

600. After these design changes are made, another calculators are tested to ensure that the modifications actually remedy the defect. Any additional problems identified by each subsequent QRA test are corrected by additional design changes developed by TI staff in Texas. These design changes may cover the entire range of calculator components, including layout of the printed circuit board, design of electronic components, quality of plastic and other materials, methods of attaching internal components, layout of internal components, packaging, and other items. (CX-388, p. 5; Heye, CX-5, pp. 15-16; Jensen, CX-394, pp. 12-13).

601. During initial product qualification, as many as units of a calculator will be tested. (Dolait, Tr. 797-798).

602. During the entire process of taking a new calculator model from conception through product qualification to the point where commercial production may begin , TI engineers will work approximately . (Heye, CX-5, p. 16).

603. Qualifying a consumer handheld calculator requires less effort than for more complex calculators though the time and the number of tests required for qualification are the same. (Jensen, CX-394, pp. 17-18).

Assembly

604. The decision on whether and when to a given model depends on many factors, including the demands on TI's production resources, comparative cost factors, the risk of delays and poor quality work in , and similar considerations. (Heye, CX-5, p. 16).

Manual and Packaging Design

605. TI has a group of individuals located in both Dallas and Lubbock, Texas who prepare, revise and update the instruction manuals and design the packaging for all of TI's portable calculators. (Heye, CX-5, p. 5).

606. The development of a box and manual for a calculator assembled offshore can cost TI as much as . (Dolait, Tr. 668).

607. Owner's manuals for calculators are in the United States. (Dolait, Tr. 725-26).

Packaging

608. All calculators sold as skin-wrapped are skin-wrapped in Lubbock, Texas. (Dolait, Tr. 763).

609. Some of the portable calculators sold are sold in a TI-designed box. (Heye, CX-5, p. 6).

610. Approximately of all calculators are skin-wrapped in the United States. (Dolait, Tr. 653).

611. In the first quarter of 1984, approximately of TI's four-function calculators were skinwrapped. (RX-71, p.10153). For the months of September, October and November of 1984, approximately of TI's four-function calculators were skinwrapped. (RX-74, p. 508152; RX-77, p. 507884; RX-80, p. 508351).

612. In the skin-wrapping process, the calculator units are fed into magazines and then brought together with the back hardboard. Typically, a manual is put underneath the calculator and the machine then performs a wrap-around process, which is a heated process. The material is clear and sticks to the back of the hardboard by virtue of an adhesive that is applied to the hardboard. (Heye, Tr. 1053, 1054).

613. TI receives a cent per unit from its for those units that TI skinwraps because ships them in bulk rather than individual packaging. (Evans, CX-393, p. 25; Heye, Tr., 1011).

614. TI does amount for a skin-wrapped calculator. (Dolait, Tr. 654).

615. Skin-wrapping serves a promotional purpose, as one way to present the calculator for merchandising. (Dolait, Tr. 653).

Quality Control

616. Irrespective of where calculator occurs, all TI portable calculators sold in the U.S. undergo a quality control ("QC") program . As in the case of initial product qualification, there is a coordinated effort among TI's engineering staff, QRA and QC departments and the assembley managers to head off and correct any potential quality defects during assembly. (Heye, CX-5, p. 17).

617. Like the QRA Department, TI's QC Department is located in Lubbock, Texas. The QC group employs individuals and uses testing facilities separate and distinct from those used by QRA for product qualification. (Heye, CX-5, p. 5).

618. Initially, after approval for commercial assembly by the QRA Department, TI performs a so-called "mini-qualifying test" on the first commercial lot of the model, . The nature and extent of this test depend on the performance of the sample prototype models during the prior QRA procedure and are designed to ensure that any problem areas identified during the QRA procedure have not resurfaced during commercial assembly. (CX-388, pp. 5-6).

619. TI's perform some in-house checks, such as testing of incoming components and in-process checks. (Heye, Tr. 1049).

620. Once the first commercial lot of a calculator model is released, TI thereafter conducts quality control tests to a sample of

calculators from . (Jensen, CX-394, pp. 19-21 and Exhs. 1, 2; Heye, Tr., 1002, 1003; Heye, CX-390, p. 32). The QC tests for each model are tailored to fully test the functions of all features on the particular model. (CX-388, pp. 5-6).

621. The following table represents the sampling size of calculator units upon which TI conducts its "QC" procedures:

Lot Size	Sample Size	Percentage Sampled
0- 1,200		-
1201- 3,200		-
3201- 10,000		-
10001- 35,000		-
35001-150,000		-

In no instance will the sample consist of less than units from any lot. (CX-381, pp. 507467-507569).

622. Exceptions to the above sampling criteria may be granted for unusual situations or products. (CX-381, p. 507468).

623. Every calculator unit in the sample is checked for applicable defects listed under the three categories below:

-
-
-
-
-
-
-
-
-
-
-

(CX-381, pp. 507466, 507468).

624. TI initially performs a so-called test on each calculator in the sample, consisting of and examinations designated by the specific test procedures for the model. (Jensen, CX-394, Exh. 1, p. 507648). All units which pass the test are then subjected to the procedure. The conditions for each model are individually

defined in the specific product test specifications, but all tests require operation of the calculator for . (Jensen, CX-394, Exh. 1, p. 507648).

625. The test in the procedure for four-function calculators involves testing of all of the calculator's functions, for example, punching all the keys and ensuring that the entries achieve the desired result. If the unit is solar, it is tested to ensure that the amount of light impending on the solar cell needed to make it work meets specifications. If it is a battery unit, it is tested to ensure that the unit doesn't draw excessive current. (Jensen, CX-394, p. 20).

626. Upon receipt of the initial lot of a new product, a unit sample is selected for a . This procedure consists basically of powering the unit up for a period of to ensure that it continues to function. (CX-381, p. 507465; Jensen, CX-394, pp. 21-22, 30).

627. Subsequent lots of product will have the test performed on a minimum of per month. units will be selected from the first lot received and a minimum of units from each lot will be selected for the remainder of the month. (CX-381, p. 507465).

628. In addition to the test, a sample of units from each lot of calculators is also subjected to tests, and tests. (CX-355, p. 506720; Evans, Tr. 891, 892).

629. In the test, the unit is kept and tested at set intervals. At these intervals, a person physically performs a specified key routine and receives a specified answer at the end of the routine. (CX-355, p. 506720; Evans, Tr. 892-93).

630. In the test, the unit is

. The interval routine performed during the test is then performed at set intervals. (CX-355, p. 506720; Evans, Tr. 893).

631. TI's QC personnel maintain an accounting and flow system to track receipt and testing of products, documentation of product specification and test routines and publishes weekly and monthly summaries of product activities. (CX-381, p. 507469).

632. The tests control the release of each commercial lot. A lot will be released to customers only if the "acceptable quality level" ("AQL") is met for both tests. (Jensen, CX-394, pp. 26, 29 and Exh. 1, p. 507648).

633. Any test failures will be reviewed by TI's QC, engineering, and manufacturing divisions. (Jensen, CX-394, Exh. 1, p. 507648).

634. A lot rejection will be cause for the lot to be

. (Jensen, CX-394, Exh. 1, p. 507648).

635. While TI's inspect the calculators during the production phase, acceptance of a calculator is not complete until it has passed TI's incoming inspection in Lubbock. (Heye, CX-390, p. 32; Jensen, CX-394, p. 22; Heye, Tr. 1049)

636. Should systemic failures begin to appear in the field after a lot is released, TI immediately calls in the appropriate engineers to evaluate the matter, as well as QRA personnel to run additional, more extensive tests. (Heye, CX-5, p. 17).

Warehousing

637. All TI calculators sold in the U.S., regardless of where , are processed through TI's finished goods warehouse, where personnel compile the calculators to respond to customer orders. (Heye, CX-5, p. 6; Heye, Tr. 1055-56).

Repair and Service

638. TI has 48 service centers in the U.S. which assist in the exchange of defective calculators and monitor the quality of TI's calculator products through these exchanges. (Dolait, Tr. 727; Heye, CX-5, p. 7).

639. TI's Lubbock repair center services all of the different models in the TI calculator line. (Heye, CX-5, p. 7).

640. TI maintains spare parts and/or replacement products in its warehouse for after the product is removed from production. (Evans, Tr. 895).

641. The following table represents net units billed (NUB), units repaired and the percentage of units repaired for the years 1980, 1981 and 1982 and forecast for 1983. All of the figures relate to TI's four-function calculators:

	1980	1981	1982	Forecast 1983
NUB (KU)				
Units Repaired				
Percent Repaired				

(RX-27, p. 506678; Evans, Tr. 862-864).

642. The downward trend in percentage of units of four-function calculators repaired has continued and the current percentage is approximately or slightly less. (Evans, Tr. 864, Dolait, Tr. 647-648).

643. Approximately of the returned calculators only need a . In such instances, the is is removed and a computational check to ensure proper operation is performed. (Evans, Tr. 868).

644. Because of the rapid turnover in calculator models, some calculators that are no longer in production or inventory may be returned by customers for repair. For such discontinued models, TI generally will . If repair parts are not available, TI will generally . (RX-160, Response to Interrogatory 114).

645. When a four-function calculator is returned as defective it is almost always by TI with a new calculator rather than being . (Dolait, Tr. 649).

Sales and Marketing

646. TI's sales force consists of approximately field salesmen and their clerical staff of about people, located throughout the country. In addition, another individuals at the Consumer Product Division's Dallas offices and in Lubbock are engaged in sales, customer service and marketing-related activities. (Heye, CX-5, pp. 5-6). TI's sales and marketing staff are responsible for products. (Heye, Tr. 1050).

647. The TI sales force is an integral part of the entire calculator business and plays a key role in new product development. The sales organization closely monitors developments in the market and provides input regarding consumer attitudes and trends which is critical for TI's new product development and design efforts. (Heye, CX-5, p. 17).

648. TI's field sales staff is responsible for dealing with any shipping problems TI may experience. (Rado, CX-6, pp. 19-20).

The Significance of TI's Non-Assembly Activities

649. TI technical product support activities, including product design, technical product development, and facilities engineering, are crucial to the continued success of TI as a competitor in the calculator market. These activities are integral to the purely manufacturing aspects of calculator production. (Finan, CX-7, p. 6).

650. The semiconductor industry presents a somewhat similar situation to the calculator industry in terms of the relationship of the activities of design and testing to the overall competitive capabilities of the industry. Process steps in the semiconductor industry can be separated into four elements: (i) device design; (ii) fabrication of the chip; (iii) assembly of the device; and (iv) final test or QC. The most complex steps are the first two and, increasingly, the last one. Assembly is not a difficult production step. Assembly is a mundane procedure; it is essentially just a packing or packaging operation. (Finan, CX-7, p. 6; Finan, Tr. 1633-34).

651. An efficient assembly operation contributes to the overall competitiveness of a semiconductor firm, but the other process steps are more important in determining a firm's competitive position. (Finan, CX-7, p. 6).

652. Design and testing operations are critical steps in the semiconductor industry. Product designs influence both product manufacturing costs as well as the reliability of the product, and competitive designs create demand. Testing is essential because competitive market pressures have led to the requirement that firms maintain an extremely high reliability rate for devices in the field. (Finan, CX-7, p. 6).

653. The importance of activities in determining the overall competitive position of a firm cannot always be judged by a numerical calculation of how much value added comes from that activity. (Finan, Tr. 1633).

654. In the semiconductor industry the performance of design is not a very significant proportion of the total value added or the total value of the final device, but it is pivotal to determining whether the firm will be successful in the marketplace. (Finan, Tr. 1633).

655. In considering the options for in , TI rejected any proposal to models and decided that the critical aspects of the business, from product design through product qualification and quality control, to inventory and shipping, would continue to be conducted by TI employees. (Dunn, CX-611, pp. 2-3).

656. TI considers product development, design and quality to be critical for success in the calculator business. (Sick, CX-4, p. 6).

657. All elements of a calculator, including the chip, the keyboard, the display, assembly, packaging, and marketing, are important. No single element is controlling. (Sick, Tr. 911-12).

Activities of Importers and Merchandisers

658. Spectra Merchandising International, Inc. (Spectra) is a merchandising and marketing company which imports products; it does not produce them. (Schoenberg, CX-457, p. 86; Schoenberg, Tr. 2335).

659. IMA - Hong Kong, Limited (IMA) acts as a liaison or confirming agent for Spectra. (Schoenberg, CX-457, p. 23).

660.

it is tested against various objective performance standards. (Schoenberg, CX-457, p. 133).

661.

The design work they have been engaged in is calculator outline, the color of the buttons and where the metal inlay goes --

. (Schoenberg, CX-457, p. 135).

662.

.

(Schoenberg, Tr. 2303-04).

663. IMA/Spectra have developed engineering specifications which must be met by manufacturers in order to ship to IMA/Spectra. (Schoenberg, Tr. 2319).

664. From time to time IMA/Spectra recommends to the manufacturer what they feel the market needs (e.g., what kind of calculator features it may need) and the manufacturers may or may not take that advice. (Schoenberg, CX-457, p. 135).

665. Of IMA's approximately employees,

. (CX-528, Responses to Interrogatories 5, 26).

666. Spectra takes back all defective calculators that are in warranty in exchange for a credit and asks its retailer customers to replace a consumer's defective calculator on the spot. (Schoenberg, Tr. 2321). If the calculator is not in warranty, Spectra replaces it for a fee. (Schoenberg, CX-457, p. 22).

667. does not manufacture any products in the United States. It is an importer. (, CX-461, pp. 9, 84).

668. does not act as a broker importing the calculators into the United States; it takes title to them and sells them. (, CX-461, pp. 5-6). maintains inventory in the United States. (, CX-461, p. 10).

669. inspects calculators offshore (through an affiliated company), and it inspects calculators when they come into the United States. (, CX-461, p. 6).

670. provides two year warranties for calculators that it sells and for a $3.50 shipping and service charge will replace or repair any calculator that comes in at its own facility in the United States. (, CX-461, pp. 8-9).

671. In the United States, unpacks, imprints, and then repacks for shipment the calculators it imports. It also does a limited amount of gift packaging or personalized packaging at the customer's request. (, CX-461, pp. 9-10).

672. The only design activity in which engages is limited to cosmetics. will take an existing calculator and cosmetically change it. (, CX-461, p. 50).

673. imports calculators from the Orient. (, CX-450, pp. 4-6).

674. overseas office inspects the goods by verifying that the model, color and packaging conform to the customer's order. (, CX-450, pp. 29, 31-32).

675. sources products for companies predominantly in the consumer electronics field. (, CX-458, p. 13).

676. Some of customers

. (, CX-458, pp. 43-44).

677.

. (, CX-458, p. 44).

678.

. (, CX-458, p. 46).

679. offers a 90-day warranty for products that it sells. (, CX-458, pp. 44-45, Exh. 5).

680. is in the premium business. (, CX-462, p. 7).

681. sends a mock-up or artwork of its customer's name and logo to Hong Kong manufacturers to use in making samples that then sends to its customers. (, CX-462, p. 8).

682. usually examines each imported product or a sample thereof. It does not monitor the manufacture of that product (, CX-462, p. 9).

683. does not maintain an inventory of portable electronic calculators. (, CX-462, p. 10).

684. A company with which is associated provides a warranty for the calculators it sells, whereby defective calculators are replaced rather than repaired. (, CX-462, pp. 5, 10, 19-20).

Value Added

685. The average unit selling price of TI's four-function calculators in 1984 was (CX-397)).

Research and Development

686. TI's research and development expenses for calculators include OST and PCC tooling. (Dolait, Tr. 644,774).

687. PCC (product cost center) tooling represents the initial start-up tooling for a new product. (Reed, CX-391, p. 30).

688. OST (objective strategy tactics) is one part of TI's research and development, (R & D) costs. OST includes market research, initial product launch costs, design, and product specification costs and product qualification costs. (CX-349, p. 502174; Reed, CX-391, pp. 33-34, 36; Dolait, Tr. 636-637, 640-641).

689. Although most of OST costs in 1983 and 1984 were spent on and calculators, some of these expenses relate to total calculator strategy and thus benefit the entire calculator line. (Dolait, Tr. 663).

690. In January 1984, TI forecast that its 1984 OST expenditures for four-function calculators would be of TI's net sales billed or NSB.

(RX-44, p. 501906). That represents (CX-397) or a total of

.

691. In November 1984, TI forecast that its 1985 OST expenditures (including PCC) for four-function calculators would be . (RX-77, p. 507868).

692. The design and specification costs are considerably higher for a product which TI makes and introduces in the U.S. than the costs associated with a product for which TI . (Dolait, Tr. 642).

693. In November, 1984, TI estimated that for consumer handheld calculators in 1985, market research and product launch will cost about or approximately of OST for consumer handheld calculators while the remainder of OST, including PCC, will comprise or approximately of OST. (RX-77C, p. 507868).

694. In November 1984, TI estimated that market research and product launch expenses for all calculators for 1985 would comprise approximately of OST while the remainder of OST, including PCC, would comprise approximately for all calculators . (RX-77, p. 507868).

695. TI's market research and product launch expenses for all calculators in 1984 comprised approximately OST, while the remaining expenditures for engineering and design comprised approximately of OST. (Dolait, Tr. 641-642).

696. Employing the same percentage of OST expenses expected to be devoted by TI in 1985 to non-market research and product launch OST activities for its four-function calculators to TI's 1984 OST costs, the following approximation is reached: TI's 1984 OST costs comprising non-market research

and product launch expenses devoted to its four-function calculators is estimated to be (FF 690) (FF 693)).

697. The per unit value added to TI's four-function calculators in 1984, resulting from TI's non-market research and product launch OST costs is estimated at approximately (FF 696) (Net units billed, NUB, 1984, CX-397).

698. The per unit value added to TI's four-function calculators in 1985, resulting from TI's non-market research and product launch OST costs (including PCC costs) is estimated at approximately (FF 693) (forecasted NUB for 1985) RX-77, p. 507886).

Repair/Replacement

699. The trend in the percentage of four-function calculators repaired by TI has continued since . (Evans, Tr. 862-864; RX-27, p. 506678).

700. TI estimates that its current percentage of repair for four-function calculators is approximately or slightly less or approximately . NUB (CX-397) x . (Evans, Tr. 864; Dolait, Tr. 647-648).

701. When a four-function calculator is returned as defective it is by TI with a rather than being . (Dolait, Tr. 649).

702. Assuming that all of the approximately units returned for repair in 1984 were at a cost to TI represented by the average cost to TI as of June, 1984 of its four four-function calculators offered in

its 1984 catalog or (TI-1100) + (TI-1706) + (TI-1766) + (TI-1780)/4). (CX-363(1984); RX-61, pp. 011032-33); the total cost to TI for repair of its four-function calculators for 1984 was .

703. An approximate value added by TI's repair/replacement activities in 1984, directed at its four-function calculators, pro-rated across TI's total four-function calculator sales for a per unit value, is (FF 702) (RX-397).

Quality Control

704. "Quality control" refers to several functions applicable to both U.S. and off-shore assembled calculators. (Reed, CX-391, pp. 19-20).

705. "RMR" means "return machine receiving" and refers to units returned to TI's repair center. (Reed, CX-391, pp. 22-23).

706. "In warranty" refers to products returned directly to the factory to be repaired.. (Reed, CX-391, pp. 24-25).

707. Of the allocated in 1984 to quality control, "RMR" and "in warranty," TI estimates that approximately is attributable to quality control and is attributable to RMR and in warranty. (CX-349, p. 502174; Dolait, Tr. 646-47).

708. For the first 10 months of 1984, the NUB for TI's four-function calculator models was units. (NUB through 9/84: (RX-74, p. 508097) + NUB 10/84: (RX-77, p. 507884).

709. For the first 10 months of 1984, the NUB for all TI calculators was units. (RX-77, p. 507829).

710. The pro rata share of four-function calculator units sold by TI in 1984 was NUB (FF 708) NUB(FF 709)).

711. The pro rata share of the approximately of quality control costs (FF) attributable to TI's four-function calculators is approximately x. (FF 710)).

712. The value added to TI's four-function calculators as a result of its quality control activities, on a per unit basis, is approximately (FF 711) (RX-397)).

Skinwrapping

713. The total cost of skinwrapping, including material, labor and overhead is approximately per unit. (Dolait, Tr. 653-654; Heye, CX-5, p. 6; Heye, Tr. 1006-07; see Evans, CX-393, p. 25).

714. For the first quarter of 1984, of TI's four-function calculators were skinwrapped. (RX-71, p. 10153).

715. For the months of September, October and November, 1984, TI skinwrapped approximately of its four-function calculators. (RX-74, p. 508152; RX-77, p. 507884; RX-80, p. 508351).

716. Averaging the percentage of four-function calculators skinwrapped by TI in six months of 1984, approximately were skinwrapped for all of 1984 (average of and (FF 714,715)

717. Assuming the cost of skinwrapping a calculator is (FF 713) and of TI's four-function calculators were skinwrapped in 1984 (FF 716), the pro rata value added by skinwrapping per unit, is approximately

. x ; x .

718. The total value added to TI's four-function calculators (on a per unit basis) by its activities pertaining to those calculators of research and development, repair/replacement, quality control and skinwrapping is approximately . (FF 697,698,703,712,717) or approximately of the average selling price of a TI four-function calculator (FF 685), .

719. The cost of skin-wrapping a professional calculator is slightly higher than the cost for four-function calculators. (Dolait, Tr. 794-95).

Overhead and Administration

720. There are four TI cost categories which include overhead and administrative costs: LAB/MOH, ALLC OOH/FD, OWN D+A, and ALLOC D+A. (CX-349, p. 502174; Reed, CX-391, pp. 17-19, 26-29, 32-33, 36-37, Exh. 1).

721. LAB/MOH is TI's direct labor and manufacturing overhead. It includes the direct labor costs and the total costs of running a manufacturing facility for TI's calculator production. For calculators assembled offshore this category includes only the labor and manufacturing costs of skinwrapping. (Reed, CX-391, pp. 17-19).

722. The total administrative and overhead costs forecast by TI for 1984 (excluding LAB/MOH expenses) were . (CX-349, p. 502174; Reed, CX-391, pp. 17-19, 26-29, 32-33, 36-37 and Exh. 1).

723. ALLC OOH/FD is "Allocated Other Overhead/Freight + Duty". Allocated other overhead includes warehousing and the material planning people who work closely with manufacturing and are not directly involved in manufacturing. It also includes raw material warehouse expense, finished good

warehouse expense, and the cost of certain material planners. With respect to offshore calculators, these two categories include incoming freight and duty that is a direct cost of the product as well as freight and duty TI cannot attribute directly to a product, costs of warehousing and material planning. (Reed, CX-391, pp. 26-29).

724. OWN D&A is "Own Department and Allocated" expenses. It is the cost of the people in the calculator business whose sole function is dedicated to managing the calculator business. (Reed, CX-391, p. 32).

725. ALLOC D&A is "Allocated Department and Allocated" expenses. It comprises the general corporate expenses allocated to calculators. It includes the cost of the Controller for calculator and eductional products, the marketing manager and TI's legal staff. (Reed, CX-391, p. 36).

726. Monies spent by TI for material, labor, overhead, allocation overhead, pcc tooling, product support, D & A, OST, and allocated D & A are attributable in part to expenses incurred in the United States relative to the calculators. (Dolait, Tr. 650-651).

727. For the first nine months of 1984, the NSB (net sales billed) for TI's four-function calculators was . (RX-74, p. 508097). For the first nine months of 1984 the NSB for all TI calculators was (RX-80, p. 508363: .

728. The four-function calculators pro rata share of NSB for 1984 is approximately (FF 727) (FF 727)).

729. The total overhead and administrative costs allocated to TI's four-function calculators is approximately (FF 722) x (FF 728)).

730. The total overhead and administrative costs allocated to TI's four-function calculators on a per unit basis is approximately . (FF 729) NUB 1984 (CX-397)).

731. The total value added to TI's four-function calculators (on a per unit basis) by its activities pertaining to those calculators of research and development, repair/replacement, quality control and skinwrapping, as well as TI's administrative and overhead expenses allocated to its four-function calculators is approximately . (FF 718,730) or approximately of the average selling price of a TI four-function calculator (FF 685), .

Alternative Value Added Analysis

732. The average unit selling price of TI's four-function calculators in 1984 was NSB/ NUB (CX-397).

733. The per unit product support expense for low end models is less than of the average unit selling price (Rado, Tr., 1389), or approximately .

734. During 1984, more than of TI NUB of four-function calculators were accounted for by three models: TI-1100, TI-1706 and TI-1766 (CX-397).

735. The following data represent the NUB*, per unit assembled cost **, and the per unit freight and duty ***, for each of models TI-1100, TI-1706 and TI-1766 for 1984:

TI-1100	Units sold in 1984	=
	Per unit assembled cost	=
	Per Unit F&D	=
TI-1706	Units sold in 1984	=
	Per unit assembled cost	=
	Per unit F&D	=

TI-1766	Units sold in 1984	=
	Per unit assembled cost	=
	Per unit F&D	=

Weighted Average Per Units Cost (including F&D) =

* Units sold data from CX-397.
** Per unit assembled cost equals average of box and bulk cost for 4th Quarter as shown on RX-61, pp. 11032-33.
*** Per unit freight & duty for 4th Quarter from CX-357, p. 8797.

736. TI's four-function calculator line is . (Dolait, Tr. 654, 777; Heye, CX-390, pp. 19-20).

737. Assuming that in 1984 on model nos. TI-1100, TI-1706 and TI-1766, the difference between the average per unit selling price (FF 685)) and the average per unit cost of the assembled unit ((FF 735)) or represents the approximate value added to TI's four-function calculator by TI's domestic activities relating to such calculators and TI's overhead and administrative expenses allocated to it four-function calculator models.

738. Under the alternative value added analysis, the total value added to TI's four-function calculators (on a per unit basis) by its domestic activities, including overhead and administrative costs is approximately of the average selling price of a TI four-function calculator (FF 685,737)).

739. Under the alternative value added analysis, the total value added to TI's four-function calculators (on a per unit basis) by its domestic activities, excluding overhead and administrative costs of and for market research and product launch costs, is approximately (FF 737)- or approximately of the average selling price of TI's four-function calculators. (FF 685)).

Commonality of and Distribution

740. TI's calculator assembly line has been capable of making a . (Sick, CX-4, p. 5). All of the critical aspects of calculator production, including R & D, product design and specification, engineering, QRA, assembly, QC, , packaging and distribution are for all models of portable calculators in the TI line. (Heye, CX-5, p. 19).

741. There is a high degree of commonality between assembly production techniques, including type and quantity of capital equipment, level of skills of the labor force and number of personnel required on the assembly line, for four-function, scientific and business calculators. (Finan, CX-7A, p. 4; RX-8, pp. 501805, 501824; RX-13, p. 006784).

742. Both professional and four-function calculators made by TI are capable of utilizing certain common components such as displays, and power sources. (RX-8, pp. 501806, 501823-24).

743. Nam Tai uses a single facility to assemble its four-function, scientific and business-oriented calculators and can switch a given line operation between models. (Hon, CX-402, pp. 110-11; CX-535, Response to Interrogatory 71).

744. The full line of portable calculator products is generally sold by mass merchandisers, retail stores, catalog outlets, discount houses, drug chains and department stores. (Finan, CX-7A, p. 9 and Table 3; Finan, Tr., 1595; RX-73, pp. 504767-68). TI's strategy is built around the fact that

and TI's

. (Rado, CX-6, pp. 6-8, CX-6A, p. 16; Dunn, CX-389, pp. 70-71; CX-369, 014439; CX-370, p. 8225).

745. Respondents' calculators are displayed side-by-side with TI's calculator products. (Rado, CX-6A, p. 18).

746. There is no one type of outlet exclusively retailing just one product segment. Thus, consumers, regardless of the retail channel selected, are very likely to have product from the different calculator categories to choose from. (Finan, RX-7A, p. 9).

747. Four-function calculators are as likely to be sold through and times more likely to be sold through than scientific calculators. At the same timem scientific calculators are nearly as likely to be sold through as four-function calculators. (Finan, CX-7A, Table 3 (based on CX-470).

748. The suggests that there is a substantial overlap between the different calculator product segments in terms of the

. (Finan, CX-7A, pp. 9-10).

Hewlett-Packard Company

749. Hewlett-Packard Company (H-P) is a domestic

. (CX-306; Donaldson, CX-610, p. 13; Donaldson, Tr. 1108-1110).

750. In 1972, H-P introduced its first commercial shirt pocket calculator, the HP 35. The HP 35 calculator is shown at CPX-222. (Osborne, RX-500, pp. 7-8).

751. The HP-35 calculator, according to inventor Kilby, is not within the scope of the '921 patent because part of its logic is bipolar and part is MOS so that the HP 35 could not be integrated. Kilby also testified that HP-35 did not have an integrated semiconductor circuit logic array mounted in one plane and that it used two boards in different planes, each of which likely had logic elements therein. However, this conclusion is on the assumption that all the MOS logic and clock driver of the HP-35 is not on the same board, which is inconsistent with the Hewlett-Packard 1972 publication 1-A. (CX-236).

752. The HP-11C Slim Line Advanced Programmable Scientific Calculator (SPX-1) was not analyzed to determine whether it falls within the claims of the '921 patent. (<u>See</u> Leach, CX-3).

753. H-P manufactures . (Erni, SX-9, pp. 78-79).

754. H-P manufactures only general purpose programmable calculators, scientific programmable calculators and financial programmable calculators. It assembles its calculators (Models) and the Model in . Calculators in the (Models) are assembled in .

755. H-P employs modern equipment in its calculator operations. (Erni, SX-9, pp. 100-101). These activities range through initial R&D, product design and engineering, machine tooling, certain assembly , testing and approval before commercial production, quality control, packaging design and packaging, shipping, marketing, and after-sale repair and service. (Erni, SX-9, pp. 22, 24-29, 31, 38, 60-61, 93, 95, 96-98, 1114-119, 121-124).

756. In its fiscal years 1983 and 1984, HP invested over in research and development in its calculator business. (CX-472).

757. On an annual basis, H-P devotes approximately of its revenues to research and development activities. (Erni, SX-9, pp. 97-98).

XIV. EFFICIENT AND ECONOMIC OPERATION

758. From 1978 through 1984, TI's annual research and development budget for portable calculators averaged approximately . (CX-372).

759. TI's research and development facilities are located in Dallas and Lubbock, texas, and utilize the most modern and up-to-date research apparatus and computer facilities, valued at some . (Heye, CX-5, p. 3).

760. TI's R&D efforts with respect to portable calculators have continually enhanced and improved TI's line of calculator products. Through licensing of the '921 patent, TI obtained cross-licensing rights to key inventions in the calculator field developed by other firms. (Heye, CX-5, p. 11).

761. Besides cross-license access to new technology, TI's licensing of the '921 patent has also generated a substantial flow of royalty income to the calculator business. This royalty income is the type of funding which can be used to support vital R&D. (Heye, CX-5, p. 12).

762. TI's continuing R&D activities are part of a constant reevaluation process that ensures that its portable calculator products are always state-of the-art. (Heye, CX-5, p. 12).

763. TI's research engineers strive to

and to introduce other cost-saving techniques to make its products more durable, more reliable and less expensive for the consumer. For example, TI has been able to convert from rigid printed circuit boards to flexible film in its portable calculator products, which represents an economic and labor saving advance made possible by TI's substantial R&D investment. (Heye, CX-5, p. 13).

764. TI also conducts ongoing research regarding calculator components, and in particular . TI's chip design work is performed in fully-equipped, modern laboratories. Much of the complexity of chip design stems from the very large number of interconnecting circuits involved, and TI uses the latest computer-aided techniques in its chip design operations. Moreover, because chip circuitry is based on semiconductor technology, TI can draw on its expertise in the semiconductor field. For example, calculators that are powered by a solar battery require the use of special chip technology .

, and and other critical work is being done in the United States. The entire cost of the project is being funded by the Consumer Products Division and will cost .
(Heye, CX-5, pp. 13, 14).

765. Irrespective of where calculator occurs, all TI portable calculators sold in the U.S. undergo strict product qualification procedures before assembly and a strict quality control program

. (Heye, CX-5, p. 17). Both in the case of initial product qualification and quality control there is a coordinated effort among TI's engineering staff, QRA and QC departments and the assembly managers to head off and correct any potential quality defects. (Heye, CX-5, p. 17).

766. Respondents Nam Tai, IMA and Enterprex concede that TI's domestic operations devoted to the production of professional portable electronic calculators are efficiently and economically operated. (Closing Arguments, Tr. 228-29; see CX-540, Answer to Request No. 61).

XV. INJURY

767. In 1974, calculators were viewed as quasi-scientific instruments. TI's lowest-end calculators were sold at a suggested retail price of . Calculators were packaged in boxes and sold by clerks who assisted the consumer. Consumers were very conscious of brand names and anxious about quality and longevity. TI's quality image was a substantial advantage at all levels of the calculator market. (Rado, CX-6, p. 9).

768. The increasing U.S. consumer familiarity with portable calculators, and the cost-reducing expansion of the calculator market led by TI, changed the nature of calculator marketing. Low-end calculators, in particular, began to be saleable as house brand or secondary brand items. This permitted retailers to source calculators abroad and induced large numbers of wholesalers to begin importing and selling foreign calculators. (Rado, CX-6, p. 9).

769. Beginning in the late 1970's, low-end calculators began to be shrink-wrapped (i.e., encased in clear plastic suitable for hanging on a display rack) and widely available for sale without assistance. (Rado, CX-6 p. 9).

770. Price and design features -- such as incorporation in checkbook wallet, combination with a clock, calendar or alarm, or incorporation within a ruler -- became more prevalent to low-end competition. (Rado, CX-6, p. 9).

771. Foreign manufacturers and the trading companies, wholesalers, and retailers have been increasingly able to penetrate this low-end market by cutting prices and taking advantage of the diminishing importance of quality factors as prices fall and consumers perceive low-end calculators as throw-away items. (Rado, CX-6, pp. 9-10).

772. TI has broad-based distribution of its calculator products across all channels of distribution. TI's customers include

(such as

. (Rado, CX-6, p. 3; Rado, Tr. 1473).

773. Both brand name and private brand calculators sit on the retail shelf, side by side, and are presented to the consumer together in the same outlets. (Rado, CX-6A, p. 18; Schoenberg, Tr. 2289).

774. TI sells calculators to premium customers, such as

. TI's name may or may not appear on these calculators, depending upon the customer's preference. (Rado, Tr. 1474-75, 1514-15).

775. TI has sales representatives across the United States and in TI's marketing organization who serve premium accounts. (Rado, Tr. 1475).

776. TI attends two premium trade shows annually. (Rado, Tr. 1476).

777. TI is interested in

. (Rado, Tr. 1476).

778. The premium industry looks for products not generally available at retail stores and for low price points. (Schoenberg, Tr. 2314).

779. TI develops and expands its business through its channels of distribution by utilizing target market media advertising (an example would be advertising financial calculators in banking and real estate magazines and scientific units in engineering journals), advertising on TV and in consumer print magazines, meeting price competition from competitors within each

channel, and providing a

. (Rado, CX-6, p. 3).

780. TI utilizes two key "Consumer Electronic Shows" in January and June for communication of its programs, new products, and advertising plans. (Rado, CX-6, p. 3).

781. Certain calculators sell better in some seasons than others. For example, printing calculators sell well during . Scientific calculators sell well during the months of . Sales of handheld calculators many increase during the season, although handheld calculators sell constantly throughout the year. (Rado, Tr. 1513-14).

782. TI offers dealer

.

. (Rado, Tr. 1527-28).

783. TI offers other promotional allowances to its customers, such as . (Rado, Tr. 1529).

Cross-elasticity:

Competition among different types of calculators

784. Most all of TI's discount and mass merchandise customers carry a range of calculator products, including both "four-function" and "professional" models. Similarly, retail bookstores and other accounts which are not has market type stores also carry both types of calculators. (Rado, CX-6A, p. 16; CX-359, pp. 504767-68).

785. TI had

. (Finan, CX-7, p. 8).

786. Dr. Wiliam Finan, a consulting economist retained by TI, interpreted a for 1983/1984. (Finan, CX-7, pp. 1, 9).

787. data show that of the basic 4 function calculators mentioned in the survey were reported to cost less than ; of the scientific models were reported to have cost under . For TI's model 30, a scientific model, over of the respondents said they paid under . There is an overlap between the prices of some four function and scientific calculators. TI prices for 1985 show a difference of only some at the retail level and at the distributor level between various four function and scientific calculators. (Finan, CX-7, p. 10; CX-364 (1985 price list)).

788. Among other findings of this study were the following: (a) ; (b) ; (c) ; and (d) . (Rado, CX-6A, p. 17; CX-348, pp. 012330-40).

789. The survey suggests that there is a substantial overlap between the different calculator product segments in terms of the . (Finan, CX-7, pp. 9-10).

790. The research commissioned by TI suggests that a significant degree of exists between calculator models of similar features, even across models with different combinations of attributes. (Finan, CX-7, pp. 10-11).

791.

. (West, SX-10, p. 24).

792. TI-30-III is the lowest-priced scientific calculator offered by TI. It is not very different from a four-function calculator. (Dolait, Tr. 595).

793. The hedonic study of TI and Nam Tai calculators also indicated the following: (1)

; (2)

; (3)

; (4)

; and (5)

. (Finan, CX-7, pp. 12-13).

794. The portable calculator market is characterized by a large number of models designed to appeal to a variety of consumer interests. TI

has 18 models in its 1985 calculator line. TI's features range from the TI-1100's four function, automatic constant, percentage and square root simplicity to the TI-66's 500 merged program steps, 64 multi-use memory, and engineering function complexity. TI's suggested retail prices range from for the TI-1100 to for the TI-66. (Rado, CX-6, p. 6; CX-363; CX-363; CX-364 (showing previous TI lines)). Nam Tai's most recent catalog includes models ranging from relatively limited low end features to Nam Tai's P-201 programmable. (RX-85).

795. Consumers are thus presented with a wide range of choice within and between low end, mid-range and high end model groups. Sellers must ensure that the price relationships between their models are appropriately adjusted to differences in features. (Rado, CX-6, p. 6; Heye, Tr. 1067; Rado Tr. 1402-03).

796. Some consumers, who require the scientific, financial or programmable features which distinguish mid-range and high end calculators, may not be satisfied by low end calculators. (Wildman, RX-110, pp. 6-7). Many other consumers, however, may have only a limited need for such additional features, but will spend additional money to buy them if the price/feature trade-off is attractive. (Finan, CX-7A, pp. 11-17). These consumers would include, for example, families with students who may use logarithmic functions or white collar workers who may find financial features useful but not essential. (Rado, CX-6, p. 5; SX-9, pp. 30-32). The presence of these consumers in the market prompts calculator sellers to accommodate the relationship between the highest four function/low end price and the lowest available professional price. (Rado, CX-6 p. 6, West, SX-10, pp. 50, 66; Dolait Tr. 775-766, CX-353, p. 012511). Prices will be determined by the need

to attract these consumers even if other consumers cannot be shifted between low end and mid-range calculators. (Finan, CX-7A, pp. 11-17; Finan Tr. 1573; Wildman Tr. 2436; CX-352, p. 506436).

797. Similar price/feature trade-offs are evident between the mid-range and high end of the calculator line. (Finan, CX-7A, pp. 11-17; West, SX-10, pp. 49-51). For example, Hewlett-Packard's evaluation of competitive products for its HP-10C, a fully programmable scientific model with a suggested retail price of , includes models ranging in price from . (RX-150, p. 21). HP's competitive analysis for the HP-11C, with a suggested retail price of , includes models with prices down to (RX-150, p. 22) and HP's analysis for its HP-12C includes priced as low as . (RX-150, p. 26).

798. The impact of price/feature trade-offs on calculator pricing is enhanced by the fact that consumers from . . (Finan, CX-7A, p. 9 and Tables, 1, 4, 5; Finan Tr. 1566, 1595; Finan, CX-7B, p. 2; CX-369, pp. 014439-46, 014460; CX-359, pp. 504770-79; CX-370, pp. 8226, 8229, 8230). Even the generally high end scientific and financial models offered by HP are including . (Erni, SX-9, pp. 81, 84-85).

799. The price/feature trade-off characteristic which arises from demand cross-elasticity in the unitary calculator market means that price changes at one point in the line may ultimately affect all other calculator prices through a series of interactions between segments. (Dolait, Tr. 775; West, CX-463, pp. 75-76).

800. One manner in which unfair competition at the low-end effects high-end calculator prices involves the promotional price point. According to Mr. Dolait, in the past, a promotional price point was used to offer a four-function calculator. Due to price pressure, that price point no longer belongs to a four-function calculator, but rather to a scientific calculator. (Dolait, Tr. 775).

801. Another factor in cross-elasticity is brand awareness. TI has recognized the need to participate in the low-end segment to maintain brand awareness by keeping the TI name in front of consumers. Ownership of TI basic four function calculators helps the consumer to upgrade or "trade up" to more advanced TI calculators. (RX-13, p. 6784; RX-15, p. 010445).

802. Lost sales and displacement of TI basic calculators from retailers' shelves prevent the "trading up" process from operating and impairs TI's overall brand awareness. If the consumer is not introduced to a TI product when he makes his first purchase of a low-end calculator, he will be less likely to trade up to the more expensive scientific and business models. (Rado, CX-6, p. 14).

803. In addition, many of TI's customers prefer dealing with suppliers . Besides TI, three licensees also feature full lines of calculators and thus compete with TI for principal brand placement at retail outlets. (Rado, CX-6, pp. 5-6).

804. Displacement of TI models from any segment of the retailers stock keeping units, or SKUs, makes TI . When TI loses sales and SKUs for its low-end models, it is in its ability to make sales of the more sophisticated models in its portable calculator line. (Rado, CX-65, p. 7).

805. The development of brand loyalty and a full line of calculators are two factors illustrating the interdependence of the four function and professional calculator classes. (See supra). A third factor showing interdependence is that the high volume base of four function calculators helps TI maintain its competitive position in manufacturing technology used for other models. (RX-15, p. 10445).

TI's

806.

. (CX-374).

807. Sharp, Casio and Cannon feature full-lines of calculators and compete with TI for principal brand placement at retail outlets. (Rado, CX-6, p. 6).

808. TI also experiences competition from manufacturers with more selective calculator lines. For example, Hewlett-Packard specializes in high-end programmable calculators and targets its effort on professional users. (Rado, CX-6, p. 6).

809. TI is unaware of competition from Hong Kong manufacturers in financial or programmable calculators. (Dolait, Tr. 714).

810.

. (Heye, Tr. 1059-61).

811. TI gained sales of scientific calculators at Best Products because the "Albinar" private label calculator was late in arriving from offshore. (Rado, Tr. 1517).

812. TI's major customers in the promotional/premium area include , and various firms. In 1983 and 1984, sales of portable calculators to these types of customers were approximately and , respectively. (Rado, CX-6A, p. 19).

813. TI loses sales of its calculator products to premium calculators sold by unlicensed manufacturers because owning these calculators may prevent their owners from purchasing a calculator from TI. (Dolait, Tr. 756).

814. TI loses sales of its calculator products to sales of novelty calculators (i.e., calculators which are part of another product, such as a keychain, watch, or clock) by unlicensed manufacturers because the owners of such calculators are unlikely to purchase a calculator from TI. (Dolait, Tr. 756-57).

815. TI's retail customers stock an average of four or five stock keeping units (SKUs). (Dolait, Tr. 618).

816. It is easier for TI to regain a SKU than it is to regain SKUs . (Rado, Tr. 1503).

817. TI loses royalty income, and thus funds to support additional R & D, from the activities of unlicensed Hong Kong and Taiwanese calculator manufacturers. (Heye, CX-5, pp. 18-19).

818. TI will not offer a calculator model for sale unless it expects to sell at least units of that model. (Rado, Tr. 1403).

819. TI estimates that it will sell checkbook calculators in 1985. (Dolait, Tr. 620).

820. TI estimates that it will sell units of its credit card calculator, TI-1786, in 1985. (Dolait, Tr. 623).

821. TI did not receive complaints from customers concerning the fact that it offered only four models of consumer handheld calculators in 1984. (Rado, Tr. 1409-10).

822. From the standpoint of functionality and outward appearance, all "four-function" calculators produced by various manufacturers are very similar (Dolait Tr. 629) and the Southeast Asian suppliers offer models that are directly comparable to TI's low end models. (Koo Tr. 2188-89; Schoenberg Tr. 2289).

823. Typically, retailers will display TI calculators on their shelves side by side with imported models from unlicensed manufacturers in Hong Kong and Taiwan. (Rado Tr. 1506; Schoenberg Tr. 2289).

824. The market for portable electronic calculators in the United States is "mature" (Dunn Tr. 807; Schoenberg, CX-457, p. 107). Most sales are now made on a replacement basis, rather than reaching new, previously untapped groups of consumers. The total size of the calculator market is thus relatively stagnant. (Dunn, Tr. 807; Schoenberg, CX-457, p. 107).

825. In 1983, total sales of low-end "four-function" or "basic handheld" models in the United States represented some million units valued at million wholesale. (RX-60, p. 12485). Approximately of those sales, or some million units, were captured by manufacturers from Hong Kong and Taiwan, rather than TI or its Japanese licensees, Sharp, Casio, and Cannon. (<u>Id</u>., p. 12486).

826. TI's sales of four-function calculators in 1983 was approximately million units worth some million. (RX-60, p. 12485).

827. Figures demonstrating TI's total revenues from four function calculators, the number of units sold, and the average unit price (calculated by dividing revenue by units sold) show a relatively stagnant market as well as falling prices per unit.

Year	1978	1979	1980	1981	1982	1983	1984
revenues in 000s							
units sold in 000s							
average unit price							

(RX-77, pp. 10124; 10126; CX-397).

Licensed Competition

828. Hewlett-Packard is a . (CX-306).

829. Hewlett-Packard's calculators are in the high end of the U.S. calculator market. (West, SX-10, p. 34; Erni, SX-9, p. 107).

830. Hewlett-Packard's calculator customers are . (West, SX 10, p. 36).

831. Hewlett-Packard offers its calculators to . (West, SX-10, p. 71).

832. The following Japanese companies sell portable electronic calculators in the United States under license from TI: and . (CX-305, 309-310, 365-367).

833. calculator manufacturers, are licensed under the '921 patent. (Donaldson, Tr. 2599; CX-601, 602).

834. each sell over calculators in the United States in a year, competing for sales with TI. (Dolait, Tr. 629; Heye, Tr. 1030).

835. sells calculators in the United States under the brand name "Compex." (Koo, Tr. 2239).

836. sells calculators under the brand name "Technico". (Schoenberg, CX-457, p. 124).

837. In 1983, a total of approximately million low-end calculators were sold in the U.S. , or about million units, is the estimated share of these sales captured by companies other than TI and its licensees. TI sold million handheld calculators in the same period. Therefore, TI licensees sold approximately million units. (See RX-60, pp. 12485, 12486).

<u>Respondents' Calculator Sales in the United States</u>

<u>Far East</u>

838. Far East United Electronics sold calculators at a dollar value of in to in . (CX-496).

839. Far East United Electronics claimed a monthly production capacity of 300,000 units in 1983. (CX-385, p. 7).

<u>Fordstech</u>

840. Fordstech is a manufacturer of calculators, watches, quartz clocks, and auto accessories which it sells to worldwide markets. In June 1983, its factory occupied approximately 1,500 square feet in an industrial building in Hong Kong. (CX-385, p. 10).

Hua Chang

841. Hua Chang Electronics claimed a monthly production capacity of 10,000 units in 1983. (CX-385, p. 12).

Integrated Display

842. In 1983, Integrated Display claimed to produce only one model of calculator. (CX-385, p. 13).

MBO

843. In 1983, MBO claimed a monthly production capacity of 96,000 units. (CX-385, p. 16).

Mino

844. Mino claimed a monthly production capacity of 300,000 units in 1983. (CX-385, p. 17).

Promoters

845. Promoters claimed a monthly production capacity of 14,000 units per model in 1983. In 1983, Promoters offered two models of scientific calculators, and four models of four function calculators. (CX-385, pp. 23-24).

Luks

846. Luks sold calculators, models LC-3322 and 33-916, in

to . (CX-506).

RJP

847. In 1983, RJP claimed a monthly production capacity of 140,000 units. (CX-385, p. 26).

Voesa

848. Voesa claimed a monthly production capacity of 350,000-500,000 units in 1983. (CX-385, p. 32).

IMA

849. Spectra Merchandising International, Inc. (Spectra) imports electronic products from Asian sources, including calculators from Hong Kong. (Schoenberg, RX-88, p. 1).

850. Spectra sells most of its calculators under the IMA name. Spectra has recently used the brand names "Sports Illustrated" and "Delphi". (Schoenberg, Tr. 2261).

851. IMA is a service company primarily to Spectra and obtains its business through Spectra. (Schoenberg, Tr. 2311-12).

852. Spectra has never imported or sold professional calculators. (Schoenberg, RX-88, p. 2).

853. General Electronics manufacturers the IMA 130 CBW calculator. (Schoenberg, Tr. 2258).

854. The IMA LC 620 calculator was originally manufactured by General Electronics; it is currently manufactured by Nam Tai and another Hong Kong company, Solid. (Schoenberg, Tr. 2258-59).

855. The IMA LC 610 and IMA LC 615 were originally manufactured by General Electronics; they are now manufactured by Nam Tai. (Schoenberg, Tr. 2258).

856. The IMA LC 640 calculator is manufactured by Luks in Hong Kong. (Schoenberg, Tr. 2259).

857. The IMA LC 6708 and IMA 680B calculators are manufactured by Nam Tai. (Schoenberg, Tr. 2259).

858. The IMA RC 200 calculator comes in two versions; one is made by Tronica and one is made by a Taiwanese company, Tecxon. (Schoenberg, Tr. 2259).

859. The IMA LC 750 calculator was originally manufactured by General Electronics in Hong Kong; it is currently manufactured by Solid. (Schoenberg, Tr. 2259).

860. The IMA LC 683 calculator is manufactured by FLX in Hong Kong. (Schoenberg, Tr. 2259).

861. The IMA LC 672 calculator is manufactured by Nam Tai. (Schoenberg, Tr. 2259).

862. The IMA LC 625 and IMA LC 905 calculators are manufactured by Tecxon in Taiwan. (Schoenberg, Tr. 2260).

863. The IMA LC 780 calculator was originally manufactured by General Electronics and Luks Electronics; it is currently manufactured by Solid in Hong Kong. (Schoenberg, Tr. 2260).

864. The RC 400 calculator is manufactured by Far East United Electronics in Hong Kong. (Schoenberg, Tr. 2260).

865. The IMA LC 800, LC 788, and LC 785 calculators are manufactured by FLX. (Schoenberg, Tr. 2260).

866. Spectra does not offer advertising promotional allowances to its U.S. customers. (Schoenberg, Tr. 2310).

867. Spectra participates at two CES shows held each year in the United States. (Schoenberg, Tr. 2310).

868. Spectra sells its calculators in the United States through Ms. Schoenberg, a sales and marketing executive, and independent sales representatives. (Schoenberg, Tr. 2310-11).

869. Spectra sells its calculators mainly to mass merchandise stores (such as Target Stores, Gold Circle, and Shopko), supermarkets, and premium distribution channels in the United States. (Schoenberg, Tr. 2312-14).

870. Spectra sells "novelty" calculators, such as ruler calculators, keychain calculators, and watches with calculators, mainly to premium distribution channels. (Schoenberg, Tr. 2313-14).

871. Spectra's sales of calculators to Shopko decreased in 1984. (Schoenberg, Tr. 2318).

872. In 1984, 30% of Spectra's sales to Target were credit card calculators. Approximately 5% of such sales were of novelty calculators. (Schoenberg, Tr. 2319-20).

873. Beginning in 1973, Spectra developed its own engineering standards for calculators. (Schoenberg, Tr. 2319).

874. Spectra leases a warehouse in Northbrook, Illinois and owns the calculators in inventory there. (Schoenberg , CX-457, pp. 19, 23).

875. Spectra provides warranty replacement on IMA calculators. (Schoenberg, CX-457, p. 23).

876. In 1984 Spectra sold approximately calculators in the United States. Approximately of the calculators were purchased by Spectra from . Spectra expects to sell approximately . (Schoenberg, Tr. 2308).

Enterprex

877. Enterpex has been importing low-end calculators for approximately eight years. These calculators always have at least one memory. (Yuan, CX-459, p. 8).

878. of the calculators Enterpex now imports are sold in the United States. This percentage has . (Yuan, CX-459, p. 9).

879. of Enterpex's calculators from come from . The amount of purchases from has been . (Yuan, CX-459, p. 25).

880. Except for those calculators sold with a special premium name on the front, and some calculators sold under the brand name all of Enterpex's calculators are sold under the name "Enterpex." (Yuan, CX-459, pp. 53-54; SX-6, Interrogatory No. 6, pp. 4-5).

881. In 1982, Enterpex realized a gross profit of approximately for its sales of calculators; in 1983, approximately ; and in 1984 through July 31, approximately . (SX-6, Interrogatory No. 9, p. 38).

882. All of Enterpex's calculator sales are made through its sales representatives. (Yuan, CX-459, p. 37).

883. Enterpex sold approximately calculators in 1983. (Yuan, CX-459, p. 38).

884. In the first seven months of 1984, Enterpex sold approximately worth of calculators. (Yuan, CX-459, p. 70).

885. Enterpex purchased Nam Tai calculators through its sales representative for sale to . (Yuan, CX-459, p. 34).

886. In 1983, Enterpex asked for a quote on calculators for sale to through . That bid may still be in progress. (Yuan , CX-459, p. 35).

887. Enterpex has sold calculators through to . (Yuan, CX-459, p. 36).

888. Enterpex sells more battery calculators (MC-2808) than solar calculators (MC-2892). (Yuan, CX-459, p. 83).

889. lowered some of the prices of its calculators at Enterpex's request so Enterpex could compete with the lower prices of Japanese calculators. (Yuan, CX-459, p. 86).

890. Enterpex is constantly getting offers from watch manufacturers in Taiwan and Hong Kong who are going into the calculator business. (Yuan, CX-459, pp. 89-90).

891. Mr. Yuan, president of Enterpex, and discusses the purchases of calculators for Enterpex from companies such as . (Yuan, CX-459, p. 21).

892. Nam Tai and other Hong Kong manufacturers and representatives send representatives to the U.S. trade shows to display their calculators. (Yuan, CX-459, p. 63).

893. Enterpex has never sold any scientific calculators and is not considering doing so now. It may have considered selling them in the past. (Yuan, CX-459, p. 68).

894. A sampling of advertisements in Asian Sources magazine shows that virtually all of respondents Cosmo, Far East United, Fordstech, General Electronics, Hua Chang, Integrated, Luks, MBO, Mino, Promoters, Success, and Voesa advertise calculators in that publication. As a major U.S. importer of calculators from Hong Kong testified, Asian Source magazine is "our bible" and

"anyone who is anybody will advertise in *Asian Sources*." (Ruwin, CX-461, p. 42; *e.g.*, CX-520, pp. 2, 4, 7, 9, 10-11, 15 (Hua Chang, Luks, MBO, Mino, Success, Tronica, Voesa); CX-521, pp. 2, 4, 11, 14, 16 (Hua Chang, Mino, Success, Tronica, Voesa); CX-522, pp. 2, 4, 10, 12, 15, 33 (Hua Chang, Luks, Mino, Success, Tronica, Voesa); CX-523, pp. 2, 9, 17-18 (Hua Chang, Mino, Tronica, Voesa); CX-570, pp. 4, 9, 11-12 (General Electronics, Integrated, Success, Voesa); CX-514, pp. 6-7, 10 (General Electronics, Success, Tronica).

895. A number of these respondents also exhibit calculators at the Consumer Electronics Shows in the U.S., a key means of marketing calculator products in the U.S. (CX-444, p. 2 (Mino), CX-560, p. 3 (Mino, Tronica); CX-533, p. 3 (Tronica); CX-560, p. 2 (Cosmo); CX-553, p. 2 (Cosmo); Chow, CX-402, p. 206; West, SX-10, p. 69; Lipper, CX-458, pp. 63-64).

896. TI's discovery against third parties pursuant to subpoenas issued by the Presiding Officer further confirmed that several of these respondents have sold calculators to U.S. importers for sale in the U.S. (Schoenberg, CX-457, pp. 66-67, 97-100 (General Electronics, Far East United, Luks); , CX-458, p. 16 (Tronica); , CX-401, p. 14 (Far East United). The calculators manufactured by these respondents include not only four function models, but also more sophisticated scientific and "slide rule" calculators. (CX-385, pp. 14-15 (Luks' advertising for two scientific models), pp. 23-25 (Promoters' brochure for scientific and "junior slide rule" calculators).

Dah Sun

897. Dah Sun was incorporated in December 1981. Mr. Danny Chan, Dah Sun's President, is in this company. (Chan, CX-400, pp. 4-6).

898. Dah Sun originally intended to manufacture ceiling fans but in decided to manufacture handheld calculators instead. Dah Sun began manufacturing handheld calculators after its decision to enter this market. (Chan, CX-400, pp. 8, 11).

899.

. (Chan, CX-400, pp. 11-13).

900. Dah Sun made approximately calculators per day and had the capacity to manufacture calculators per day in . Presently, Dah Sun manufactures calculators per day. (Chan, CX-400, pp. 13-14).

901. To increase Dah Sun's capacity, the most important factor is . (Chan, CX-400, p. 15).

902. Dah Sun manufactures four models of calculators, all of which are handheld. These models include: CC-760 (clip-on size), LCD-199 (credit card size), LCD-380 (credit card size), and GC-7s (credit card size and solar powered). (Chan, CX-400, pp. 17-22).

903. Dah Sun sells of its calculators to local Taiwanese trading companies who export to other countries. The remainder of Dah Sun's sales are made directly to . (Chan, CX-400, p. 26).

904. Dah Sun estimates that of its calculators are sold in the United States. Some of its sales in the United States are made through the local trading companies Dah Sun deals with, while the remainder of sales are made directly to United States companies. (Chan, CX-400, pp. 27-30).

905. Dah Sun does not manufacture scientific calculators. (Chan, CX-400, pp. 30-31).

906. Dah Sun buys chips for its calculators from through a trading company and, more recently, has purchased chips on a direct basis from in . (Chan, CX-400, p. 31).

907. Dah Sun has no present intention of entering the market, but, if it chose to do so, Dah Sun would use . (Chan, CX-400, pp. 32-33).

908. The main marketing factor in selling handheld calculators is price, design and quality. In some instances even a few cents difference in price can be determinative if the seller does not have an established reputation with the buyer. (Chan, CX-400, pp. 32-33).

909. Up through September 12, 1983, Dah Sun sold calculators at a price of . (CX-569). This represents an average unit price of .

910. From through , Dah Sun sold calculators at a price of . (CX-569). This represents an average unit price of .

911. From through Dah Sun sold calculators at a price . (CX-569). This represents an average unit price of .

912. Dah Sun has been manufacturing calculators only since , but as of had already produced a total of almost million units. (Chan, CX-400C, pp. 8, 18-19; CX-569). To market its products, Dah Sun advertises portable calculators in <u>Asian Sources</u>. (CX-530, supplemental Response to Interrogatory 11(a); CX-516, p. 13). Dah Sun participated in the summer 1984 Consumer Electronics Show in Chicago. (CX-444, p. 2; Peress, CX-401, p. 43). Complainant's physical exhibits CPX-63, CPX-119, and CPX-132 are portable calculators manufactured by Dah Sun. (CX-231).

913. Dah Sun's experience highlights the ease of entry and lack of skilled labor and equipment that characterizes the calculator business in Southeast Asia. Once Dah Sun, which had previously been manufacturing ceiling fan components, decided to get into the calculator business as well, it took only about to actually begin producing calculators. (Chan, CX-400, p. 9). It was not necessary for Dah Sun to in calculator manufacture. Rather, Dah Sun continued in its ceiling fan business. These Nor did Dah Sun find it necessary to purchase any in order to being the manufacture of calculators. (Chan, CX-400, p. 11).

Nam Tai

914. The following comprise the Nam Tai group of companies: Nam Tai Management Services Limited; Nam Tai Electronics & Electrical Products Limited; Nam Tai Electronic Manufacturing Limited; Nam Tai Supplies Limited; Nam Tai Research & Development Limited; Nam Tai Electrical Products (China Trade) Limited; Nam Tai Finance Services Limited; Nam Tai Electronic Co., Ltd.; Nam Tai Plastic Factory Limited; Merrion Limited; Ballinteer Limited; and Tolka Limited. (CX-425).

915. Fortec Corporation (Fortec) is a trading company in Canada with a staff of three people. owns of the stock and owns of Fortec's stock. Nam Tai has recently started selling calculators to Fortec. (Koo, CX-402, p. 139; Chow, CX-402, p. 218).

916. Since its incorporation in May 1984, Fortec has started to trade a calculator products in Canada, although there is nothing preventing Fortec from selling calculators in the United States. (Koo, CX-402, pp. 139-140).

917. Nam Tai began to manufacture calculators in early 1980. (Koo, RX-87, p. 1).

918. Nam Tai first exported calculators to the United States in 1981. (Koo, Tr. 2218).

919. In 1982, besides Nam Tai, Tronica, Luks and Far East United Electronics were involved in exporting calculators to the United States and Europe. (Koo, CX-402, p. 25).

920. Since 1981 and 1982, Nam Tai's sales of calculators in the United States . (Koo, CX-402, p. 25).

921. In 1982, between five and twenty United States customers placed orders with Nam Tai for calculators. (Chow, CX-402, pp. 69-70).

922. the calculators issued from Nam Tai's inventory have the brand names "Compex" or "Fortec". Nam Tai's calculators bears no brand name. (Chow, CX-402, pp. 81-82).

923. Nam Tai manufactures only calculators which operate on either a dry cell or solar cell battery. It does not manufacture any calculators that plug into the wall. (Koo, CX-402, p. 26).

924.

. (Koo, RX-87, p. 3).

925. Nam Tai sold less than scientific calculators in the United States in 1984. (Koo, RX-87, p. 3).

926.

. (Id.; Koo, Tr. 2219).

927. Nam Tai features over 30 different models of four-function consumer handheld calculators, including novelty models or combination

products, such as a calculator in a ruler, a calculator key chain, and a calculator in a wallet. (Koo, RX-87, p. 4).

928.

. (Koo, Tr. 2216).

929. Nam Tai is the third largest calculator manufacturer in the world. (Koo, Tr. 2059).

930. In 1984 Nam Tai produced assembled and semi-assembled calculators. (Koo, Tr. 2061).

931. In 1984 Nam Tai produced fully-assembled calculators. (Koo, Tr. 2062).

932. Nam Tai can produce fully assembled calculators in one month. (Koo, Tr. 2065).

933. Nam Tai's total capacity for fully-assembled and partially-assembled calculators is . (Koo, Tr. 2065).

934. Nam Tai could increase its capacity by in one year. (Koo, Tr. 2070).

935. Nam Tai makes finished four-function calculators and finished scientific calculators in the same plant. (Koo, Tr. 2073).

936. Nam Tai utilizes to assemble its calculators. (Hon, CX-402, p. 110).

937. During a normal business day, Nam Tai has approximately 450 employees working on calculators. (Koo, Tr. 2216).

938. Nam Tai's employees work one shift, 5 1/2 days per week. (Koo, Tr. 2216).

939. Although Nam Tai advertises a P-201 programmable calculator in its catalog, it will not sell this calculator in the United States. (Koo, Tr. 2073-78).

940. Nam Tai has used the "Fortec" brand name on its P-210 programmable calculator. (Koo, Tr. 2083).

941. Nam Tai's salesman expend virtually no time and effort seeking to sell scientific calculators in the United States. (Koo, RX-87, p. 3).

942. During 1981-1982, Nam Tai offered scientific calculator models LC-1002S, LC-1001S, and LC-0818S under the "Compex" brand name. (CX-404, p. 3; Hon, CX-402, p. 105).

943. Nam Tai exhibited its scientific calculators at the recent CES show in the United States. (Koo, Tr. 2153).

944. Through its distributors, Nam Tai specializes in servicing customers who use its calculator products as a premium to be given away to the public for promotional or goodwill purposes. (Koo, RX-87, p. 4).

945. Nam Tai may not always know if calculators it sells to a Hong Kong trading company are eventually sold in the United States, although trading companies may ask for TSP forms if they intend to export to the United States. (Koo, Tr. 2098-103).

946. Approximately 30% of Nam Tai's U.S. sales in 1984 were of solar credit card calculators. (Koo, Tr. 2228).

947. Nam Tai has never made a financial calculator,

. (Koo, Tr. 2242).

948. In October 1984, Nam Tai predicted that of its export sales would be to the United States. (CX-429, p. 2).

949. From January through August 1984, of Nam Tai's calculator sales were to the United States and Canada; of such sales were to China. (CX-430, p. 4).

950. Nam Tai believes that its major growth market for calculators will be the People's Republic of China. (Koo, RX-87, p. 3).

951. Nam Tai has participated in the two CES held yearly in the United States since 1982. (CX-408, p. 4).

952. Nam Tai displays its calculators at trade shows in Hong Kong. Some U.S. customers attend Hong Kong trade shows. (Koo, Tr. 2226).

953. Nam Tai has received trial orders for premium calculators from . (CX-432); Chow, CX-402, pp. 91-92).

954. Nam Tai invested approximately for calculator tooling, i.e., plastic, metal, PCB, PVC, and rubber, for the period 1984-85. (CX-412, p. 8).

955. Nam Tai sold calculators at a price of in to . (CX-485).

956. Nam Tai sold calculators at a price of between and to . (CX-486).

957. Nam Tai sold calculators at a price of in and calculators at a price of in to . (CX-487).

958. Nam Tai sold calculators to . (CX-494).

959. Nam Tai sold calculators at to . (CX-495).

960. Nam Tai sold model calculators at in to . (CX-440).

961. Nam Tai sold model calculators at calculators at ; calculators at ; calculators at ; and calculators at in to . (CX-441).

962. Prior to 1980, Nam Tai operated strictly as a trading company importing and wholesaling calculators. (Koo, CX-402, pp. 13-18; CX-527, Response to Interrogatory 33). Despite the fact that Nam Tai had no prior experience in manufacturing, it was able to locate a factory, modify the factory's internal design, hire employees, obtain necessary equipment and begin the production of portable calculators, all in little more than six months time. (Koo, CX-402, pp. 41-43).

963. When Nam Tai started initial calculator production in 1980, it promptly began exporting its calculators to the U.S. Nam Tai entered the U.S. market by placing an advertisement in Asian Sources magazine. (Koo, CX-402, pp. 22-23; see CX-510, p. 14).

964. From the beginning, Nam Tai's line of portable calculators included both low end "four function" models and more sophisticated "scientific' models. In 1981, Nam Tai's first full year of production, its calculator line consisted of six or seven different models, two of which had scientific functions. (Koo, Dep., CX-402, p. 23). Nam Tai can readily shift its production between four-function and scientific models because its manufacturing equipment and facilities are largely interchangeable for these models. (CX-535, Response to Interrogatory 71).

965. At any one time, Nam Tai generally offers 40 calculator products across the model spectrum and has

. (CX-527, Response to Interrogatory 7). Nam Tai's current calculator brochure lists a number of models at both the low and high end of the four function segment, ranging from the basic battery-powered models to the more technically-advanced and expensive solar products. (RX-85, pp. 19-20, 10-16, 10-16; Hon, CX-402, pp. 106-07).

966. Nam Tai produces calculators under dozens of different brand names, including Tozai, IMA, Enterpex, Compex, Dynatone, Fortec, Ruby, Pierre Cardin, Hanimex and Penguin. (See CX-527C, pp. 3007-3040; CX-419; Chow, CX-402, pp. 181-83).

U.S. Calculator Sales by Nonparty Manufacturers, Distributors and Retailers

Foreign Calculator Manufacturers

967. has purchased calculators with a dollar value of from since . (CX-477, pp. 2, 4).

968. The LC 650 calculator was manufactured by Luks Electronics and General Electronics. (Schoenberg, Tr. 2261-62).

969. Many sellers of calculators use LC as a prefix for calculator model numbers. (Schoenberg, Tr. 2265).

970. Victor makes calculators in Japan. (Schoenberg, Tr. 2324).

971. Most Unisonic calculators are made by Cal-Comp. (Schoenberg, Tr. 2324).

972. Aurora calculators are made in Taiwan. (Schoenberg, Tr. 2324).

973. "Unisonic" calculators have been sold by K-Mart and Caldor. (Rado, Tr. 1492).

974. A Private label scientific calculator manufactured offshore called "Albinar" was introduced in the United States in 1985. (Rado, Tr. 1501).

975. make calculators. of the calculators produced by these manufactures . (Koo, Tr. 2181).

976. Truly is a recent Hong Kong manufacturer of calculators who formerly made time pieces. Truly reportedly offers its calculators at low prices. (Chow, CX-402, p. 211).

977. The October 1984 issue of Asian Sources Electronics magazine, page 199, shows a calculator advertisement for Tecxon Electronics Co., a manufacture of calculators for over two years. (Chow, CX-402, p. 199).

978. The October 1984 issue of Asian Sources Electronics magazine, page 207, shows a calculator advertisement for Kinson Calculators Co. (Kinson), who has been manufacturing calculators since mid-1984. (Chow, CX-402, pp. 200, 201).

979. Kinson . Kinson exhibited its calculators at the Consumer Electronics Show in Chicago in June 1984. (Chow, CX-402, p. 201).

980. Kinson manufactures LCD watches, calculators and telephones and markets its products at electronics shows. Kinson's facility in Hong Kong includes about three floors of factory space with a fairly large production staff. (Peress, CX-401, pp. 45-46).

981. The October 1984 issue of Asian Sources Electronics magazine, page 291, shows a calculator advertisement for Power Electric Co., a manufacturer of calculators for approximately a year, who sells low priced calculators. (Chow, CX-402, p. 207).

982. The October 1984 issue of Asian Sources Electronics magazine, page 15, shows an advertisement for Walco Industries Co., a trading firm and manufacturer of watches, who recently started manufacturing calculators. (Chow, CX-402, p. 192).

983. The October 1984 issue of Asian Sources Electronics magazine, page 130, shows a calculator advertisement for Elelux, a manufacturer of calculators in Taiwan for several years. (Chow, CX-402, pp. 197-198).

984. Imported calculators exhibited at the recent CES show include: Aurora, Hanimex, Lipper & Co., Novis, and Technico. (CX-555, Rado, Tr. 1487-88).

U.S. Importers, Distributors, and Retailers

985.

. has also purchased calculators on a one-time basis from Hua . In addition, purchased calculators from Tronica. (CX-477, pp. 2-3).

986. Since 1983, has purchased approximately calculators at a dollar value of from . (CX-478, p. 2).

987. , has been selling calculators since . (CX-479, p. 1).

988. Since , has purchased approximately calculators at a dollar value of from . (CX-479, p. 3).

989. Since has purchased approximately calculators at a dollar value of from . (CX-479, p. 4).

990. , has been selling calculators since . (CX-480).

991. Since has purchased approximately calculators at a dollar value of from . (CX-480, pp. 2 and 5; CX-572, p. 1271).

992. Since has purchased approximately calculators at a dollar value of from . (CX-480, p. 4).

993. Since has purchased approximately calculators at a dollar value of . (CX-480, p. 5).

994. Since has purchased approximately calculators at a dollar value of from . (CX-484, p. 3).

995. , located in Cleveland, Ohio, has been selling calculators for ten years. (CX-481, p. 1).

996. In purchased approximately calculators at a dollar value of from . (CX-481).

997. , has imported a few shipments of calculators from . (CX-482).

998. Royal Consumer Business Products, Windsor, Connecticut, has been purchasing calculators since 1979. In the past, it has purchased calculators from General Electronics. Currently, it purchases from Cal-Comp in Taiwan and Soarex in Japan. (CX-491, p. 3).

999. In 1983, Sonex (Export) Limited, 295 Fifth Ave., New York, N.Y., began purchasing calculators from for sale in the United States. Sonex switched from its original suppliers to because offered better prices than previous supplier. (RX-157).

Non Party Manufactures

1000. Akron, a small chain store located in Los Angeles, is the end buyer of U.S. Fiji, who imports and distributes calculators from . (Chow, CX-402, p. 233).

1001. Time Processor is a Hong Kong factory that has manufactured many items for several years, including time pieces and, more recently, a few models of calculators at low prices. (Chow, CX-402, p. 235).

1002. has purchased approximately calculators from , a company in Taiwan. (, CX-461, p. 40).

1003. has purchased approximately calculators from . (, CX-461, p. 41).

1004. Kinson has visited several times in the United States trying to sell calculators. (, CX-461, p. 68).

1005. has sold several units of calculators: (1) units of model E-2; (2) units of model SL771; (3) units of model SL672; and (4) units of model SC70. (, CX-461, pp. 25-29).

1006. Approximately percent of the total volume of business is in the sale of calculators. (, CX-461, p. 4).

1007. imports calculators and cosmetically fashions its own line of calculators under the brand name "Sweda." (, CX-461, p. 85).

1008. first started to sell calculators in . It sold calculators in 1982, calculators in 1983, and calculators in 1984. (, CX-461, p. 5).

1009. imports its calculators for sale to U.S. companies. It inspects its calculators both overseas before shipment and in the United States upon arrival. (, CX-461, p. 6).

1010. affiliated company in Hong Kong, Paul Soo, inspects the calculators, imprints them with the various brand names, and consolidates shipments. (, CX-461, pp. 6-7).

1011. maintains an inventory of approximately worth of calculators. (, CX-461, p. 10).

1012. has imported and sold approximately calculators of model no. CK12M manufactured by . This model is one year old. (, CX-461, p. 12).

1013. In the last five years, has sold approximately calculators of model MM845W, manufactured by . (, CX-461, p. 14).

1014. Some of the models imported from and sold by include: (1) 10,000 pieces of model no. LC100; (2) 75,000 pieces of model no. LC111; (3) 30,000 pieces of model no. LC127A; (4) 10,000 pieces of model no. LC133; (5) 150,000 - 200,000 pieces of model no. LC109; and (6) 100,000 pieces of model no. MC06. (, CX-461, pp 11-19).

1015. has sold among others approximately 500 pieces of model no. manufactured by in the last seven months and approximately 2,000 pieces of calculator model . (, Cx-461, pp. 19, 25).

1016. A number of foreign manufacturers are beginning to make scientific, financial and business calculators since there is little profit in four-function calculators. (Ruwin, CX-461, pp. 71-72).

1017. Three years ago, there were between 20 to 25 companies manufacturing calculators in Hong Kong. Today there are at least 50 calculator manufacturers in Hong Kong. (Ruwin, CX-461, p. 74).

1018. percent of business constitutes the sale of portable electronic calculators that have been customized for customers by putting their logo, name, or colors on them. (, CX-462, pp. 9-10).

1019. does not actually purchase calculators but represents U.S. customers in their purchase of calculators from who contacts . (, CX-462, pp. 18-19).

1020. has obtained calculators from Luks, , and Dah Sun in Hong Kong, and Sanyo in the United States. (, CX-462, p. 11).

1021. has obtained the following quantities of calculators from : 5,540 pieces on December 27, 1983; 2,516 pieces on February 3, 1984; 35 pieces of February 21, 1984; and 1,008 pieces on July 11, 1984. (, CX-462, p. 12).

1022. , provides sales of premium items, ranging from pencils, ballons, and buttons, to premium incentives such as calculators, televisions, radios, and luggage. (Fitzpatrick, CX-449, p. 9).

1023. purchased units of a , model number , from on October 11, 1983. These calculators were sold to Time-Life Books. The product was shown to by who provided with samples and took care of the shipping arrangement. (Fitzpatrick, CX-449, pp. 12-14).

1024. On approximately September 7, 1984, purchased 25 credit card calculators directly from for sale to . (Fitzpatrick, CX-449, p. 16).

1025. , is a representative for overseas Orient offices and does business as . (, CX-450, p. 4).

1026. imported its first calculators into the United States in either 1979 or 1980. (, Cx-450, p. 5).

1027. represents the following trading companies:

, and a trading company in both Korea and Japan. All of these companies do business under the name . (, CX-450, pp. 7-8).

1028. The electronic products for which J & M represents these trading companies include sound equipment, radios, stereos, quartz watches, calculators, and telephones. (, CX-450, p. 9).

1029. represents the products of these trading companies to 50 to 60 U.S. customers, primarily in the drug chain business, but also included are mass merchants and catalog showrooms. (CX-450, p. 10).

1030. key customers in the drug chain business include , and ; in the mass merchant area, ; and in the catalog showroom channel, under the trade name . (, CX-450, pp. 10-11).

1031. It is responsibility to arrange for its customers in the United States to travel overseas, meet the people in the trading office there, and arrange factory, as well as showroom, visits to see how the product is being made. (, CX-450, p. 13).

1032. Mr. , senior vice-president of , has visited two factories in Hong Kong--those of Luks and Tronica. (, CX-450, p. 13).

1033. Many manufacturers and trading companies send their representatives to the United States to call on buyers for chain stores, etc. However, the buyers know that they can purchase the goods better by dealing directly with the Orient and will request that companies like set up appointments in the Orient with the factory involved. (, CX-450, p. 16).

1034. On rare occasions, has opened a direct letter of credit for calculators for an account that would buy F.O.B. the port in the United States so that became the importer of record even though it has never stocked calculators in its warehouse. (, CX-450, p. 18).

1035. There are many companies in the United States which import and stock the goods or just represent someone and have them open a direct line of credit. (, CX-450, p. 19).

1036. Other U.S. companies that serve as representatives like include Trade Power, American Import Merchants, and New York Merchandise. There are many other individuals that also act in this capacity. (, CX-450, p. 20).

1037. Once an order for calculators is placed with makes sure the goods are inspected as they are produced, that they are produced to the specifications of the buyer, and that they are shipped on a timely basis. (, CX-450, p. 30).

1038. The unit and dollar volume of calculators imported into the United States in 1982-84 is as follows:

. (Peress, CX-401, pp. 13-14).

1039. The companies that served as sources of calculators in 1982-84 were as follows:

, a trading company whose calculators were manufactured by . (Peress, CX-401, pp. 14-15).

1040. total sales of electronic products and other items that were imported in 1983 was about and for 1984 was approximately . Calculator sales were approximately in 1983 and in 1984 of overall sales. (Peress, CX-401, p. 16).

1041. In 1982 and 1983, imported calculators into the United States under its own brand name, (Peress, CX-401, p. 17).

1042. of total order of calculators supplied by

of its calculators

. (Peress, CX-401, pp. 18-19).

1043. has imported what it considers to be a credit card calculator -- a 3" by 5" calculator with one memory that sometimes has a square root function and a percentage function and also performs addition, subtraction, multiplication and division. (Peress, CX-401, pp. 21-22).

1044. In the past, imported from , through . (Peress, CX-401, pp. 23-24).

1045. has imported calculator model from . (Peress, CX-401, p. 24).

1046. has imported calculator model from through . (Peress, CX-401, p. 24).

1047. purchased calculators from in 1982 and 1983 but not in 1984 because it considered price to be high. (Peress, CX-401, p. 26).

1048. is purchasing calculators from , and because it considers their prices to be more favorable. (Peress, CX-401, pp. 26-27).

1049. manufactured by manufactured by and by ; and by through . (Peress, CX-401, pp. 27-28).

1050. customers include wholesale distributors of consumer electronics, retail chain stores, and advertising premium specialists. percent of these customers are located east of the Mississippi. (Peress, CX-401, pp. 29-30).

1051. has made contact with representatives of and at trade shows in the United States. (Peress, CX-401, p. 31).

1052. considers to be a potential source of calculators. has contacted and they were close to a deal but price was a problem. (Peress, CX-401, p. 36).

1053. has had discussions with about the purchase of calculators but they never agreed on a price. (Peress, CX-401, pp. 39).

1054. is aware of some sources of calculators in including and . (Peress, CX-401, pp. 39-40).

1055. In discussions with manufacturers, these manufacturers have indicated that it would be relatively easy for them to expand their production facilities. (Peress, CX-401, p. 41).

1056. Some of the chain stores to whom has sold calculators since 1982 include , located in ;

; and . (Peress, CX-401, pp. 48-49).

1057. Respondent Nam Tai's U.S. sales from 1981 to 1984 were as follows:

	1981	1982	1983	1984
$ FOB HK (million)				
Units (million)				

(CX-527, pp. 3008, 3013, 3025 (1981-83); Koo, RX-87, p. 3 (1984)).

1058. Respondent Dah Sun also experienced in its U.S. sales:

$ FOB HK (million)	Not in
Units (million)	Business

(CX-569; Chan, CX-400, p. 23 (identifying source of invoice summary)).

1059. Hong Kong export statistics show the following exports of "Calculator Machines Electronic Pocket Type" to the United States since 1981:

	1981	1982	1983
Units (million)	4.6	3.8	6.3

(CX-386, pp. 5-8).

1060. The following table represents TI's U.S. sales of portable calculators from 1979 - 1983:

	1979	1980	1981	1982	1983
$ (million)					
Units (million)					

(RX-71, pp. 10124, 10126 (sales revenues or net sales billed ("NSB") and units or net units billed ("NUB") for the combined professional and four function categories).

1061. TI's average unit prices ("AUP") for its portable calculators for 1979 to 1983 were as follows:

	1979	1980	1981	1982	1983
AUP					

(Average unit price ("AUP") equals sales revenues ("NSB") divided by units ("NUB") (see supra).

1062. Hong Kong companies have often entered the U.S. calculator market by price cutting and below cost sales. For example,

. (CX-527, p. 3013

forth in CX-417 (p. 2),

-- *i.e.*,

of its calculator models --

Indeed, on its

. (CX-527, p. 3025

).

1063. Similarly, in reporting to Nam Tai's President Mr. Koo regarding the June, 1984 Consumer Electronics Show in Chicago, Mr. Chow explained the impact of price suppression caused by the new calculator manufacturers trying to break into the U.S. market:

> Lots of newcomers/existing calculator makers want to make calculators, (Hong Kong - Truly, Mino, Time Processor, Kinson, Dah Sun. Taiwan-Sterling) quoting very low price around USD 3.20 for slim card calculator intentionally to spoil the market ...." (CX-444, p. 2).

1064. As a result of such activities, Mr. Chow reported that "potential customers [are] hesitating to place orders and asking for lower prices" and that "lots of plastic calculator buyer all skipped away to [Kinson] from us." In retaliation, Nam Tai "tried to dump the price on solar metric calculator," but without success. (*Id.*). Mr. Chow subsequently stated: "Due to competition, all makers quote low price to attain orders. It will have an psychological effect to the buyers placing orders." [sic] (CX-430, p. 1 (Item "2")).

1065. Japanese manufacturers tend to price their calculators in a similar manner to TI and to offer co-op advertising allowances, advertising money, and special credit terms. (Dunn, Tr. 828; *see*, *e.g.*, RX-115, pp. 510898-511071 (first 25 records); Moore Tr. 1991-2023).

1066. The Hong Kong and Taiwanese suppliers, by contrast, rarely appear in the records, reflecting TI's perceived

. (Moore, RX-113, p. 4 (and see supra FF 806)).

and,

. (Koo, Tr. 2103; Schoenberg,. Tr. 2310). The absence of Southeast Asian suppliers in TI's meet/comp records demonstrates that, unlike the Japanese, TI

. (Rado, Tr. 1460-61, 1476).

1067. TI experienced the

. That was the same time period that

. (findings of fact 914-946, supra.).

1068. TI's total gross profits for 1979 - 1983 for its four-function calculators were as follows:

	1979	1980	1981	1982	1983
Total GP ($ millions)					

(RX-71, pp. 10124-25 (Total GP equals NSB minus for the "HH Total" category).

1069. TI's total gross profits have since 1979. (FF above).

1070. operates a chain of mass merchandise outlets in the Mid-West and West. (Rado, CX-6, pp. 11-12). Between 1981 and 1984, TI's sales of low end models to from million to , representing almost . (CX-375, p. 1).

1071. During the same period of time, of competitive low end models, most of which were manufactured . According to purchased the following volumes of IMA brand calculators during the period indicated:

7/83 - 12/83	1/84 - 10/84
units	units
(FOB HK)	(FOB HK)

(CX-552 (individual transactions summarized); <u>see</u> Schoenberg, Tr. 2274-77).

During the same period, also sold an additional from U.S. inventory valued in excess of . (CX-550, pp. 10-11; CX-551, pp. 15-16).

1072. TI's overall sales of calculators to in 1984. (Rado, Tr. 1421).

1073. TI to Hong Kong or Taiwanese-manufactured calculators between 1981 and 1984. (Rado, Tr. 1507; CX-375, p. 2).

1074. operates a chain of mass merchandise outlets on the East Coast. From 1981 to 1984, TI's sales of low-end models to from approximately . (CX-375, p. 2). The period of started in 1983 when . (Id.).

1075. purchased calculators from and in the United States as follows:

YEAR	TOTAL NUMBERS OF UNITS
1981	
1982	
1983	
1981	
1982	
1983	
1984	

(RX-152, pp. 2-3).

1076. TI low-end calculators between 1981 and 1984. (Rado, Tr. 1508; Cx-375, p. 3).

1077. TI increased its sales of low-end calculators to in 1984. (CX-375, p. 3).

1078. was distributor for calculators. terminated as a distributor, thus terminating access to calculator products. (RX-155. p. 2).

1079. In 1983, shipped to 21,180 calculators bearing the brand name "Viscount". These shipments were comprised of 14,180 units of various calculator models manufactured by Luks and 7000 of HE/TRLC-12, an 8-digit LCD horizontal credit card size calculator, manufactured by Tronica. (CX-455, p. 1).

1080. In 1982, , a Hong Kong trading company, shipped to 10,000 units of HE/LC-300A-1, an 8-digit LCD pocket size calculator, bearing the brand name "Etron." These calculators were manufactured by Luks. (CX-454, p. 1).

1081. TI calculators at to Hong Kong or Taiwanese-manufactured calculators between 1981 and 1984. (Rado, Tr. 1510, CX-375, p. 4).

1082. TI increased its sales of low-end calculators to in 1984. (CX-375, p. 4).

1083. operates a chain of mass merchandise outlets in the upper Mid-West. From 1981 through 1983, TI's sales of low-end model calculators to

. (CX-375C, p. 4).

1084. Available records indicate that started purchasing during this same time period. Most of these calculators were manufactured in by . The volume of purchased by was as follows:

7/83-12/83	1/84-10/84
units	units

(CX-552 (individual transactions summarized); <u>see</u> Schoenberg Tr., p. 2274-77.)

1085. In 1981, TI sold some $730,000 worth of low-end calculator models to , a well-known nationwide chain of drug stores. (CX-375, p. 5).

1086. TI

sells a private label calculator under the name . (Rado, Tr. 1510).

1087. In 1983, shipped to 60,328 calculators bearing the brand name . These shipments included 15,128 units of E-268, an 8 -digit horizontal mini-card size calculator manufactured by Tronica. (CX-455, p. 1; , CX-450, pp. 21-15).

1088. In 1982 shipped to 54,295 calculators bearing the brand name . The shipments included units of , an 8-digit LCD mini-card size calculator, manufactured by . (CX-454, p. 1).

1089. In 1981, shipped to 325,104 calculators bearing the brand names , "Ronica", and "Tronica". The shipments included units of , a mini-card size calculator, manufactured by and 150,000 units of HE/TR-288, a vertical credit card size calculator, manufactured by Tronica. (CX-453, p. 1).

1090. In 1980, shipped to 207,004 calculators bearing the brand names and "Tronica". These shipments included 202,000 units of HE/TR-288, a vertical credit card calculator, manufactured by Tronica. (CX-452, pp. 1-2).

1091. imported portable electronic calculators in 1983 and 1984 as follows:

<u>1983</u>

Model	Manufacturer	Units	$ (U.S)
#268 Checkbook Battery			
#E-259 Credit Card Battery			
#E-539 Solar Credit Card			

#E-257
Pocket
LCD Battery

#E-204
Solar
Pocket

<u>1984</u>

#E-259
Mini-Card
Credit Card
Battery

#E-539
Solar Credit
Card

#E-842
Ultra-thin
Credit Card

#E-805
Solar Credit
Card

#E-806
Solar
Standard
Pocket

(RX-150, Attachment A).

1092. operates a chain of mass merchandise outlets in the Southeastern United States. In 1981, TI sold almost $80,000 worth of low end model calculators to . The following year, however, purchases of such calculators from TI . Thereafter, purchased only of low-end models from Ii in 1983 and in 1984. (CX-375, p. 6).

1093. Available sales records from indicate that purchased , most of which were manufactured in by . In 1984, for example, purchased more than units of worth approximately . (CX-5521 (individual transactions summarized); CX-551, p. 12).

1094. operates a chain of drug stores in the Western United States. In 1979, TI sold more than $200,000 worth of low end model calculators to . The following two years,

. Since 1982, TI's sales of low end calculators to

.

(CX-375, p. 7).

1095. In 1982,

calculators bearing the brand names "Ronica" and "Hi-Tec". The shipments were comprised of 8,470 units of various calculator models manufactured by Tronica, and 9,700 units of HE/LC-277, an 8-digit LCD calculator, manufactured by Luks. (CX-454, p. 1; , CX-450, p. 25).

1096. In 1981, shipped to 21,384 calculators bearing the brand names and "Ronica". These shipments were comprised of 6,404 units of various calculator models manufactured by Luks, and 14,880 units of various calculator models manufactured by Tronica. (CX-453, p. 1; , CX-450, p. 26).

1097. In 1980, shipped to 14,800 units of 8-digit LCD credit calculators manufactured by Tronica. (CX-452, p. 1).

1098. From January 1980, to approximately July 1982, sold calculators supplied . (RX-153, ¶ 3).

1099. Beginning in approximately July 1982, began the development of an of calculators. From that date to the present, has developed this by the purchase of portable electronic calculators from views the purchase from one company the same as a purchase from the other company. (RX-153, ¶ 4).

2000. calculator business has from in 1981 to over in retail sales in 1984. In 1984, carried calculators and calculators. The latter represented approximately of annual sales volume. (RX-153, ¶ 6).

2001. continues to purchase calculators from TI, including four function calculators, student calculators, scientific calculators, Business Analyst calculators, and desktop printers. (RX-153, ¶ 6).

2002. purchased in order to expand the variety and price points of its calculator line, and because the packaging of the import line could be pegged on a gondola for easier customer service. (RX-153, ¶ 6).

2003. All calculators in the U.S. market are at the mature stage, although printer display and programmable scientific calculators are growth segments. (Heye, Tr. 1070-71).

2004. TI utilizes the poll to track calculator on a . The survey consists of . (CX-359; Rado, CX-6, p. 3).

2005. The . In the survey, the following: (1) ; (2) ; (3) ; and (4) . The focus of this study is on assessing trends. (CX-359, p. 504745).

2006. TI's market share in four-function calculators from . (Dolait, Tr. 674, 676).

2007. TI estimates a performance in the scientific calculator market in the United States between with some potential . (Dolait, Tr. 694).

2008. Approximately of the U.S. professional calculator market is represented by Hong Kong and Taiwan-manufactured calculators. (Dolait, Tr. 697-98).

2009. In both 1983 and 1984, sold . Compare CX-527, p. 3025 with RX-71, p. 10126 in 1983); and RX-87, p. 3 with CX-397 in 1984). Thus, for the last two years also has in basic calculators .

2010. In 1981, TI and its major Japanese competitors accounted for about of the four-function category, while the . (RX-13, p. 6777). By 1983, the combined share held by

TI and its Japanese licensees in the four-function calculator market had . The so-called of unlicensed Hong Kong and Taiwanese suppliers, , had . (RX-60 p. 12486 ("Basic Handheld")).

2011. TI forecasts for 1984 estimate that TI and its licensees will retain about of the market, with non-licensed imports keeping the remaining . (RX-60, p. 012486; RX-84, p. 4).

2012. TI has maintained its with respect to . (RX-84).

<u>Underselling by Respondents</u>

2013. During 1981 and 1982, the low end of TI's calculator line was coming under price pressure due to imports of low-priced calculators for the Far East. (Dunn, CX-611, p. 2; Sick, CX-4, p. 6; Sick, Tr. 964-65).

2014. Southeast Asian competition in 1982, excluding Japanese companies, created price pressure on low-end calculators which reflected up the line. (Sick, Tr. 958).

2015. TI was faced with lower Japanese prices in 1982 which were sometimes lowered as a result of Southeast Asian competition. (Sick, Tr. 959).

2016. The real driving force for TI's low cost strategy program in 1982 was competition from Hong Kong and Taiwanese calculator manufacturers. (Dunn, Tr. 826).

2017. In 1982, the prices of Hong Kong and Taiwanese calculators were less than the price of Japanese calculators. (Dunn, Tr. 827-28).

2018. In 1981 and 1982, the prices of some Japanese calculators were less than the prices of TI's calculators. (Dunn, Tr. 827; Sick, Tr. 960).

2019. In September 1982, TI decided to pursue calculator . (Dunn, CX-611, p. 2).

2020. Price is everything in selling the least expensive four-function calculator models and just a few cents can make the difference between being on the retail shelf or not. (Rado, CX-6, p. 13).

2021. In 1982, TI had to on various low-end models by approximately in response to being offered for IMA brand calculators. Although TI was able to retain some of the , in 1983 and 1984, IMA dropped its price even more and . (Rado, CX-6, p. 13; CX-374).

2022. TI , TI-1776, TI-1706, and TI-1006, . (Rado, Tr. 1497-48).

2023. To meet changes in low-end pricing, . TI has had to take this action to present a reasonable choice to the family consumer, who must decide whether a more limited need for additional (<u>e.g.</u>, trigonometric) key features is worth the price differential over a simpler calculator, and to meet private brand competition. (Rado, CX-6, p. 10).

2024. . (West, SX-10, pp. 75-76).

2025. Because of price pressures in the market, TI negotiated . (Dolait, Tr. 709).

in the Domestic Industry

2026. Four-function or general purpose calculators account for approximately of TI's net sales. (Dolait, Tr. 608).

2027. More than of TI's sales of scientific calculators are sales of U.S. scientific calculators. (Dolait, Tr. 609).

2028. Sales of printer display calculators account for approximately of TI's calculator revenues. (Dolait, Tr. 588).

2029. TI's objective is to meet a profit after tax return on assets; this is adequately profitable. (Heye, Tr. 1075).

2030. TI's consumer handheld calculators show . (Heye, Tr. 1075; Dolait, Tr. 777).

2031. TI's scientific calculators, business/financial calculators, programmable calculators, and printer/display calculators are . (Heye, Tr. 1075-76).

and in the Domestic Industry.

2032. In the fall of 1982, TI's Consumer Products Group focused significant . To accommodate the resource needs of these other products, TI decided to . (Sick, CX-4, p. 5).

2033. The number of TI's employees was increasing in 1982 because of the Consumer Products Division's shift to . (Sick, Tr. 960-61).

2034. The in TI's calculator-related employees between 1983 and 1984 reflects a . The number of between 1983 and 1984. (CX-320, p. 1; Heye, Tr. 1076-77).

2035. The in TI's calculator-related employees between 1983 and 1984 is not attributable to sales of Hong Kong-manufactured calculators in the United States. (Dolait, Tr. 761).

2036. In 1984, TI produced million professional calculators in is Lubbock, Texas facility. (Heye, Tr. 1000).

2037. TI's assembly facilities in Lubbock Texas, are currently operating at approximately potential capacity on a basis. (Dolait, Tr. pp. 762, 780). TI's warehouse, QC facility and overall plant space are operating at capacity and TI could expand to its present volume of calculator assembly. (Heye, Tr. pp. 1043-44).

2038. TI runs a in most of its Lubbock operations. (Heye, Tr. 1042).

2039. TI currently produces approximately calculator units per shift on . (Heye, Tr. 1042-43).

2040. When automated line equipment is installed in Lubbock, each line will be capable of producing units per shift. (Heye, Tr. 1045-46).

Respondents' Intent and Capability to Remain in the U.S. Market.

2041. At the most recent Consumer Electronics Show, held in Las Vegas in January 1985, a number of Hong Kong calculator manufacturers exhibited goods. (Rado, CX-6, p. 3; CX-553).

2042. Respondents displaying calculators at the recent CES show included: Enterprex; Nam Tai; RJP; and Tronica. (CX-553, "Official Directory").

2043. RJP advertised calculators for sale in the January 1978, July 1979, January 1980, July 1980, July 1981, July 1982, January 1983, May 1983, July 1983, January 1984, March 1984, July 1984, November 1984 and January 1985 issues of Asian Sources Electronics magazine. (CX-507; CX-509 - CX-511; CX-513; CX-515 - CX-523).

2044. Luks advertised calculators for sale in the January 1978, July 1978, July 1979, January 1980, July 1980, January 1981, July 1981, July 1982, January 1983, May 1983, July 1983, January 1984, March 1984 and November 1984 issues of Asian Sources Electronics magazine. (CX-507 - CX-513; CX-515 - CX-520; CX-522).

2045. Voesa advertised calculators for sale in the July 1978, July 1979, January 1980, July 1980, January 1981, July 1981, July 1982, January 1983, May 1983, July 1983, March 1984, July 1984, November 1984 and January 1985 issues of Asian Sources Electronics magazine. (CX-508 - CX-513; CX-515 - CX-518, CX-520 - CX-523).

2046. Tronica advertised calculators for sale in the July 1979, July 1980, January 1981, July 1981, January 1982, July 1982, May 1983, March 1984, July 1984, November 1984 and January 1985 issues of Asian Sources Electronics magazine. (CX-509; CX-511 - CX-515, CX-517; CX-520 - CX-523).

2047. General Electronics advertised calculators for sale in the July 1979, January 1980, January 1982, May 1983, March 1984, July 1984, November 1984 and January 1985 issues of Asian Sources Electronics magazine. (CX-509 - CX-510; CX-514; CX-517; CX-520 - CX-523).

2048. Success advertised calculators for sale in the July 1979, January 1980, July 1980, January 1981, July 1981, January 1982, January 1983, May 1983, July 1983, January 1984, March 1984, July 1984 and November 1984 issues of Asian Sources Electronics magazine. (CX-509 - CX-514; CX-516 - CX-522).

2049. Far East United Electronics advertised calculators for sale in the July 1982, January 1983, May 1983, July 1983, January 1984, March 1984 and July 1984 issues of Asian Sources Electronics magazine. (CX-515 - CX-521).

2050. FLX advertised calculators for sale in the January 1983, May 1983, July 1983, January 1984, March 1984, July 1984, November 1984 and January 1985 issues of Asian Sources Electronics magazine. (CX-516 - CX-523).

2051. Dah Sun advertised calculators for sale in the January 1983, May 1983, July 1983, March 1984, July 1984, November 1984 and January 1985 issues of Asian Sources Electronics magazine. (CX-516 - CX-518; CX-520 - CX-523).

2052. Hua Chang advertised calculators for sale in the January 1983, May 1983, July 1983, January 1984, March 1984, July 1984, November 1984 and January 1985 issues of Asian Sources Electronics magazine. (CX-516 -CX-523).

2053. Mino advertised calculators for sale in the May 1983, July 1983, January 1984, March 1984, July 1984, November 1984 and January 1985 issues of Asian Sources Electronics magazine. (Cx-517- Cx-523).

2054. MBO advertised calculators for sale in the January 1984 and March 1984 issues of Asian Sources Electronics magazine. (CX-519 and CX-520).

2055. Nam Tai advertised calculators for sale in the July 1978, January 1980, January 1981, July 1981, January 1982, July 1982, January 1983, May 1983 July 1983, January 1984, March 1984, July 1984 and November 1984 issues of Asian Sources Electronics magazine. (CX-508; CX-510; CX-512 - CX-522).

2056. In other consumer electronic products, such as television and xerography, market entry began at the low segment and there was an evolution to more sophisticated products. (Finan, Tr. 2506-07).

2057. TI offered the basic handheld calculator and a limited scientific calculator when it began selling calculators in the United States. (Rado, Tr. 1464).

2058. Hewlett-Packard

. (Erni, SX-9, p. 110).

2059. Assembly lines which produce simple calculators can also be used to produce more sophisticated calculators. (Erni, SX-9, p. 111).

2060. Nam Tai set up its calculator manufacturing operation

. (Koo, CX-402, pp. 41-43).

2061. Calculator manufacturers from Hong Kong and Taiwan initially concentrated on the low end of the market while seeking a foothold to expand their lines into more sophisticated calculator models. (Rado, CX-6, pp. 6-7).

2062. Hong Kong and Taiwan calculator manufacturers represent a greater threat in scientific calculators today than two or three years ago. (Dolait, Tr. 717-18).

2063. There were many more calculator manufacturers in Hong Kong in 1984 than there were in 1981 in addition to increased competition from Korea, Japan and Taiwan. (Chan, CX-40, pp. 16-17).

2064. There are no significant barriers to potential entry of unlicensed importers into the scientific segment of the U.S. calculator market. (Finan. CX-7, p. 29).

<u>TI's plan:</u>

2065. In late 1982, TI made a corporate decision to investment in its business and to its resources

. (RX-16 p. 50570; RX-17, p. 5255).

2066. To implement this decision the Consumer Products Group decided to in order to , especially , for the production of . (Dunn, Tr. 807-09).

2067. When TI chose , it was prompted by . The growth in the and TI's prompted the move overseas. TI did not . The was taking a . Therefore, TI . (Dunn, Tr. 807 - 815).

2068. In 1982, TI estimated that from 1981-82 on a worldwide basis the market for would grow by while the market for would . In the same document, TI projected that from 1981-82, its U.S. market share for calculators would grow by while its market share from would grow by . (RX-11, p. 12864).

<u>High End Importation and Capacity to Import:</u>

2069. Respondent Nam Tai has invested in developing models. According to the September 1984 Monthly Meeting Report of the Nam Tai R&D Department, of the models then under investigation were units. By contrast, of the new model were one was and one was a unit. (CX-410, p. 3).

2070. Nam Tai has developed and produced a programmable model, the P-201 (CPX-209), and (CX-410, p. 3). The instruction manual for the P-201 is in English. (CPX-209).

2071. TI's least expensive programmable model, the TI-55-II, is currently sold a a distributor price of $27.08. (CX-364, January-June 1985 "Distributor Price List"). In comparison, Nam Tai offered its programmable P-201 model at the Las Vegas CES for only $10.50. (CX-553, Nam Tai single sheet price list).

2072. TI's current distributor prices (CX-364) for its four least expensive scientific models are as follows:

TI-30-III	TI-30SLR	TI-35-II	TI-35 SOLAR
$8.79	$11.40	$13.30	$16.39

At the recent Las Vegas CES convention, Nam Tai offered five separate scientific models prices as follows (CX-553):

LC-1239	LC-1006S	LC-1002S	LC-1004S	LC1007S
$5.80	$6.20	$6.30	$6.30	$6.40

2073. Nam Tai's production facilities can be readily utilized for

. (Hon, CX-402, pp. 110-11).

2074.

, made an initial purchase of calculators from in October of 1983. The 1983 purchases sold well, so doubled its purchases for the 1984 Christmas season. retailer customers include major drug store chains and department stores. (CX-479, pp. 2, 7).

2075. Besides Nam Tai, a number of other Hong Kong and Taiwanese firms have begun to solicit sales of scientific, business-oriented and programmable calculators in the Unites States. See, e.g., Quartz 1984-85 Catalog distributed at January, 1985 Las Vegas CES, p. 6 (contained in CX-553); Qualitron Sterling Corp. solicitation materials (CX-490), pp. 6-9 (scientific and advanced scientific models); Specter Catalog, (CX-499), p. 5 (scientific model).

2076. TI does not claim that it has suffered substantial lost sales of professional model calculators due to unlicensed imports in the past. (Complainant's Response to Respondents Proposed Economic findings, p. 36, contained in Complainant's Factual Rebuttal and Rebuttal Findings of Fact).

2077. In the past, TI's most significant competitors in the sale of professional calculators have been . As Mr. Dolait made clear, however, private label professional calculators now account for about of the market. (Id; Dolait, Tr. 698, 717-18).

2078. In a TI document prepared by TI's marketing department in the last quarter of 1984, TI, and it licensees, , are forecasted to share of the sliderule (scientific) calculator market in 1984 and in 1985. While critical of this document's projections for the handheld segment, Mr. Dolait vouched at the hearing for its accuracy in the scientific segment within 2-4 percentage points. The same document projects TI and Hewlett-Packard sharing of the financial (business) calculator market in 1984, and Hewlett-Packard, TI and Sharp controlling in 1985. (RX-84; Dolait, Tr. 693-95).

2079. TI's U.S. sales of portable four-function and professional calculators for 1979 - 1983 are as follows:

	1979	1980	1981	1982	1983
$ (Million)					
Units (million)					

(RX-71, pp. 10124,10126 (sales revenues ("NSB") and units ("NUB") for the combined "Prof To" and "HH Totl" categories)).

2080. TI's average unit price for its portable four-function and professional calculators for 1979-1983 is as follows:

	1979	1980	1981	1982	1983
AUP					

(average unit price ("AUP") equals sales revenues ("NSB") divided by units ("NUB"); (FF 2079).

CONCLUSIONS OF LAW

1. Each of claims 1, 2, 6, 7, 30, 37, 41 and 53 of Letters Patent No. 3,819,921 (the '921 patent) is not invalid under 35 U.S.C. §§ 103 and 112.

2. Each of claims 1, 2, 6, 7, 30, 37, 41 and 53 has not been infringed by any of respondents APF, Cosmo, Dah Sun, Enterprex, Far East, Fordstech, General Electronics, Hua Chang, Integrated Display, IMA, Luks, MBO, Mino, Nam Tai, Promoters, Success, Tronica and Voesa.

3. Assuming infringement has been established by TI, on the record before the Administrative Law Judge there has been no release by TI of any respondent from certain claims of infringement nor does any respondent have an implied license from TI under the '921 patent.

4. Because complainant does not produce calculators in accordance with the claims in issue of the '921 patent, no domestic industry exists.

5. Importation of the accused portable electronic calculators has not substantially injured a domestic industry.

6. Because there exists no domestic industry and no infringement of the '921 patent, importation of the accused portable electronic calculators does not have the tendency to substantially injure a domestic industry.

7. There is no violation of Section 337 of the Tariff Act of 1930, as amended. 19 U.S.C. § 1337.

8. If a domestic industry existed, and if the accused calculators of the hearing respondents infringed, and if certain other accused calculators which met a TI infringement test (see supra., pp. 41-44) infringed:

1) the domestic industry would consist of complainant's domestic operations devoted to product development and qualification, quality control, skinwrapping, manual and packaging design and repair and replacement activities associated with complainants' four-function and professional portable electronic calculators produced in accordance with the claims in issue of the '921 patent as well as complainants' domestic assembly operations devoted to its professional portable electronic calculators produced in accordance with the claims in issue of the '921 patent as well as complainants' domestic assembly operations devoted to its professional portable electronic calculators produced in accordance with the claims in issue of the '921 patent; 2) the domestic industry would be efficiently and economically operated; 3) importation of the aforementioned infringing portable electronic calculators would not have the effect of substantially injuring the domestic industry; 4) importation of the aforementioned infringing portable electronic calculators would have the tendency to substantially injure the domestic industry; 5) there would be a violation of Section 337 by the following respondents: Nam Tai, IMA, Enterprex, Hua Chang, Integrated Display, MBO, Promoters, Luks, General Electronics, Cosmo, Tronica, and Dah Sun.

INITIAL DETERMINATION AND ORDER

Based on the foregoing findings of fact, conclusions of law, the opinion and the record as a whole, and having considered all of the pleadings and arguments presented orally and in briefs, as well as proposed findings of fact and conclusions of law, it is the Administrative Law Judge's DETERMINATION that there is no violation of Section 337 in the unauthorized importation and sale in the United States of America of the accused portable electronic calculators.

The Administrative Law Judge hereby CERTIFIES to the Commission the Initial Determination, together with the record of the hearing in this investigation consisting of the following:

1. The transcript of the hearing, with appropriate corrections as may hereafter be ordered by the Administrative Law Judge; and

2. The Exhibits accepted into evidence in the course of the hearing.

The pleadings of the parties are not certified, since they are already in the Commission's possession in accordance with Commission Rules of Practice and Procedure.

Further, it is ORDERED that:

1. In accordance with Rule 210.44(b), all material heretofore marked _in camera_ because of business, financial, and marketing data found by the Administrative Law Judge to be cognizable as confidential business information under Rule 201.6(a), is to be given five years _in camera_ treatment from the date this investigation is terminated; and further

2. The Secretary shall serve a copy of the public version of this Initial Determination upon all parties of record and the confidential version upon all counsel of record who are signatories to the protective order issued by the Administrative Law Judge in this investigation; and further

3. This Initial Determination shall become the determination of the Commission forty-five (45) days after the service thereof, unless the Commission, within forty-five (45) days after the date of filing of the Initial Determination shall have ordered review of the Initial Determination or certain issues therein pursuant to 19 C.F.R. 210(b) or 210.55 or by order shall have changed the effective date of the Initial Determination.

Paul J. Luckern

Paul J. Luckern
Administrative Law Judge

Issued: April 18, 1985

CERTIFICATE OF SERVICE

I, Kenneth R. Mason, hereby certify that the attached Errata was served upon Denise T. DiPersio, Esq., and upon the following parties via first class mail, and air mail where necessary, on May 9, 1985.

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